

THE AVOCADO FRUIT BORER, *Stenoma catenifer* (WALS.) (LEPIDOPTERA: ELACHISTIDAE): EGG AND DAMAGE DISTRIBUTION AND PARASITISM¹

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ABSTRACT - The avocado fruit borer, *Stenoma catenifer* (Wals.) has been a limiting factor in growing avocados over the last years in many Brazilian states. This is a result of the lack of safe and feasible management practices to minimize the fruit borer damage. The aim of this study was to obtain information on the pest biology and ecology as well as on the role of natural enemies to define strategies to control the pest. Samples were taken biweekly and consisted of 20 fruits collected randomly (10 from the upper half and 10 from the lower half of the plant) in ten plants, cv. Margarida, in a commercial avocado grove in Arapongas and Cambé regions, PR, from October/2001 to September/2002. Laboratory determinations of the percentage of damaged fruit per plant region, location and number of bored fruit sites, and the number and location of the fruit borer eggs, including parasitized ones, were performed. The results showed that *S. catenifer* preferred to oviposit and attack fruits located on the upper half of the trees. The majority of the eggs were laid on the fruit pedicel whereas the damage was mainly located on the lower half of the fruits. Trichogrammatids were the most constant and abundant parasitoids found in both localities throughout the study period.

Index terms: Insecta, ecology, biological control, *Persea americana*.

A BROCA-DO-ABACATE, *Stenoma catenifer* (WALS.) (LEPIDOPTERA: ELACHISTIDAE): DISTRIBUIÇÃO DE OVOS E DE DANOS E PARASITISMO

RESUMO - A broca-do-abacate, *Stenoma catenifer* (Lepidoptera: Elachistidae), continua sendo fator limitante para o cultivo do abacate em vários estados do Brasil, nos últimos anos. Isso se deve a falta de métodos seguros e viáveis para reduzir os prejuízos causados pela praga. Com o intuito de obter informações sobre a sua bioecologia e ação de inimigos naturais, para auxiliar na elaboração de estratégias de controle, realizaram-se coletas quinzenais de 20 frutos ao acaso (10 da metade superior e 10 da metade inferior) em 10 plantas, em pomar comercial, cv. Margarida, nos municípios de Arapongas e Cambé, PR, durante os meses de outubro/2001 a setembro/2002. Em laboratório determinaram-se a porcentagem de frutos atacados por estrato da planta, local e número de orifícios de penetração da broca e o número e local das posturas nos frutos, incluindo ovos parasitados. Ficou evidenciada uma preferência para oviposição, e consequentemente de ataque, de *S. catenifer* pelo estrato superior das plantas nas duas localidades. Apesar de o local preferido para postura ser o pedúnculo, a maioria dos danos concentrou-se na parte inferior dos frutos. Parasitóides da família Trichogrammatidae foram constantes e abundantes em ambos pomares durante o período em que se realizou o estudo.

Termos para indexação: Insecta, ecologia, controle biológico, *Persea americana*.

INTRODUCTION

The unavailability of feasible and safe management practices to control the avocado fruit borer, *Stenoma catenifer* (Lepidoptera: Elachistidae), have maintained the avocado production at a high risk in the State of Parana, and in various other states of Brazil in the last years.

The adult is a small moth measuring approximately 1.5 cm in length, with yellowish color and typical "S" shaped dark dots on the front wings. The larva is purple and feeds on the fruit pulp opening galleries that reach the avocado fruit seed.

As *S. catenifer* lays its eggs directly on the fruit control strategies must be applied during a short interval to be effective, i.e., from the time the egg hatches to the time the first instar larva bores into the fruit. Despite the severe losses caused by *S. catenifer* over the years, there is still need for basic studies on the spatial and seasonal distribution of eggs and injuries, and on the role of natural enemies as a pest control factor. Thus, in this study we seek to improve our understanding on the biology and ecology of the avocado fruit borer as to improve insect monitoring and the application of control measures. Besides, we evaluate the possibility of using egg parasitoids as a key component within an IPM program for *S. catenifer*. Trichogrammatids are common natural control agents associated to the avocado fruit borer in the State of Parana (Hohmann & Meneguim, 1993; Hohmann et al., 2000; Hohmann et al., 2001).

MATERIAL AND METHODS

The study was conducted in commercial avocado orchards,

cv. Margarida, in Arapongas and Cambé regions, Parana, Brazil, from October 2001 to September 2002. Random samples were collected biweekly in a two-hectare plot and consisted of 20 fruits, ten from the upper half and ten from the lower half of the plant. In both orchards, plants were 10 years old Arapongas plants were 5 m high while cambé's were 10 m high. The distance between trees was 10 x 10 m in Arapongas and 10 x 15 m in Cambé, respectively. The orchard was sprayed with pyrethroids four times in Arapongas, and one time in Cambé to control the avocado fruit borer.

The samples were taken to the Laboratorio de Entomologia, Instituto Agronomico do Parana - IAPAR where the percentage of damaged fruit per plant region, location and the number penetration holes, and the number and location of *S. catenifer* eggs, including parasitized eggs, were determined. Parasitized eggs were individually placed inside gelatine capsules and maintained under controlled conditions (26±1°C, 60±10% RH, and complete darkness). After emergence, adults were sent to Ranyse Querino and Roberto A. Zucchi, Departamento de Entomologia, Fitopatologia e Zoologia Agrícola, Escola de Agricultura Luiz de Queiroz/USP and to John D. Pinto, Department of Entomology, University of California Riverside to be identified.

RESULTS AND DISCUSSION

Distribution of *S. catenifer* eggs and damage

Arapongas

The number of eggs laid by *S. catenifer* as well as the percentage of fruits attacked by the larvae showed a rapid increase

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with time. Injured fruits reached high values in the early stages, 40% in January, and exceeded 50% in June (Figure 1). Although the losses increased with time it is not possible to visualize the increments in damage along the crop season in Figure 1. The premature dropping of infested fruits increased the number of healthy fruits in the orchard, thus biasing the number of healthy fruits in the subsequent samplings.

The analysis of the spatial distribution of eggs and pest attack on the avocado tree revealed that 66% of the eggs and 56% of the damage were present on fruits located on the upper half of the tree (Figures 2A and 2B). The preferred site for oviposition was the pedicel (58%) (Figure 3A). Despite the moth preference to lay its eggs on the fruit the majority (82%) of the *S. catenifer* larvae holes was located on the lower half of the fruit (Figure 3B).

Cambé

The increments in the number of eggs laid by *S. catenifer* in the Cambé were smaller than that observed in Arapongas, possibly as result of the most efficient pest control program undertaken in Cambé during the previous season (2000/01). A direct and positive relationship was found between the number of eggs laid and percentage of fruits injured was found, especially until June, when 32% of the sampled fruits were damaged (Figure 4). In the following months (Jul-Aug) there was also a premature dropping of attacked fruits therefore decreasing the percentage of damaged fruits. However, in September more than 40% of the fruits sampled were attacked (Figure 4).

Similarly to the results obtained in Arapongas, most of the eggs (81%) and the damage (72%) were present on fruits located on the upper half of the avocado trees in Cambé (Figures 5A and 5B). The preferred site for oviposition on the fruit was also the pedicel (50%) (Figure 6A). As with samples from Arapongas, the majority of the attack occurred on the lower half of the fruit (Figure 6B).

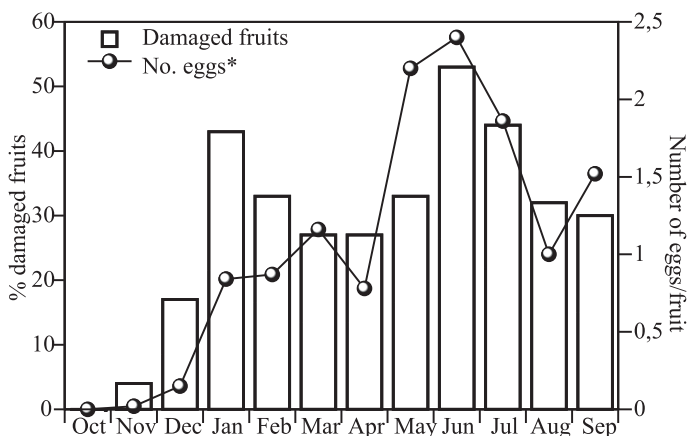


FIGURE 1 - Percentage of damaged avocado fruits and number of *Stenoma catenifer* eggs/fruit (n = 400 fruits/mo.). Arapongas, PR, Oct/2001 - Sep/2002. *sum of unhatched, hatched, and parasitized eggs.

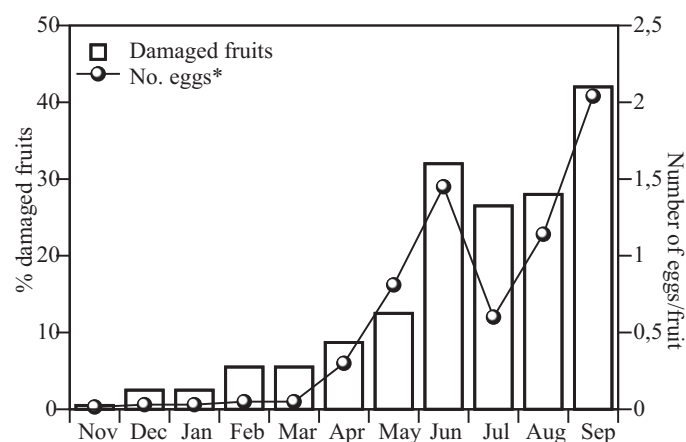


FIGURE 4 - Percentage of damaged avocado fruits and number of *Stenoma catenifer* eggs/fruit (n = 400 fruits/mo.). Cambé, PR, Oct/2001 - Sep/2002. *sum of unhatched, hatched, and parasitized eggs.

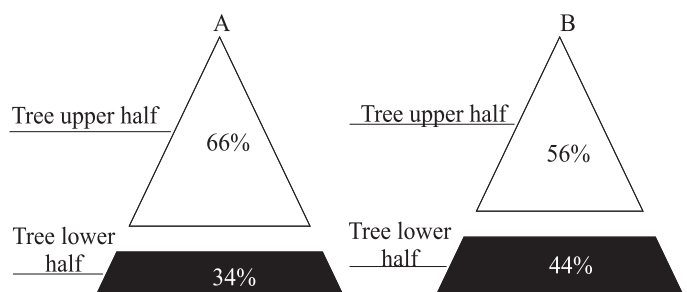


FIGURE 2 - Distribution of *Stenoma catenifer* eggs (A) and damage (B) caused by larvae on avocado fruits located on different parts of the tree. Arapongas, PR, Oct/2001 - Sep/2002.

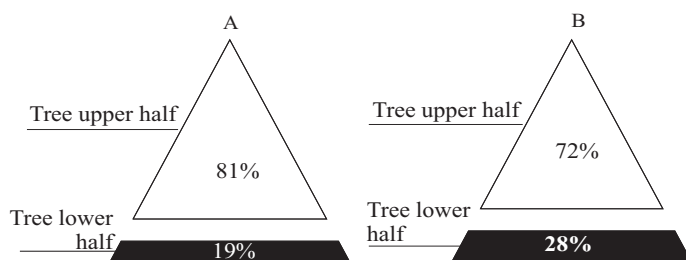


FIGURE 5 - Distribution of *Stenoma catenifer* eggs (A) and damage (B) caused by larvae on avocado fruits located on different parts of the tree. Cambé, PR, Oct/2001 - Sep/2002.

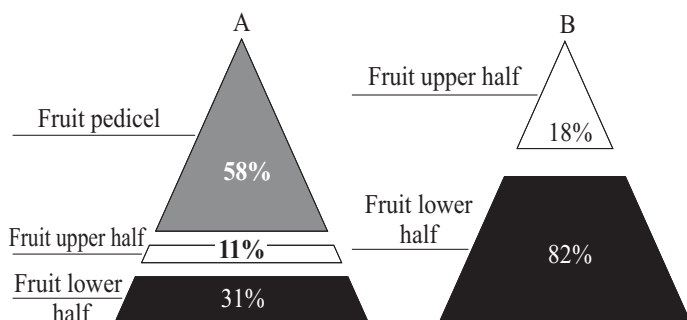


FIGURE 3 - Distribution of *Stenoma catenifer* eggs (A) and damage (B) caused by larvae on different avocado fruit parts. Arapongas, PR, Oct/2001 - Sep/2002.

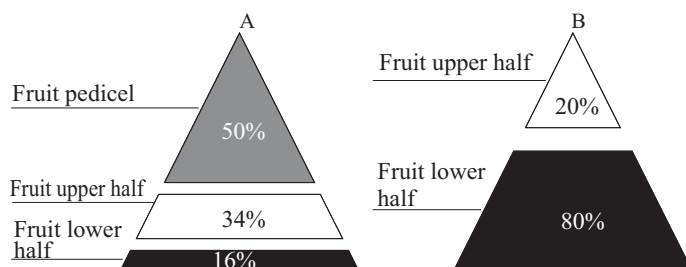


FIGURE 6 - Distribution of *Stenoma catenifer* eggs (A) and damage (B) caused by larvae on different avocado fruit parts. Cambé, PR, Oct/2001 - Sep/2002.

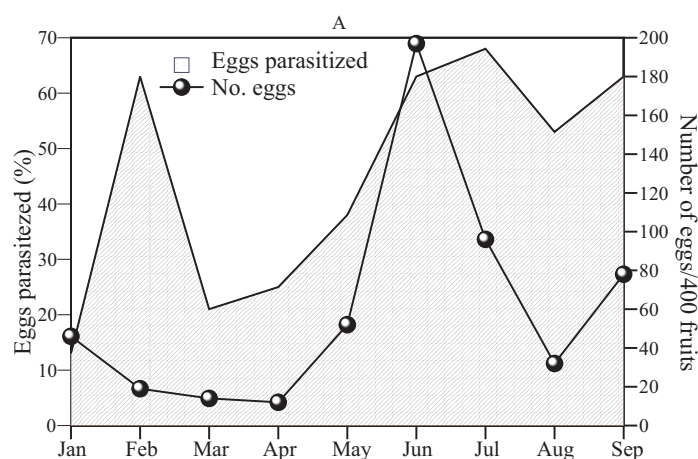
This preference for laying eggs on the fruit pedicel reported in this study was not confirmed by Jaramillo et al. (1972) in Mexico or by Martinez and Godoy (1986) in Venezuela. According to the authors the *S. catenifer* eggs were evenly distributed on the fruit epidermis with few eggs being laid on the fruit pedicel.

Natural Enemies

Various groups of natural enemies of the avocado fruit borer were detected in orchards located in Arapongas and Cambe, including parasitoids in the family Ichneumonidae, possibly *Eudeleboea costanetoi* Blanchard and Braconidae, near *Apanteles desantisi* Blanchard (Hohmann et al. 2001), and entomophagous nematodes, all collected from *S. catenifer* larvae. However, the most frequent and abundant biological control agents found in the two localities were egg parasitoids of the family Trichogrammatidae, namely *Trichogramma pretiosum* Riley, *Trichogramma bruni* Nagaraja and *Trichogrammatoidea annulata* De Santis. The latter was the most common egg parasitoid species found in the studied areas (C.L.H., pers. obs.).

Although the egg parasitoid population densities have reached relatively high levels, over 60%, during certain months in Arapongas and Cambe (Figures 7A and 7B), parasitism rates were not sufficiently high to avoid severe yield losses.

The highest percentage of eggs parasitized was found on upper half of the avocado tree. However, this probably was not a preference of the female wasp to parasitize eggs in that plant stratum, but a consequence of the higher number of eggs laid by the *S. catenifer* female on that plant region (Figures 2A and 5A).



The study allows us to understand the evolution of the avocado fruit borer attack over the crop season, and to determine its preferred site for oviposition and attack in commercial avocado orchards in Northern Parana. The existence of an interval between egg hatching and first instar larva penetration inside the fruit – eggs are laid mostly on the pedicel and larvae prefer to attack the lower half of the fruits - is significant to put in practice control measures, either contact insecticides or biological agents. Flint and van den Bosch (1981) emphasized the importance of determining the most susceptible stage of the target insect before chemical control is undertaken. The outcome of this work may improve both pest monitoring and the application of control procedures.

Although the egg parasitoid populations were not high enough to keep the pest under economic injury levels, they have been frequent, constant and eventually abundant over the years in the northern Parana (Hohmann and Meneguim, 1993; Hohmann et al., 2001; this study). These attributes, added to the greater stability of the agro ecosystem in which the avocados take part, are strong indicators of the great potential of mass released Trichogrammatids in controlling the avocado fruit borer. Historically, the majority of the successful cases in biological control were in crops that persist in the field for more than one year (Stehr, 1982).

In order to achieve our goal, studies are under way aiming to select the most promising line of egg parasitoid to initiate a mass release program in organic orchards in the State of Parana. The equilibrium of the environment in this system may help to improve the chances of the biological control agent.

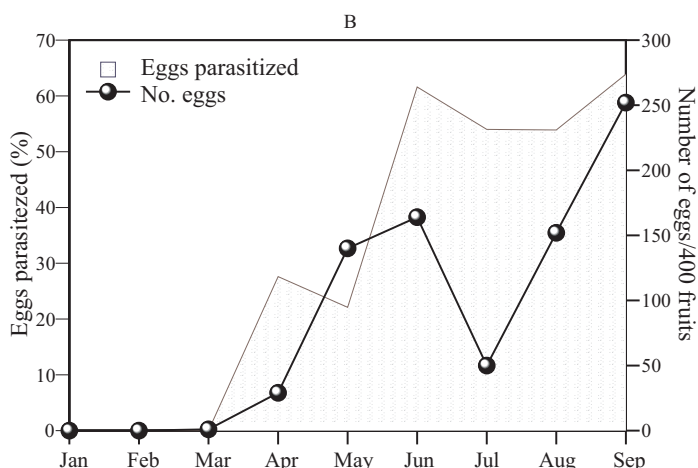


FIGURE 7 - Percentage of parasitism by Trichogrammatids and number of *Stenoma catenifer* eggs/400 avocado fruits. Arapongas (A) and Cambe (B), PR, Jan - Sep/2002.

CONCLUSIONS

- 1) There is a preference of *S. catenifer* to oviposit and consequently to attack fruits located in the upper stratum of the avocado trees.
- 2) The majority of the *S. catenifer* eggs are allocated on the fruit pedicel.
- 3) The majority of the injury is concentrated on the lower half of the fruit.
- 4) Egg parasitoids in the family Trichogrammatidae show potential to be mass released to control *S. catenifer*.

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