

Biology and control of the *Annona* fruit borer *Cerconota anonella* (Lepidoptera: Oecophoridae).

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**BIOLOGY AND CONTROL OF THE ANNONA FRUIT BORER,
CERCONOTA ANONELLA LEPIDOPTERA : OECOPHORIDAE).**

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Fruits, Jan.-Feb. 1992, vol. 47, n° 1, p. 81-84

ABSTRACT - Biological studies were conducted on the moth *Cerconota anonella* Sepp. (Lep:Oecophoridae) a fruit borer of *Annona* spp. Mean developmental time from egg to adult was 36.43d at 21±2°C. Total number of progeny produced was 11.14 - 27.5 individuals per female when 5% honey in water was provided daily. Mean adult longevity was not significantly different for both sexes (5d). Preliminary results from biological and chemical control experiments are discussed.

**BIOLOGIE ET CONTROLE D'UN INSECTE DES FRUITS
DU GENRE ANNONA, CERCONOTA ANONELLA
(LEPIDOPTERE : OECOPHORIDAE).**

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RESUME - On a entrepris des études de biologie sur le papillon *Cerconota anonella* Sepp. (Lépidoptère : Oecophoridae) un ravageur des fruits d'Annona. La durée moyenne du cycle de l'oeuf à l'état adulte a été de 36,4 jours à une température de 21°C plus ou moins 2 degrés. Le nombre total de descendants produits allait de 11,1 à 27,5 individus par femelle lorsque l'on ajoutait journallement à l'eau 5 p. 100 de miel. On n'a pas noté de différences significatives entre les deux sexes, pour la longévité. Présentation et discussion des résultats préliminaires d'essais de luttes chimique et biologique.

INTRODUCTION

The genus *Annona* as known today consists of more than 110 species. Edible species native to tropical and subtropical America include *Annona muricata* L., (soursop), *A. squamosa* L., (sugar apple), *A. cherimola* L., (cherimoya), and *A. reticulata* L., (custard apple), (Safford, 1914; Noonan, 1954; Schroeder, 1970; Fouque, 1972; Falcao *et al.*, 1982; George and Nissen, 1985). While progress has been made in developing these fruit crops, in Tropical America and the Caribbean Region, an integrated pest management program has not been implemented in the Neotropics.

Two key pests attack *Annona* in tropical America and the Caribbean. One key pest consists of a complex of different species of *Bephratelloides* spp. (Hymenoptera: Eurytomidae) which are stenophagous, multivoltine Annona-seed feeders that commonly occur in damaging numbers in

South and Central America, the Caribbean, and southern Florida (Peña *et al.*, 1984; Brunner and Acuña, 1967; Brussel and Wiedjik, 1975). Another key pest is the *Annona* fruit borer *Cerconota anonella* Sepp. (Lepidoptera: Oecophoridae; Stenommatinae). This species is recorded from northern South America, Ecuador, Central America and the Caribbean (Fennah, 1937; Martinez and Godoy, 1983; Laurence, 1974; Zenner and Saldarriaga, 1969; Gutierrez and Trochez, 1977). This stenophagous insect damages the fruit epidermis, pulp and seeds (Fennah, 1937). The same author provided what little information exists on the species biology and morphology of this species. In those studies, little specific information was reported concerning adult and larval biology. Therefore, we investigated the immature development of *C. anonella* and the adult biology at constant temperature. Adult fecundity and longevity in the laboratory were also determined. In addition, preliminary studies on biological, chemical and cultural control were conducted.

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MATERIAL AND METHODS

Biology.

A laboratory colony of *C. anonella* was initiated in 1989 with larvae and pupae collected from *A. muricata* fruits found in an orchard in Bello, Antioquia, Colombia. Five days after the pupal stage was formed, insects were sexed and placed in containers until moth emergence. Adult moths (5 ♂s and 5 ♀s) were confined in one-gallon glass oviposition jars with pieces of fruit. Once eggs hatched, larvae were reared individually in a petri dish and fed small pieces of soursop fruit. Food was changed as required. Data were daily collected on oviposition, number of instars of each stage, head-capsule width, developmental time, and sex ratio.

Adult longevity was observed in moths fed with a 5% solution of honey-water, water only, and a check (no food). To determine sexual response, Pherocon 4 C traps (n = 30) individually baited with *C. anonella* virgin females were evenly distributed in a soursop orchard located in Santa Barbara, Antioquia, Colombia. Traps were positioned on the tree at approximately 1.5 m above the surface. Traps were inspected weakly from March to May 1989 and number of moths captured recorded.

Biological control.

Larval Parasite Survey. Sampling for parasites of *C. anonella* consisted of collections of fruits of *A. muricata* (n = 82), *A. reticulata* (n = 22), *A. montana* (n = 8) and *A. cherimola* (n = 102) in Palmira, Colombia, and in Quevedo and Guayabamba, Ecuador, during March and May 1987. Samples were placed in plastic bags and transported to the laboratory, where they were placed in glass containers and observed daily for parasite emergence.

Egg Parasitism. *C. anonella* infested soursops were collected in Antioquia, Colombia, during 1989. Fruits were individually placed in cubical screen cages (45 cm), for adult emergence. Five newly emerged males and females were placed in glass containers with portions of soursop as ovipositional substrate. Adults were fed a aqueous solution with 5% honey. Newly oviposited eggs (n = 100) were removed and exposed for 24 hours to parasites of the genera *Trichogramma exiguum* Pinto y Platner (n = 40) and *Telenomus* sp., (n = 40). Number of eggs parasitized, sex, and parasite longevity were evaluated during 20 days following exposure. To determine egg parasitism under field conditions, newly oviposited *C. anonella* eggs (n = 200) were placed in *A. muricata* trees. Thereafter, approximately 500 *Trichogramma exiguum* and 600 *Telenomus* sp., were released near the egg-infested trees.

Chemical and cultural control.

The effect of different types of protective bags and insecticides were tested in 3-5 year-old *A. muricata* trees, from October, 1988, through May, 1989. Approximately 10 small fruits (4 cm in diam.) were selected per tree. Treatments were : (1) fruits covered by plastic bags (60 x 40 cm) opened at one end and treated with chlorpyrifos (1.0%), (2) fruits covered by bags (60 x 40 cm) closed at

both ends, (3) carbaryl (80% WP) and mancozeb (Dithane M-45) (2.5 g/l) applied to fruits and (4) untreated fruits. Each treatment was applied to 40 fruits. The treated fruit attacked by *C. anonella* was analyzed and compared with number of untreated fruits, using analysis of variance and Duncan's multiple range test (P = 0.01) was used to separate treatment means.

RESULTS AND DISCUSSION

Biology.

The effect of food on adult longevity was significantly different when compared with individuals that received no food (Table 1). More eggs were obtained when moths were fed, however the low yield of 11.1 to 27.5 eggs/female in the laboratory indicated that these conditions are not the optimal for egg deposition (Table 2). According to Boggs (1987), certain species of Lepidoptera with few or less than optimal feeding will have a decline in fecundity. The effect of nutrition on *C. anonella* merits further investigation. Total life cycle from egg to adult emergence averaged 36.4 days (Table 3). This insect undergoes five instars, and larval duration was 18.56 at a room temperature (21°C ± 2°C). In the field where temperatures are higher, a shorter developmental period is expected. Table 4 lists the 5 instar model which best fit the head capsule width data according to Dyar's rule (Dyar, 1890).

Preliminary observations showed that males are attracted to virgin females placed in cardboard traps ; in 45% of the traps tested, male capture was obtained. We also observed that adults were attracted to black-light traps. These observations could be useful in monitoring populations of *C. anonella*.

Biological control.

Larval parasitism. All *Annona* species except *A. cherimola* were infested by *C. anonella*. Two braconid parasites were identified as natural enemies of *C. anonella* larvae in Colombia and Ecuador. *Apanteles* sp. and an unknown genus of the subfamily Rogadinae were the only parasites emerging from *C. anonella*. Parasitism by *Apanteles* ranged from 2-5% in Colombia and 2% in Ecuador. The Rogadinae species was recorded for the first time from *C. anonella* and was only recovered from Palmira, Colombia. These results are in contrast with the high parasitism levels from other braconid species observed in Venezuela by Martinez and Godoy (1983).

Egg parasitism.

T. exiguum was the only parasite of *C. anonella* eggs under laboratory conditions. Neither parasite parasitized eggs in the field. In the laboratory, 72% of the eggs were parasitized by *T. exiguum*. Only 56% of adult parasites emerged. When unhatched eggs were dissected, embryos of parasites were observed. A sex ratio of 23:1 (female: male) was obtained. Adult parasite longevity was 23.2 days with a developmental time of 29.4 days. Under confined conditions, *T. exiguum* does not discriminate insect egg species (Flanders, 1930 ; Sweetman, 1958), which may explain

TABLE 1 - Effect of three diets on *C. anonella* adult longevity under laboratory conditions ($21 \pm 2^\circ\text{C}$; 60-90% RH).

Diet	n	Average days \pm SD	
		female	male
Honey (5%)+ water	100	4.9 a \pm 0.89	4.9 a \pm 0.93
Water	32	4.4 a \pm 1.23	4.2 ab \pm 1.10
No food	35	3.1 b \pm 1.04	3.3 b \pm 1.32

* Means in a column followed by the same letter are not significantly different (P 0.05 ; Duncan's multiple range test).

TABLE 2 - Reproductive development, longevity, oviposition and fecundity of *C. anonella* under different sex ratio ($21 \pm 2^\circ\text{C}$; 60-90% RH).

Females n	Females: Male	Preoviposition Period (d)	Oviposition Period (d)	Longevity x \pm SD (d)	Egg/female x \pm SD
4	1:0	1	3	5.24 \pm 1.29	15.50 \pm 4.63
4	0.8:1	2	3	6.25 \pm 1.70	20.00 \pm 5.25
14	1.75:1	1	5	8.14 \pm 1.79	12.85 \pm 3.84
7	1.16:1	1	4	6.00 \pm 1.63	11.14 \pm 6.35
4	0.57:1	1	6	8.25 \pm 1.71	27.50 \pm 6.65

TABLE 3 - Duration of life stages of *C. anonella* reared under laboratory conditions ($21 \pm 2^\circ\text{C}$; 60-90% RH).

Stage	n	Mean \pm SD Duration (days)	Range
Egg	83	7.37 \pm 0.933	6-8
Larva			
I	56	3.0 \pm 0.38	2-4
II	43	2.7 \pm 0.45	2-3
III	42	2.6 \pm 0.72	2-4
IV	38	3.9 \pm 0.78	2-5
V	33	6.2 \pm 1.16	4-10
Pupa	46	10. \pm 1.15	8-14
Total			
Egg to adult		36.43	

TABLE 5- Effect of cultural and chemical control on *Cerconota anonella* in soursop fruits. Santa Barbara, Antioquia, Colombia.

Treatment	% Fruit infested	% Undamaged * fruit
Chlorpyrifos bag	5.4	91.9 a
Nylon bag	14.3	65.7 b
Carbaryl+		
Dithane M45	44.4	55.5 b
Untreated	72.7	22.7 c

* Means followed by the same letter within a column are not significantly different, Duncan's Multiple Range Test (P= 0.01).

TABLE 4 - *Cerconota anonella* head capsule width ($21 \pm 2^\circ\text{C}$; 60-90% RH).

Instar	N	Head capsule width (mm)	Range (mm)	Ratio of increase
I	55	0.232 \pm 0.012	0.195-0.253	
II	43	0.388 \pm 0.021	0.351-0.499	1.80
III	42	0.636 \pm 0.041	0.468-0.702	1.33
IV	38	1.031 \pm 0.042	0.936-1.131	2.00
V	33	2.249 \pm 0.195	1.872-2.535	2.00
				x : 1.78

the different results obtained in the laboratory and field.

Chemical and cultural control.

Results are shown in Table 5. Fruits with chlorpyrifos treated bags were attacked at significantly lower rates than

fruit with plastic bags or direct chemical treatment. All treated fruit was less damaged than untreated ones. Thus, only chlorpyrifos treated bags appeared to be sufficiently efficacious to be of practical use in protecting fruits from *C. anonella* attack. Protection of fruits using direct chemical treatment from attack by *C. anonella* appears to be diffi-

cult due to low residuality of the product used. Our study suggests that fruit bagging may be a useful addition to control programs for *C. anonella*, and the use of bags containing pesticides may enhance efficacy. Pesticide treated bags also have been shown to reduce infestation of *B. cubensis* in Costa Rica (Villalobos, 1987) and may, therefore, give an adequate control of both insect species.

ACKNOWLEDGEMENT

We thank H. Nadel, D. Habeck and C. Hallman for reviewing the manuscript, and N. Cruz for typing this manuscript. Research was supported by the U.S. Department of Agriculture under CSRS Special Grant No. 86-CSRS-2-2845, managed by the Caribbean Basin Administrative Group (CBAG). Florida Agricultural Experimental Station Journal Series R-01752.

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Fruits, Jan.-Feb. 1992, vol. 47, nº 1, p. 81-84.

RESUMEN - Se condujeron estudios biológicos sobre la mariposa *Cerconota anonella* (Lepidoptero : Oecophoridae) una plaga de los frutos de la Anona. La duración media del ciclo de huevo al estado adulto fue de 36,4 días a una temperatura de 21°C más o menos 2 grados. El número total de descendientes producidos iba de 11,1 a 27,5 individuos por hembra, cuando se agregaba diariamente al agua 5 p. 100 de miel. No se observaron diferencias significativas entre los dos sexos, para la longevidad. Presentación y discusión de los resultados preliminares de ensayos de control químico y biológico.

