Observations on *Cactoblastis cactorum* (Berg) as a Pest of Cactus Pear (*Opuntia ficus-indica*) in Argentina with Suggestions On Possible Control Methods

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INTRODUCTION

Several cultivars of *Opuntia ficus-indica* (cactus pear) are used in northwestern Argentina as a source of forage, fruits, and vegetables and for medicinal purposes (Ochoa et al., 1992). Cactus pear cultivation is important in subsistence agriculture in many countries and is an alternative succulent crop that is able to reduce the consequences of droughts (Pimienta-Barrios, 1993)

Cactus pear cultivation in Argentina is continually expanding (1000 ha in 1997) because of the increasing demands from the national market and because of good export possibilities (Ochoa, 1995). The plantations vary from as little as one hectare up to 50. Some of the larger plantations utilize the latest fertigation technology for optimum production.

Among the factors that limit the production of the *Opuntia* are diseases and insect infestations. Phytopathenogenic organisms and arthropods have been listed by Mann (1969), and Zimmermann et al.,1979) as potential problems in the cultivation of cactus.

Cactoblastis cactorum (Berg) (Pyralidae) is an important insect pest because it feeds internally on cladodes and, occasionally, on the fruit. The overall damage to the plant is directly related to the structural damage caused by this insect. This loss of structure causes diminished production and longevity of the plant.

C. cactorum is native of South America. The bioecology of this Pyralidae has been studied with the aim of using it in the biological control of several *Opuntia* spp. which invaded Australia and South Africa in the early part of this century (Dodd, 1940; Zimmermann and Moran, 1981; Moran and Zimmermann, 1984; Robertson and Hoffman, 1989). The bioecology of *C. cactorum* has also been studied with the objective of controlling it in commercial spineless cactus pear plantations.

C. cactorum recently also received considerable attention when it started to invade Florida, where it threatens some native *Opuntia* spp. (Pemberton, 1995).

Unfortunately, it has not always been possible to control *C. cactorum* satisfactorily and it continues to interfere with cactus pear cultivation for human and animal consumption.

This paper presents preliminary results of a one-year study on the biology and behavior of the pest, which could lead to improved control methods.

MATERIALS AND METHODS

The observations of the various aspects of the biology and behavior of *C. cactorum* were made in the collection of about 60 *Opuntia* selections containing about 1,000 plants in the Facultad of Agronomia and Agroindustrias of UNSE in Santiago del Estero, Argentina. The plant spacing was 5 x 1m and the plants ranged from 1 to 7 years of age.

Seventy five plants were inspected from the collection for periodic observation from July 19, 1996 until July 1997.

The observations made during this period were: number of eggs laid, the date of hatching, larvae and pupae development, and the presence of predators and parasitoids.

To determine the mean number of eggs per egg batch and their survival, 100 gravid females were randomly selected and the number of eggs laid were counted, these measurements on *C. cactorum* egg production were conducted in the winter-spring generation (August-September) and in the summer-autumn generation (March-April). In *C. cactorum*, the eggs occur in linear fashion in "egg sticks" that are about 1 mm in diameter and 12 mm long (Figure 1). All egg sticks were maintained in the laboratory in individual tubes until they hatched.

RESULTS AND DISCUSSION

C. cactorum started ovipositing in the first week of August 1996 (late winter), with the peak in the first week of September. The mean number of egg sticks per plant in the first spring-winter generation was 1.5, with 70% of the plants having egg sticks. The average number of eggs per egg stick was 43, with a range of 6 and 89 eggs per stick (Table 1).

During the summer-autumn generation, there were 50% fewer egg sticks than the previous season. However, there were no large differences in the number of eggs per egg stick, with the average number of eggs per egg stick being 48 with the range being 8 to 76. At this time 92% of the sampled plants had egg sticks of the *C. cactorum*.

Table 1. Values of Different Parameters Observed in *C. cactorum* from July 1996 to July 1997

Parameter	**Winter-spring Generation**	**Summer-autumn Generation**
Mean egg sticks / plant	1.5	2.5
Plants with egg sticks (%)	70	92
Mean egg / egg sticks (mean + SD) (range)	49 (17.63) (6-89)	48 (15.4) (8-76)
Pupal parasitism (%)	3	1.8

We counted a maximum of 5 egg sticks per plant on the same sample and up to 12 cladodes with eggs in the same plant in the second generation. The mean number of eggs in this second generation was 2.5 egg sticks per plant (Table 1).

Under laboratory conditions, 95% of the eggs hatched successfully from the first generation and 96.3% from the second generation.

Only 50% of the cladodes with eggs eventually showed *C. cactorum* damage. A large proportion of the eggs were destroyed by predators. High larval mortalities of the first instar larvae caused by gum exudations when entering the cladodes were observed by Robertson and Hoffman (1989), and this was also observed in this study. On the undamaged cladodes we observed completely open eggs and other eggs that were partially or completely destroyed by predators. In South Africa, Robertson and Hoffman (1989) found that young larvae were unable to penetrate the cladodes and this may be the reason that some of the cladodes were not damaged.

Approximately 30% of the egg mortality was caused by predators. A large proportion of the damage could be attributed to predacious ants, as observed by Robertson and Hoffman (1989) in South Africa. Unidentified factors, including rainfall, could be the cause of further egg loss. Robertson and Hoffman (1989) detected at least six species of ants responsible for 56.6% of the egg mortality in South Africa.

No egg parasitoids were found in this study. Previously, low egg parasitism caused by a *Trichogramma* spp was observed. La Porta (pers. comm.) observed 100% egg parasitism of *C. cactorum* eggs in northern Cordoba (Argentina) caused by an unidentified absolutely black microhymenoptera. Robertson and Hoffman (1989) found 1% of the egg layings parasitized by Trichogrammatoidea sp (probably *T. lutea* Gyrault).

The braconid larval/pupal parasitoid, *Apanteles alexanderi* Brethes parasitized the first instar larvae of *C. cactorum*. Up to 18 adults emerged from one infected pupa. Between November and December less than 3% of the pupal sample was parasitized. In the following generation, 1.8% of the pupae were infected. Zimmerman et al., (1979) determined a high level of parasites (>30%) of this Braconidae during his studies of insect pests of South American cacti. Vattuone et al., (1993), cited *A. alexanderi* as a *C. cactorum* parasite found in Catamarca, Argentina.

The pupae of *C. cactorum* are found in or under desiccated cladodes that were destroyed by *C. cactorum*. These may remain attached to the plant or may lie on the soil at the base of the plant. The number of pupae observed in the soil near the plant is significantly less than the number of larvae found in the plant.

All the cladodes on some of the plants were destroyed by *C. cactorum*. Some plants were partially destroyed and, where the trunk was affected, the plants collapsed during heavy winds. There was only one incidence where the larvae attacked the fruit. At a final survey at the end of this period, 90% of the plants showed slight damage (no more than one cladode damaged). Other plants were severely damaged with more than 50% of the cladodes attacked.

The long egg stage of *C. cactorum*, lasting approximately 25 days, is conducive to effective control. A long-residual-contact insecticide will not only kill the eggs, but also will control the first instar larvae when they come in contact with the insecticide while searching for an entry point. The long egg stage can also be of advantage by manually collecting the conspicuous egg

sticks from the plants on a weekly basis. This is viable with small fruit-bearing plants, but would not be practical on a large scale.

Based on present observations of different aspects of the bioecology and the behavior of the *C. cactorum*, this insect severely affected the cultivation of cactus pear. Without control this pest will cause severe damage to the plants, diminishing the production and longevity of the plantation.

There does not appear to be sufficient opportunities for management of factors affecting natural *C. cactorum* mortality to reduce the damage resulting from this pest to avoid seriously compromising profitability of the plantation for both small and large producers.

Because the larvae develop in the interior of the cladodes, the possibilities for an effective chemical control are limited, especially with the pesticides that only act through ingestion. In this sense, special devices should be developed that permit spraying the pesticides in the primary larvae stages while the ingestion of tissue is minimal and, therefore, does not affect the integrity of the cladodes or plants.

The long embryo period (approximately 25 days), impedes the possibility of using contact insecticides, which, in general, have reduced residual activity. However, this characteristic can be used to control the eggs by means of manual elimination during the laying period by inspecting the plantation once per week. This is viable with small, fruit-bearing bushes. However, it would be impractical on a large scale.

The interception of adults or mating disruption are further options to reduce the negative impact of this pest. The use of light traps during the flying stage could also help. The identification, synthesis, and formulation of sexual pheromones for mating disruption could be implemented. This technique was efficiently tried with other pests (e.g., "*Pectinophora gossypilla*" in cotton). However, the development of this technique demands a high investment of money and time.

The knowledge gained about *C. cactorum* in these preliminary studies will allow further studies to improve the control of this pest. Effective control of *C. cactorum* should meet the following basic conditions: be effective, economical, offer no danger to producers or consumers, and permit the sustainability of the ecosystem.

Figure 1. *C. cactorum* and Damage to Cladodes

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