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The effect of colony size on the establishment of feeding activity of *Cactoblastis cactorum* larvae on cactus plants

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Abstract
The study was conducted in the laboratory to observe the effect of the colony on the establishment of feeding activity and development responses of *Cactoblastis cactorum* (Berg) (Lepidoptera: Phycitidae) on two cactus species namely and *Opuntia lindheimeri.* The main objective was to establish the minimum number of *C. cactorum* larvae needed to facilitate a successful attack on a cactus cladode. We also examined the effect of cladode age on the larva establishment. In order to get this information replicates of cactus cladodes collected from different levels of cactus plants were infested with 5, 10, 15, 20, and 25 egg batches. All the different levels of egg batches placed on the cladodes hatched well. It was observed that the neonate larvae initially kept together while attempting to enter the cladode. Successful entrance into *O. ficus indica* cladode was observed on those cladode infested 15 were 20 and 25 eggs were placed. Those larvae fed, developed and eventually pupated and the adults emerged normally. On the other hand, larvae which hatched on *O. lindheimeri* larvae were unable to establish on this cactus species. When the neonate larvae attempted to penetrate into the cladode they drowned in the exudates produced at the point of entrance. As a result all larvae on *O. lindheimeri* did not complete their developmental cycle.

Keywords: *Opuntia ficus indica, Opuntia lindheimeri*, *C.cactorum,* cladode, eggs, terminal, stems, mature cladodes

Introduction

Description of the cactus plant

Prickly pear is branching shrub or tree that can grow up to 5m tall. Old plants develop a thick, round, well-defined trunk. The fleshy leaf-pads are flattened, 1-3cm thick, 30-60cm long, 6-15cm broad, varying from heavy spined to spineless depending on the species. During November plants are covered with a magnificent display of bright yellow to orange flowers that emerge from the margins of leaf-pads. The succulent, edible fruits are about the size of large elongated plums, yellowish when ripe but turning pink when old. They are covered with clusters of minute spines. These clusters make it painful to handle and peel the fruits with bare hands.

The background of cactus plant

Prickly pear is considered by most authors to be a plant native to central Mexico. It has been introduced into many countries of Mediterranean Europe, Africa and Asia for the use as an ornamental plant, fodder, a hedge plant and as a source of edible fruit. It has spread from cultivation and is now an invasive plant in California and in South Africa and Australia. Prickly pear was probably introduced into the South-west Cape via India by the Dutch East India Company. It was only after its introduction to the warmer Eastern Cape in approximately 1750 that it reached pest status. Prickly pear is now found in Kwazulu Natal, the Free State and Gauteng.

In Mexico, cacti have been of importance since ancient times and featured in the history, economy and cultural life of the country (Hoffmann, 1983) and have contributed to the economy because cacti are used to make juices, jams, confectioneries, pharmaceuticals, and cosmetics. Prickly pear opuntias are so important in the life and culture of Mexico that they are depicted in the national flag and on the modem day Mexican coat of arms.

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The prickly pear problems

The prickly pear is a rapid invader of natural vegetations which it eventually replaces. Once dense infestations have developed, there remains little natural vegetation to support grazing animals, and passage through infested veld becomes restricted. During the fruiting season the minute spines on the fruits can be highly irritating and can result in animals being unable to feed.

Control of the cactus plants

According to legislation proclamations 161/1938 and 171/1940 of the weeds Act, no. 42 of 1937, the prickly pear, as well as other Opuntia spp., except spineless Burbank varieties, was proclaimed a noxious weed throughout the Republic of South Africa. Since this plant is a problem we have to control it. As early as 1883 various methods of mechanical and chemical control were employed to suppress prickly pear, but without much success. Until 1932, when a largely successful campaign of biological control commenced, this plant was regarded as the worst invader in South Africa. Beginning in 1932, insects were imported from abroad for the release in South Africa. After screening in quarantine, a number of insect species were selected and released. Insects released included the prickly pear cochineal *Dactylopius opuntia* (order- Homoptera, family- coccidae) aided by felling, caused the collapse of 80 % of 400 000 ha of dense infestations. The re-infestation of previously heavily infested areas is today prevented to a very large extent by the cochineal *D. opuntia* and another introduced insect, the prickly pear moth *Cactoblastis cactorum* (Berg) (Lepidoptera: Phycitidae) In this project the emphasis is on *C. cactorum.* The moth (*Cactoblastis cactorum).*

Distribution

Cactoblastis cactorum occurs naturally in the northern parts Argentina, Paraguay, Uruguay, and in the northern parts of Brazil. It was first introduced as a biological control agent against alien opuntia cacti in Australia during the 1920s (Dodd, 1940) [5] and in South Africa during the 1930s.

This moth has an oligophagous habit and ability to destroy numerous species of opuntia. In Australia and S. Africa where there is no native Opuntia species or other con-familial cactus species, the release of the moth was rational and safe. The moth was more successful in Australia than South Africa due to high levels of predation by ants, (Robertson and Hoffmann 1989) [10, 15] and baboons as well as unfavorable climatic extremes, especially hail, heavy rains and wind which causes egg losses. In spite of this, the moth is still recognized as a good biological control of cactus plant in S.Africa (Annecke and Moran, 1978) [1]. Another factor that affects the effectiveness of *Cactoblastis* between Australia and South Africa; can be partially explained by imperfect adaptation of *Cactoblastis* to the woody cactus tree, *O.ficus indica*, and also the larvae do not readily kill hosts that comprise more than about 14 cladodes (Zimmermann & Malan 1981) [16].

A study on the efficacy of *C. cactorum* showed that the effectiveness of *C. cactorum* larvae is related to the size of the host plant and agents do not destroy hosts that comprise more than 14 cladodes (Zimmermann and Malan 1981) [16].

Robertson (985, a, b 1988) showed that first-instar larvae sometimes fail to penetrate *O.ficus indica* cladodes because the cuticle is too tough and impenetrable, and because of gum exudation. Thus the effect of host plant incompatibility to *C.cactorum* in S.A may be as important as formerly supposed by Monro (1975) [11], Annecke and Moran (1978) [1] and Zimmermann (1980) [16].

In 1957, the moth was released in the Caribbean islands to control the native cactus species. The moth dispersed naturally to many islands of the Caribbean including Hispaniola, the Bahamas then from there to Florida in the USA where it was first noticed in 1989. The moth may have dispersed on its own from Cuba to Florida a distance 144km. alternatively, the moth may have been introduced into Florida as contaminators in shipments of horticultural plants. Although the moth is a strong flyer, there is little direct evidence of natural unaided inter-islands dispersal in the Caribbean. The moth could use either of these avenues to cross the Yucatan channel and get into Mexico. If this happens, the effects may be severe.

Biology

This cactus-feeding phycitid, in common with some other cactophagous moths (Moran, 1980), lays its eggs one on top of the other to form spine-like “eggsticks”. An eggstick comprises, on average, 60-100 eggs and each female usually lays a total 0f 200-300 eggs (Dodd, 1940; Peetey 1948; Roberson 1985) [5].

The neonate larvae, collectively, burrow and enter cactus cladodes through a single entry hole, thus probably overcoming the defensive gum-secretions of the host plant (Hoffmann and Zimmermann, 1989) [10, 15]. Larvae feed gregariously within the cladodes for about two months in summer and about four months in winter, before exiting to pupate in leaf-litter or in the soil (Dodd, 1940; Peetey, 1948) [5]

In Australia and South Africa, where C. cactorum occurs in temperate latitudes, there are two generations per year (Pettey 1948; Robertson, 1985). In the warmer tropical climate of the Caribbean and Florida there may be more generations each year.

Objectives of current study

In the current project the aims are twofold:

1. Establish the minimum numbere of *C. cactorum* larvae needed to facilitate a successful attack on a cactus cladode. We are examining the effect of colony size on the feeding responses of *C. cactorum* larvae on two cactus plants namely *Opuntia ficus indica* and *Opuntia lindheimeri*
2. Examine the effect of cladode age on the feeding success and development of *C. cactorum* larvae

Materials and Methods

Opuntia ficus indica and O. Lindheimeri used in the experiment were collected from the field. *Opuntia ficus indica* (Picture 3) was collected from Uitenhage and *O. lindheimeri* (Picture 1) was collected from from fields in the vicinity of Fort Beaufort. In the laboratory Metal tongs were used to hold the cactus cladodes while laying them out on the table. The different cladode classes (top middle and bottom were arranged and numbered as indicated in Table1. The arrangement took note of the level of the plant the cladode was collected and the number of eggs put on each cladode.

The egg-sticks of *C. cactorum* were collected from the PPRI insectery at Uitenhage. Each egg-stick was observed under a

microscope and with the aid of a pair of forceps it was dismantled into batches of 5, 10, 15, 20, 25. The egg batches were transferred on to the arranged cladodes where each of the five treatments was replicated three times as indicated in Table 1.
Fluorescent lights were used to illuminate the cladodes and the room temperature was maintained at ± 27°c. When the eggs hatched the behaviour neonate larvae was recorded. The larvae, which succeeded in entering the cladode, were allowed to feed for 3-5 week after which they were dissected out counted and weighed. The data was recorded as shown in Table 2

Table 1: Lay out and numbering of cladodes base on the level of the plant they were obtained and the number of eggs put on each cladode

Plant level	Cladode no	No. of eggs placed on cladode	Date hatched	Larval behaviour	Date larvae recovered	No. of larvae recovered	Weight of larvae	Mean weight of larvae
Top	1	5	05/10/05					
	2	5	05/10/05					
	3	5	03/10/05					
	4	10	11/10/05					
	5	10	05/10/05					
	6	10	03/10/05					
	7	15	03/10/05					
	8	15	03/10/05					
	9	15	03/10/05					
	10	20	29/09/05					
	11	20	30/09/05					
	12	20	29/09/05					
	13	25	29/09/05					
	14	25	04/10/05					
	15	25	04/10/05					
Middle	16	5	03/10/05					
	17	5	05/10/05					
	18	5	03/10/05					
	19	10	03/10/05					
	20	10	03/10/05					
	21	10	03/10/05					
	22	15	03/10/05					
	23	15	03/10/05					
	24	15	03/10/05					
	25	20	04/10/05					
	26	20	05/10/05					
	27	20	06/10/05					
	28	25	04/10/05					
	29	25	04/10/05					
Bottom	30	25	04/10/05					
	31	5	04/10/05					
	32	5	04/10/05					
	33	5	04/10/05					
	34	10						
	35	10	10/10/05					
	36	10						
	37	15	10/10/05					
	38	15	10/10/05					
	39	15	11/10/05					
	40	20	07/10/05					
	41	20						
	42	20	10/10/05					
	43	25	30/10/05					
	44	25	30/10/05					
	45	25	05/10/05					

Results

Observations on *O. ficus indica* cladodes

i. Neonate larvae

As indicated in material and methods 45 cladodes were infested with different the eggs batches of *C. cactorum*. All the different levels of egg infestation hatched well. It was observed that the neonate larvae initially kept together while attempting to enter the cladodes. Successful entrance into the cladode was observed on *O. ficus indica* cladodes numbered. 10, 12, 13, 14, 15. Those numbers corresponded to cladodes infested with 20 and 25 eggs batches.

ii. Larvae feeding activity

The neonate larvae, collectively, burrow and enter cactus cladodes through a single entry hole, thus probably overcoming the defensive gum-secretions of the host plant (Hoffmann and Zimmermann, 1989) [10, 15]. Larvae feed gregariously within the cladodes. As the larvae fed on cladodes their feeding activity was signified by the appearance and build up of frass material in the entrance hole (Figure 1). Cladodes that received less than 20 egg batches had no larval development and feeding. When such cladode were eventually opened up the moth larvae were healthy as shown in Fig 2.

As shown in Table 2 cladodes from the top and middle of the cuctus plant gave the best results in terms of numbers of larvae recovered and as well as their weight gains. On the other hand *C. cactorum* larve did not feed that well on the old cladodes collected from the bottom parts of the cuctus plants. These negative responses on the bottom cladodes are also clearly shown in Table 3 showing the Mean number of larvae recovered from each cladode group and the mean larval weight in grams. Here, as expected, the bottom cladodes produced the lowest values in terms of larval weight gains.

Fig 1: Cladodes of *O. ficus indica* with frass mounds are containing actively feeding larvae of *C. cactorum*

Fig 2: Well-developed larvae of *C. cactorum* dissected out of the cladodes that were successfully attacked

Table 2: Plant level of *Opuntia ficus indica* and number of eggs which contributed to successful attack of *Cactoblastis cactorum* on the cladodes as indicated by the larval weight (The values in brackets are the actual number of larvae weighed because the some of the recovered larvae were destroyed during dissection)

Level of plant	Cladode No.	No. of eggs placed/ cladode	Date hatched	Date larvae recovered	No. of larvae recovered	Total weight of recovered larvae in grams	Mean weight of individual larvae in grams
Top	10	20	29/09/05	01/11/05	15	2,6	0,17
	12	20	29/09/05	01/11/05	15	1.18	0,11
	13	25	29/09/05	01/11/05	18	2,01	0,11
	14	25	04/10/05	01/11/05	11	1,14	0,01
	15	25	04/10/05	01/11/05	24	3,1	0,13
Middle	25	20	04/10/05	01/11/05	11 (9)	0,71	0,08
	28	25	04/10/05	01/11/05	22 (2	2,73	0,13
	29	25	04/10/05	01/11/05	22 (20)	3,3	0,17
	30	25	04/10/05	01/11/05	21	3,08	0,15
	40	20	07/10/05	01/11/05	15	0,67	0,04
Bottom	41	20	07/10/05	01/11/05	7	0,06	0,02

Table 3: Data collected from groups of cladodes in *Opuntia ficus indica* treatment MLR = Mean number of larvae recovered from each cladode group. MLW = Mean larval weight in grams

Plant level where cladodes were collected		Egg batch numbers placed on the cladode groups				
		5	10	15	20	25
Top	MLR	0	0	0	10	18
	MLW	0	0	0	0,09	0,11
Middle	MLR	0	0	0	4	22
	MLW	0	0	0	0,03	0,28
Bottom	MLR	0	0	0	11	0
	MLW	0	0	0	0,02	0

Observations on *O. lindheimeri* cladodes

i. Neonate larvae and feeding activity

As shown in Figure 3, *O. lindheimeri* cladodes were relatively resistant to *C. cactorum* attack. The neonate larvae were initially immobile after hatched and after sometimes they started wondering and when they attempted to enter the cladode they drowned in the creamy material oozing out of the entrance hall.

Those which did not drown died of starvation. Some larvae on cladodes infested with 25 egg batches subsisted on the surface of the cladode and feeding surface tissues of the cladode. The development of those larvae was retarded as shown in Figure 4.

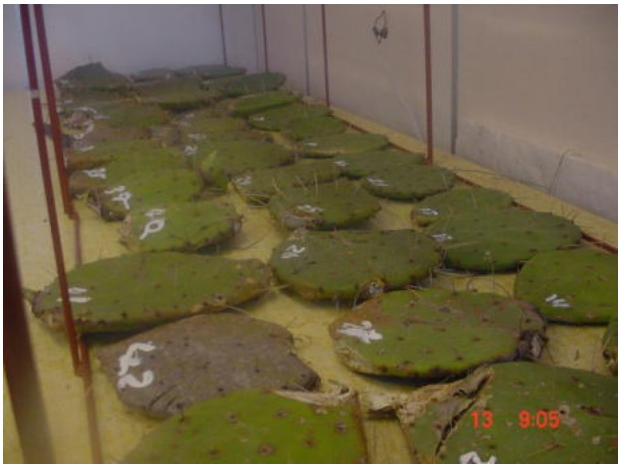

Fig 3: Cladodes of *O. lindheimeri* infested at the same time as the *O. ficus indica* shown in Figure 2 but showing no signs of *C. cactorum* larvae feeding activity.

Fig 4: Retarded larvae of *C. cactorum* subsisting on the surface of a *O. lindheimeri*. cladode. These larvae were of the same age as those shown in Figure 3

References

1. Annecke DP, Moran VC. A critical reviews of biological pest control in South Africa. 2. The prickly pear, *Opuntia ficus indica* (L.) Miller. J Entomol. soc. South. Afr. 1978; 41:161-188.
2. Bergivinson DJ, Hamilton RI, Arnason JT. leaf profile of maize resistance factors to European corn borer, *Ostrinia nubillalis*. Journal of chemical Ecology, 1995a, 21343-54
3. Bergivinson DJ, Larsen JS, Arnason JT. Effect of light on changes in maize resistance against the European corn borer, *Ostrinia nubillalis* (Hubner). Canadian Entomologist, 1995b; 127:111-22.
4. Boucher C, Stirton CH. Prickly Pear. In: plant invaders: Beautiful, but dangerous. Department of nature and environmental conservation of the Cape provincial administration, Cape Town, S.A, pg112 Dodd, A.P., 1940. The biological campaign against prickly pear. Cmmonwealth prickly pear Board Bulletin, Brisbane, Ausralia, 1978, 77.
5. Dodd AP. The biological campaign against prickly pear. Cmmonwealth prickly pear Board Bulletin, Brisbane, Australia, 1940, 77.
6. Feeney P. Seasonal changes in Oak leaf tannins and nutrients as a cause of spring feeding by winter moth caterpillars. Ecology. 1970; 51:565-81.
7. Casher LE. leaf toughness in *Quercus agrifolia* and its effects on tissue selection by first instars of *Phryganidia califonia* (Lepidoptera: Dioptidae) and *Bucculatrix albertiella* (Lepidoptera: Lyonetiidae). Annals of the Entomological Society of Americ. 1996; 89:109-21.
8. Florida Entomologist, Zimmermann HG *et al*. the renowned cactus moth, *Cactoblastis cactorum* (Lepidoptera: Pyralidae): its natural history and threat to native opuntia floras in Mexico and the United State of America. 2001; 84(4):543-548.
9. Hoffmann. Agriculture, Ecosystem, and Environment, 1991; 37:32
10. Hoffmann JH, Zimmermann. Ovipositional and feeding habits in *Cactophagous pyralids*: Predation for biological control of cactus weeds. Proceeding of the VIIth symposium on Biological of weeds, MAF, Rome, 1989, 395-399
11. Monro JM. Environmental variation and the efficiency of biological control- Cactoblastis in the Southern Hemisphere. In: J. Kikkawa and H.A. Nix (Editors), Managing Terrestrial Ecosystems. Proceeding of the Ecological Society of Australia. 1975; 9:204-212.
12. Pettey FW. The biological control of prickly pears in South Africa. Sci. Bull. Dep. Agric. For., Union S.Afr., 1948; 271:1-63.
13. Robertson HG. The ecology *Cactoblastis cactorum* (Berg) (Lepidoptera: Phycitidae) in relation to its effectiveness as a biological control agent of prickly pear and jointed cactus in South Africa. PhD Thesis, Rhodes University, Grahamstown, (unpublished). 1985a, 181.
14. Robertson HG. Egg predation by ants as a explanation of the difference in performance of *Cactoblastis cactorum* on cactus weeds in South Africa and Australia. In: E.S. Delfosse (Editor), Proceeding of the Sixth International Symposium on the Biological Control of Weeds, 1984, at Vancouver, Canada, 1985b, 83-88.
15. Robertson HG, Hoffmann JH. Mortality and life-tables of *Cactoblastis cactorum* (Berg) (Lepidoptera: Pyralidae) compared on two host-plant species. Bull. Entomol. Res. 1989; 79:7-17.
16. Zimmermann HG, Malan ED. The role of imported natural enemies in suppressing re-growth of prickly pear, *Opuntia ficus indica*, in South Africa, In: E.S. Delfosse (Editor), Proceeding of the Fifth International Symposium on the Biological Control of Weeds, at Brisbane, Australia, 1980, 1981, 375-381.