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Cactoblastis Cactorum: A Successful Weed Control Agent in the Caribbean, Now A Pest in Florida?

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A South American phycitine moth, *Cactoblastis cactorum*, was introduced into Nevis, West Indies in 1957 to control *Opuntia triacantha*. Following its successful establishment it was sent from Nevis to Antigua, Montserrat and the Cayman Islands. It spread naturally to several Caribbean islands, including Jamaica, Puerto Rico, Cuba and the Bahamas. Its discovery in the Florida Keys in 1989 is the first record of its establishment in continental USA. It poses a serious threat to endangered and other rare *Opuntia* spp. in Florida. Its eventual spread to Texas and Mexico appears inevitable. The results of surveys to determine its distribution in Florida and the impact of native natural enemies on it are given. Finally the pros and cons of attempting biological control of *C. cactorum* in Florida by the introduction of specialized natural enemies from South America and of other control tactics are discussed.

Introduction

Cactoblastis cactorum Berg. (Lepidoptera: Pyralidae) a phycitine moth native to Argentina, Paraguay, Uruguay and southern Brazil was introduced purposely into Australia in 1925 to control several North American and South American species of *Opuntia* (Cactaceae; Dodd 1936). More than 25 million acres (over 16 million acres in Queensland) of severely infested land were reclaimed for agriculture by the action of this insect. It has also aided in the control of *Opuntia* spp. in Hawaii, Mauritius and South Africa.

In 1952 one of us (FDB) visited several of the islands of the Lesser Antilles to ascertain pest problems which might be amenable to biological control. *Opuntia* spp. were listed as important weeds in St. Kitts and Nevis, Antigua and Montserrat and the introduction of cochineal insects and the cactus moth *Cactoblastis cactorum* was proposed. In 1957 2 species of *Dactylopius* (Homoptera: Dactylopiidae) and *C. cactorum*, obtained from South Africa were released in Nevis. On the basis of information from South Africa, it was expected that the cochineal insects would be more effective against the most serious pest species *Opuntia triacantha* (Willdenow) Sweet (= *curassavica* [L.] Miller). Control, entirely due to the cactus moth, was spectacular (Simmonds and Bennett 1966; Bennett *et al.* 1985). Eggs and larvae in infested cactus pads were sent from Nevis to Antigua and Montserrat in 1962 where establishment also occurred. It spread naturally across the 5-mile stretch of sea separating St. Kitts from Nevis. Undocumented reports suggested that it had been carried illegally to the US Virgin Islands by the mid-1960s. *Cactoblastis cactorum* was introduced from Antigua and Nevis into Grand Cayman in 1970 for the control of *Opuntia stricta* var. *dillenii* (Ker-Gawl) L. Benson. As early as 1963 it had invaded naturally and was widespread in Puerto Rico (Garcia Tuduri *et al.* 1971). It was reported to be present in Haiti, Dominican Republic and Bahamas (Starmer *et al.* 1987). Dickel (1991), based on unconfirmed reports, states that this phycitid has been present in Cuba since 1988. Its distribution in the Caribbean is indicated in Fig. 1. Although there has been little or no documentation of the impact of *C. cactorum* on *Opuntia* spp. on most of the islands, its action has alleviated the weed problems and may have driven one or more species of *Opuntia* close to extinction in Nevis and Grand Cayman.

The likelihood that *C. cactorum* would eventually arrive in Florida, in view of its inter-island spread in the Caribbean, has been a foregone conclusion for several years. Nevertheless, the discovery of *C. cactorum* in the Keys in 1989 caused consternation to those dedicated to the conservation of *Opuntia* species.

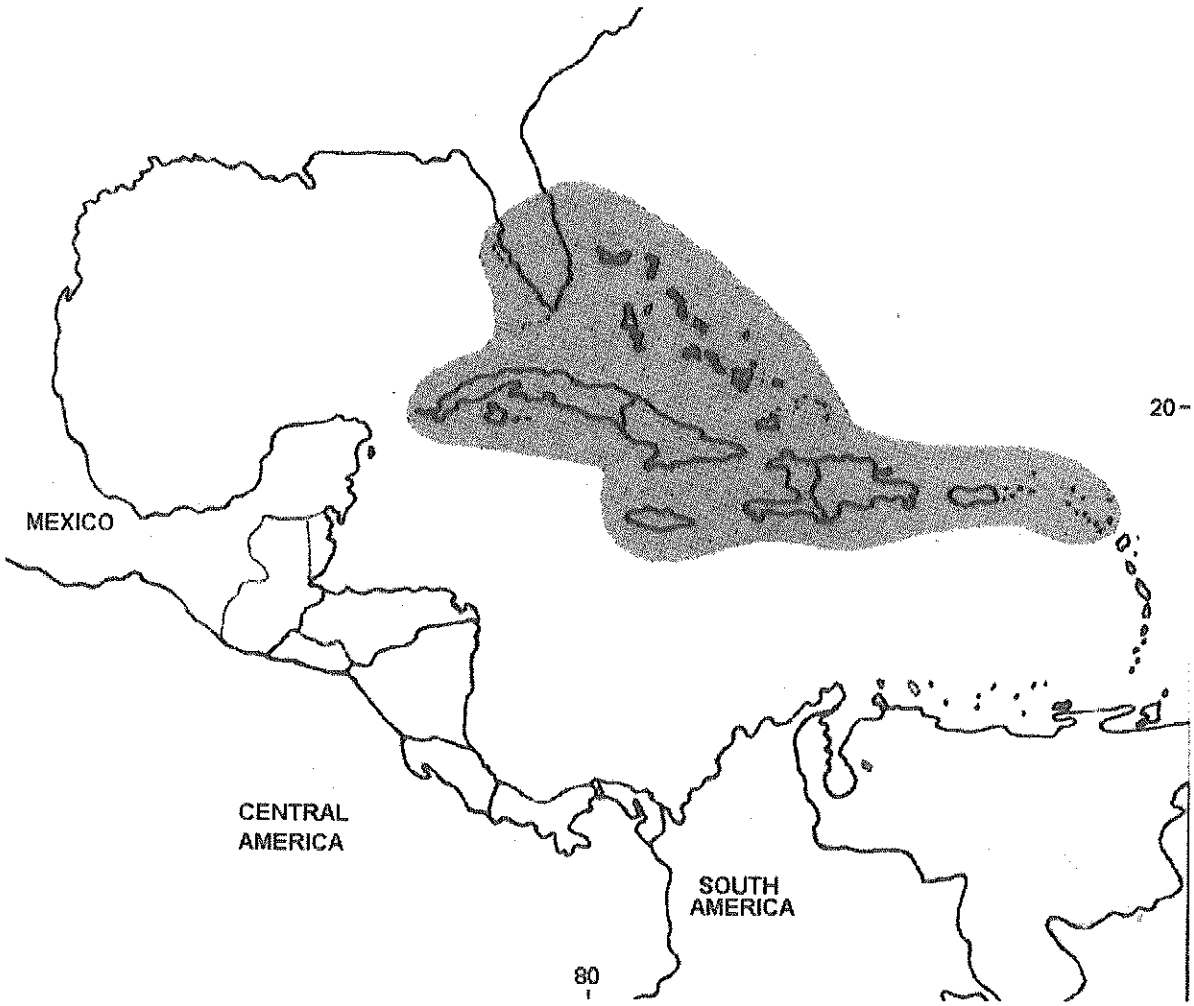

Figure 1. Documented distribution of *Cactoblastis cactorum* in the Caribbean.

In Florida there are 10 or more species of native or naturalized *Opuntia* spp. (Table 1). One of these, O. *spinosissima* (Martyn) Miller, the semaphore cactus, is known from only 12 naturally-occurring specimens (plus several vegetatively propagated "clones" at Fairchild Gardens and other private collections). Other species such as *O. triacantha* and *O. cubensis* Britton and Rose also have a restricted distribution in the Florida Keys. State action has been taken to prevent further habitat destruction, a major cause for the rarity of these species. Nationally, the U.S. Fish and Wildlife Service lists 13 species of *Opuntia* as candidates for endangered species status under the Federal Endangered Species Act (Lippincott, Carol, personal communication, 1991).

Methods and Materials

After learning of its arrival in June 1990 (Habeck and Bennett 1990), we commenced preliminary studies on its distribution and host range in Florida and to determine whether native natural enemies of other Lepidoptera were switching to it. Surveys to determine its distribution in the Florida Keys were conducted personally and by inspectors of the Florida Department of Agriculture and Consumer Services (FDACS). Records on its occurrence elsewhere in Florida were mostly obtained by FDACS plant inspectors in connection with other duties. To obtain information on natural enemies occasional visits of very limited duration were made to the Florida Keys while in south Florida for other purposes (Table 2). A maximum of 2 h, usually less than 1 h was spent at any site; usually 3 or 4, but at times only 1 site was visited/trip. At each site plants of any species of *Opuntia* present were inspected for egg sticks and for cladodes infested with larvae. Protected niches under and near infested plants were searched for cocoons. Any egg sticks or cocoons which could be located were collected and held in the laboratory for emergence of hosts or parasites. Cladodes containing larvae of various sizes were collected and held in the laboratory to determine whether larval parasites occurred. Cocoons which did not produce adults in the laboratory, were cut open with small surgical scissors to determine the cause of mortality, or whether adults of *C. cacti* or parasites had emerged prior to collection.

Table 1. *Opuntia* spp. occurring in Florida (from L. Benson 1982).

Native	Introduced
cubensis Britton and Rose	*vulgaris* Miller
triacantha (Willdenow) (Sweet)	*cochenillifera* (L.) Miller
pusilla (Haworth) Haworth	*ficus-indica* Miller
stricta Haworth	*leucotricha* DeCanolle
humifusa (Rafinesque) Rafinesque	
spinosissima (Martyn) Miller	

Table 2. Analysis of *Cactoblastis cactorum* cocoons collected in the Florida Keys.

Date	Total Cocoons	Moths Emerged	*Brachymeria*		No Emergence	Evidence of:	
			ovata	*pedalis*		Predation	Fungal Attack
26.vi.90	11	6	1			4	
24.xi.90	17	15	1			1	
2.iv.90	23	18	2	0		3	
22-23.vii.91	57	20	17	1	10[1]	9	
31.viii.91	22	14	5			1	2
18.x.91	22	17	5				
22.ix.91	10	7	1		1	1	

[1] Flooding due to heavy rains may have affected emergence.

Results and Discussion

Observations indicated that all of the native species of *Opuntia* occurring in the Florida Keys were susceptible to attack. R.W. Ehrig, Torchwood Hammock Preserve, Little Torch Key, confirmed that the semaphore cactus was attacked. To protect the few naturally occurring plants of the semaphore cactus and to conserve the limited gene pool, he erected large wooden framed screen field cages over each of the 12 plants. Vegetative planting material representative of all 12 plants was sent for propagation to the Fairchild Tropical Garden.

By December 1990 the occurrence of *C. cactorum* on the northern-most Keys, Key Largo, and on Key Biscayne, just off shore from Miami, was confirmed. Heavy damage to plants

of *O. stricta* had occurred on several of the Keys and to *O. triacantha* on Long Key. Our observations indicated that all immature stages were present from June-November 1990 which suggested the occurrence of several overlapping generations. During a one-day survey on 4 Keys in early February 1991, only large larvae and pupae were found suggesting a pause in reproduction during December-January. However, emergence of adults a few days after the February collection indicated that reproductive activity was likely to start again. All immature stages were encountered in surveys conducted in April, July, October and November 1991. Some of the plants which had been examined and photographed during the first survey in June 1990 had disappeared completely and others continue to deteriorate due to repeated or almost continuous attack.

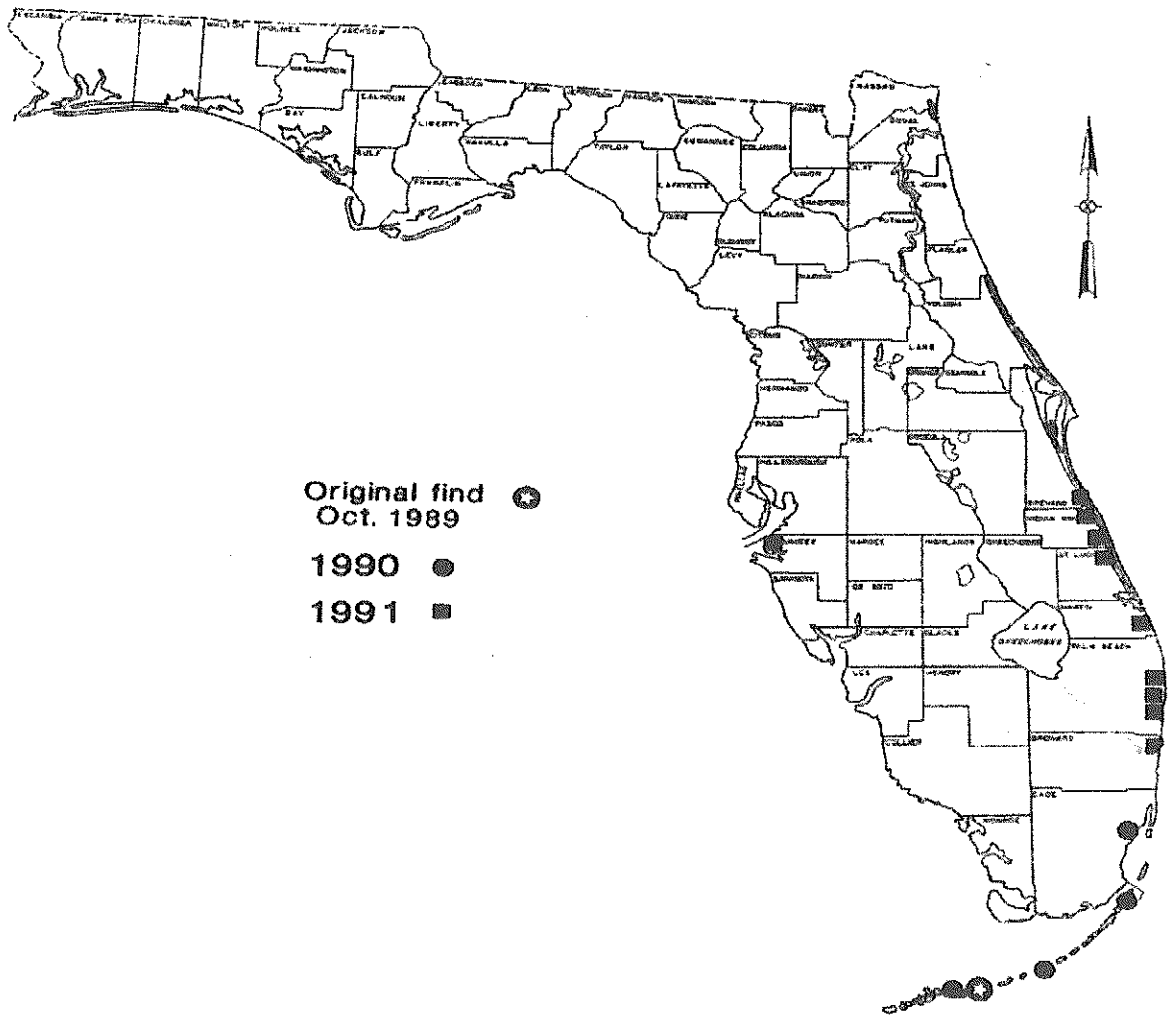

Figure 2. Documented distribution, by year, of *Cactoblastis cactorum* in Florida.

Surveys in 1991 by FDACS inspectors have extended the known geographic range of *Cactoblastis* from the Florida Keys in southern Florida northward to Brevard County on the east coast and to Manatee County on the west coast of Florida (Fig. 2). A similar rate of expansion during 1992 would extend its range into Louisiana.

Natural enemies

No larval parasites were reared from the several hundred larvae obtained from infested cladodes of *O. stricta* Haworth collected in the Florida Keys. *Brachymeria ovata* Say (Hymenoptera: Chalcididae), a pupal parasite has been reared repeatedly from *Cactoblastis* cocoons collected on Key Biscayne, Key Largo, Long Key, and Bahia Honda Key. In the July 1991 collection on Long Key, 55% of a collection of 42 *Cactoblastis* cocoons were parasitized by this species. A second pupal parasite, *Brachymeria (Pseudobrachymeria) pedalis* (Cresson) emerged from 1 pupa collected on Key Largo in July 1991. This parasite is known only from specimens reared from other specialized phycitid moths attacking cacti. Therefore if it turns its attention to *C. cactorum* it may provide partial biological control. Two egg sticks from one collection on Bahia Honda have yielded *Trichogramma pretiosum* Riley (Hymenoptera: Trichogrammatidae). This parasite is known to heavily parasitize eggs of *C. cactorum* in Hawaii (Oatman, E., personal communication, 1991). Several cocoons exhibited evidence of predation. Egg predation by ants is considered to be an important factor accounting for the mediocre performance of *C. cactorum* in South Africa (Robertson 1985). The role of ant predation, on all stages of *C. cactorum*, merits investigation particularly in areas of Florida where the imported fireant *Solenopsis invicta* Buren is abundant.

Control

No satisfactory method of chemical control of *C. cactorum* is known. The widespread use of pesticides in the Florida Keys is not recommended because of the occurrence of rare and endangered fauna such as Schaus swallowtail *Papilio aristodemus ponceanus* Schaus (Lepidoptera: Papilionidae), Florida leaf-wing *Anaea floridalis* Johnson and Comstock (Lepidoptera: Nymphalidae), and Bartram's hairstreak *Strymon acis bartrami* (Comstock and Huntington) (Lepidoptera: Lycaenidae) butterflies. Similarly, inundative releases of egg parasites such as *Trichogramma* spp. could have an adverse impact on other desirable Lepidoptera in the Keys.

Classical biological control could be considered. In its native habitat in South America several natural enemies are known (Zimmermann *et al.* 1979). These include *Apanteles alexanderi* Brethes (Hymenoptera: Braconidae), *Phycticiplex doddi* (Cushman) and *P. eremnus* (Porter) (Hymenoptera: Ichneumonidae), *Brachymeria cactoblastidis (Blanchard)* (Hymenoptera: Chalcididae), and *Epicoronimyia mundelli* (Blanchard) (Diptera: Tachinidae). The host range of these natural enemies would have to be determined before the release of any of them for the control of C. *cactorum* could be approved.

There are at least 3 native and another introduced species of phycitids associated with cacti in the Florida Keys (Habeck and Bennett 1990). The impact of introduced parasites on these would have to be considered. Also, parasites released in Florida might eventually spread to the Caribbean and negate the successful biological control of *Opuntia* spp.

The feasibility of developing a synthetic sex pheromone to serve as a monitoring tool or as a control technique should be considered. Such pheromones have been developed and are currently used experimentally or commercially to control crop pests (McLaughlin, J. R., personal communication, 1991)

There is a high probability that *C. cactorum* will spread north through Florida and west to Texas and into Mexico where the fruit and young vegetative parts of *Opuntia* spp. form part of the staple diet of humans and where chopped

plants serve as cattle fodder in times of drought. Alternatively it could invade the Yucatan peninsula directly from the Caribbean islands. The distance between Cuba and the Yucatan is similar to the distance between Cuba and the Florida Keys (see Fig. 1). The well-intentioned introduction of *C. cactorum* into the Caribbean provided excellent control and a solution for a serious weed problem; and some cattle ranchers would welcome a similar result in Texas. However, its impact in Florida and the potential loss of fauna associated with, or dependent on, *Opuntia* spp. have given rise to statements that biological control of weeds should not be permitted. At the time of the introduction of *C. cactorum* into the Caribbean no useful value was placed on the target weeds and no objections were raised by any Caribbean organization. At the time of introduction, it was considered unlikely that, unaided, this moth would extend its range beyond the target areas. Today the Caribbean is much more conservation conscious and there is a greater awareness of the need to protect insular fauna and flora. Therefore, it is unlikely that authorization for the introduction of *C. cactorum* into the Caribbean would be permitted today.

Acknowledgments

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