EXTENDED GEOGRAPHICAL DISTRIBUTION AND HOST RANGE OF THE CACTUS MOTH, *CACTOBLASTIS CACTORUM* (LEPIDOPTERA: PYRALIDAE), IN ARGENTINA

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The cactus moth, *Cactoblastis cactorum* (Berg), is native to Argentina, Uruguay, Paraguay and southern Brazil (Mann 1969). Larvae feed gregariously inside the cladodes of many species of *Opuntia* (Cactaceae), often facilitating secondary pathogenic infections and, eventually, death of the plant (Starmer et al. 1988). In the 1920s, this moth was successfully used for the biological control of invasive *Opuntia* spp. in Australia and southern Africa, where no native cacti occur. This program represented one of the most spectacular cases of successful biological control of weeds. In 1957 the cactus moth was introduced into Nevis, an island in the Caribbean Sea, to control native *Opuntia*. The moth spread throughout the Caribbean, either naturally or by human-assisted introductions (García-Turudi et al. 1971), and in 1989 was found in the Florida Keys (Habeck & Bennet 1990). The northward geographical expansion of the cactus moth along the Atlantic and Gulf coasts of Florida was monitored intermittently (Hight et al. 2002) and estimated to be approximately 160 km/yr (Solis et al. 2004); the westward movement of the moth reached Louisiana in 2009 (Hight & Carpenter 2009). The cactus moth was detected on the Mexican islands of Mujeres in 2006 and Contoy in 2007, probably originating from islands in the Caribbean such as Cuba (Bloem et al. 2007; Hight & Carpenter 2009). Establishment of the moth represents a potential threat to the diversity of both wild and cultivated *Opuntia* species in North America (Strong & Pemberton 2000; Perez-Sandi C. 2001; Soberón et al. 2001). Bioclimatic models have been used to predict the ultimate geographical range and the potential impact of the cactus moth in North America (Soberon et al. 2001). In these models the ecological requirements of the cactus moth have been based upon the locations from which the moth has been collected. Unless the full extent of the indigenous geographical range of the cactus moth is known, bioclimatic models may under-estimate the potential invasion and impact of the moth in North America.

The native host range and the geographical distribution (Fig. 1) of the cactus moth have been reported in many studies (Heinrich 1939; Dodd 1940; Mann 1969; Zimmermann et al. 2000, 2007). However, recent detailed host range studies of *C. cactorum* populations in Argentina (unpublished data) and the discovery of its high genetic diversity (Marsico et al. 2011) have altered some of the earlier findings. For example, *C. cactorum* from central Argentina were consistently successful in attacking plants up to 8 yr old of the native species *O. quimilo* K. Schum. at high enough levels for this cactus species to be used in developmental and life table studies on *C. cactorum*. Earlier reports identified *O. quimilo* as a non-suitable host plant for *C. cactorum,* citing only occasional records of the moth attacking the youngest of plants (Dodd 1940; Mann 1969; Zimmermann et al. 1979; Zimmermann et al. 2000, 2007).

In addition, the systematics of *Opuntia* is complex and accurate identifications difficult to obtain (Kiesling 1999; Anderson 2001). Consequently, misidentifications of *Opuntia* species are common, making the cactus moth field host range not yet fully characterized. For example, *O. longispina* How. var. *corrugata* (Salm-Dyck) Backeb., reported as a non-host by Zimmermann et al. (1979, 2000), was first transferred to the genus *Tunilla* as *T. corrugata* (Salm-Dyck) Hunt and Iliff (Hunt & Iliff 2000) and finally to the genus *Airampoa* as *A.corrugata* (Salm-Dyck) Doweld (Doweld 2002). *Opuntia delaetiana* (F. A. C. Weber) Vaupel, reported as one of the cactus moth hosts by Dodd (1940) and Mann (1969) is now identified as *O. elata* Link & Otto var. *cardiosperma* (Schum.) Kiesling (Kiesling 2005). Even the identification of the original host plants, *O. monacantha* (Willd.) Haw., from which the cactus moth source population was collected for shipment to Australia (Dodd 1940) has now come under scrutiny; because this species is now considered native to Brazil (Taylor et al. 2002; Lenzi 2008) and not naturalized in Argentina, where it occurs only as an ornamental.

The known southern boundary of the *C. cactorum* distribution in Argentina was reported to be the area of La Plata (Fig. 1; 34° 56' S, 57° 56' W) in northeastern Buenos Aires province (Heinrich 1939; Dodd 1940; Mann 1969). However, recent collections of this moth indicated its presence further south. To confirm the moth's distribution and to identify potential new hosts, a field exploration for the presence of the cactus moth was conducted in May 2011 in the provinces of Buenos Aires, La Pampa, San Luis, Mendoza and Río Negro (Fig. 1).

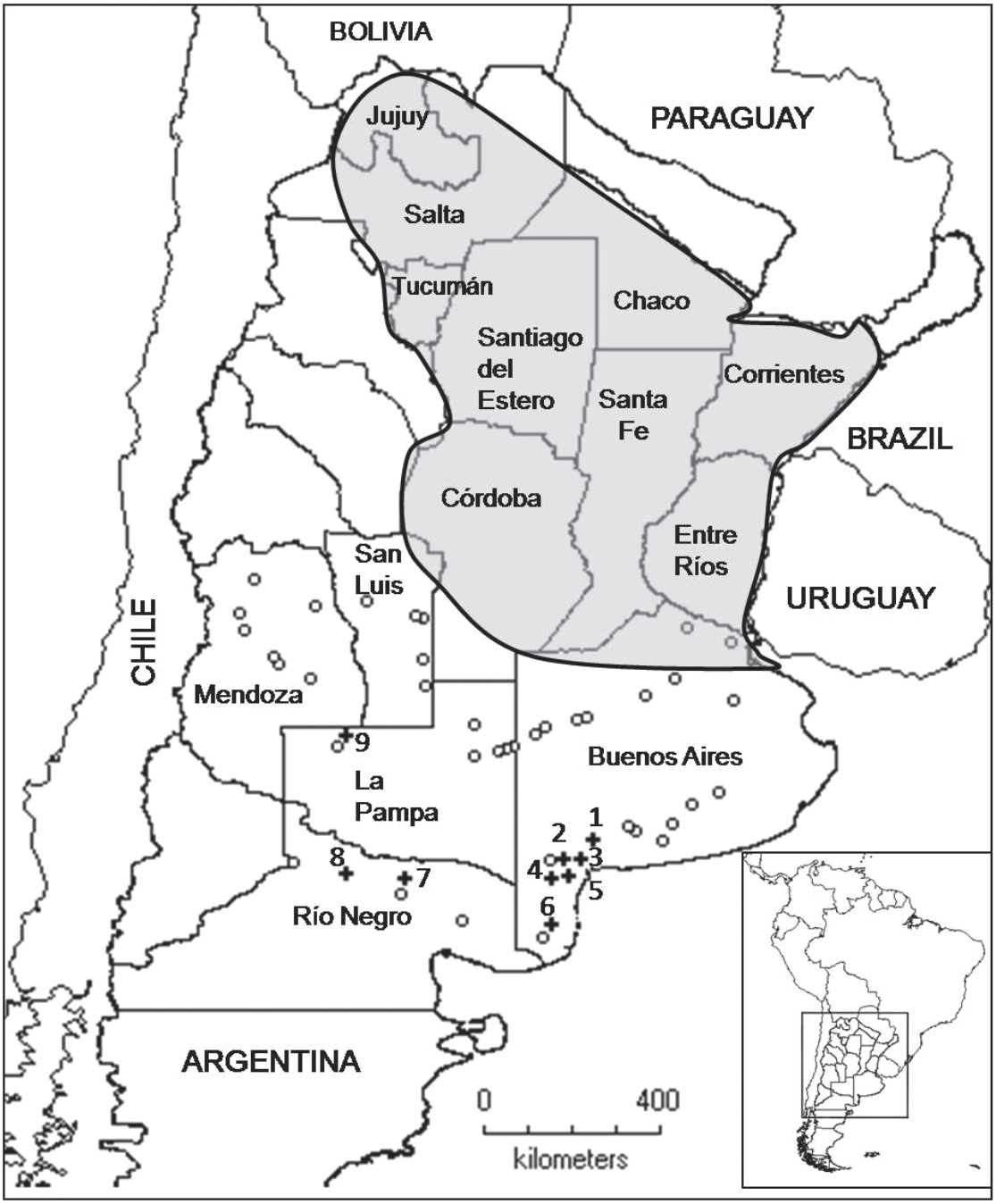

Fig. 1. Partial map of Argentina showing: (1) Known distribution (shaded area) of *Cactoblastis cactorum,* and (2) New localities surveyed: white small circles represent negative localities and black crosses (numbered) show the positive localities listed in Table 2.

A total of 1,000 *Opuntia* plants was examined at 62 roadside sites arbitrarily selected by the occurrence of host plant patches, between coordinates 32° 53' and 40° 48' S, and 58° 38' and 64° 10' W. At sites with large patches (more than 150 plants), at least 50 plants were visually inspected for the presence of moth damage on the cladodes. In small patches of less than 50 plants, all plants were inspected. Cladodes exhibiting damage from larval feeding were dissected and examined for the presence of

C. cactorum larvae. Host plants were tentatively identified in the field and voucher specimens were collected for identification and confirmation by Fabián Font (School of Pharmacy and Biochemistry, Herbario Museo de Farmacobotánica Juan Domínguez, Buenos Aires, Argentina). *Opuntia* species names were assigned according to Zuloaga et al. (2008).

Eleven *Opuntia* species were observed in the area surveyed (Table 1). Larvae of *C. cactorum* were found in the southern provinces of Buenos Aires at 6 of 26 sites, La Pampa at 1 of 11 sites, and Río Negro at 2 of 8 sites (Fig. 1). Of the 53 plants attacked, 64% were *O. megapotamica* Arechav., 34% *O. ficus-indica* L., and 2% *O. penicilligera* Speg. This is the first record of *C. cactorum* collected on the endemic species *O. penicilligera* (Table 2, Fig. 1, site #1). The southernmost collection of *C. cactorum* was in Stroeder, Buenos Aires province (Table 2, Fig. 1, site #6), on the exotic species *O. ficus-indica* and the westernmost collection was at Santa Isabel, La Pampa province (Table 2, Fig. 1, site #9), on *O. megapotamica*.

Although a survey of natural enemies was not the main purpose of this work, the parasitoid *Apanteles* sp. (Hymenoptera: Braconidae) was found in Villa Arias, Buenos Aires province on *C. cactorum* collected on *O. megapotamica.* In addition, a total of 37 larvae of different sizes collected at 7 sites within the area surveyed were examined for the presence of microsporidia. Larvae were ground individually with a homogenizer (Tissuemizer®, Tekmar Co., Cincinnati, Ohio) and a drop of the aqueous extract was examined under a phase-contrast microscope (400×) for the presence of spores. Several cactus moth larvae were found infected with abundant numbers of spores of a microsporidium, tentatively identified as *Nosema cactorum* Fantham. Infected larvae were collected in Villa Arias, Stroeder, and Buratovich, all in southern Buenos Aires province. These natural enemies should be given further attention as potential biocontrol agents.

Our findings represent an important southern extension of the geographic distribution of *C. cactorum* in its native land, approximately 800 km further south of the original limit, and should be useful in improving bioclimatic models to predict the potential geographic range in North America. Surveys further south and southwestern of the new distribution range are now advisable given the new occurrences identified here. Also, *O. penicilligera* was found to be a new native host plant of *C. cactorum*.

Summary

A field exploration was conducted to confirm the southern distribution of *Cactoblastis cactorum* in Argentina. The distribution of the moth was

Table 1. Survey at 62 roadside sites for *Cactoblastis cactorum* on *Opuntia* spp. In the provinces of Buenos Aires, La Pampa, San Luis, Mendoza, and Río Negro, Argentina.

Opuntia spp.	Number of sites with *Opuntia* sp.	Number (%) of sites with *C. cactorum*	Number of plants available	Number of plants examined	Number (%) of plants attacked
O. megapotamica Arechav.	25	5 (20)	1,050[4]	215	34 (15.8)
O. ficus-indica[1] L.	16	4 (25)	400[4]	291	18 (6.2)
O. penicilligera Speg.	2	1 (50)	25	25	1 (4)
O. bonaerensis Speg.	14	0	550[4]	167	0
O. sulphurea Gillies ex Salm-Dyck	10	0	400[4]	116	0
O. robusta H.Wendland ex Pfeiff.	4	0	29	29	0
O. arechavaletae Speg.	3	0	100[4]	41	0
O. monacantha[1] (Willd.) Haw.	2	0	40	40	0
O. elata Link & Otto var. *elata* Salm-Dyck	2	0	200[4]	50	0
O. elata Link & Otto var. *cardiosperma* (Schum.) Kiesling	2	0	22	22	0
O. microdasys[1] (Lehm.) Pfeiffer	1	0	4	4	0
Total	81[2]	10 (16.1)[3]	2,820	1,000	53 (5.3)

[1]Exotic to Argentina.
[2]Total number of sites differed from the 62 checked sites because more than one *Opuntia* spp. was found at some locations.
[3]Based on 62 sites. Total number of sites differed from positive sites (n = 9) because 2 *Opuntia* spp. were found at 1 location.
[4]Estimated.

TABLE 2. WEATHER INFORMATION AT THE 9 LOCALITIES WITH *CACTOBLASTIS CACTORUM* ON *OPUNTIA* SPP. IN THE PROVINCES OF BUENOS AIRES, LA PAMPA, AND RÍO NEGRO, ARGENTINA.

		Coordinates		Mean temperature (°C)		
#[1]	Locality	South	West	January	July	Annual precipitation (mm)
1	Dique Paso Piedras	38°24'38.3"	61°45'20.1"	20.6	6.5	607
2	Argerich	38°46'59.3"	62°38'35.2"	22.8	7.3	481
3	Villa Arias	38°49'22.2"	62°06'12.1"	21.5	7.0	522
4	Mayor Buratovich	39°14'0.21"	62°35'51.3"	22.5	7.2	453
5	La Mascota	38°47'35.6"	62°39'44.3"	22.8	7.3	481
6	Stroeder	40°10'48.9"	62°37'35.8"	21.3	7.0	380
7	Choele Choel	39°16'23.1"	65°39'16.8"	24.6	7.4	262
8	Chinchinales	39°06'46.9"	66°56'04.4"	22.2	5.8	186
9	Santa Isabel	36°13'53.1"	66°56'16.3"	24.8	6.8	280

[1]Numbers correspond to positive localities (black crosses) in Fig. 1.

found to be extended to the south (40° 10´S) and west (66° 56´W). The native species *Opuntia penicilligera* was recorded as a host for the first time. These findings should be useful in improving bioclimatic models to predict the potential geographic range of *C. cactorum* in North America.

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