

Project Summary

Petition to release *Apanteles opuntiarum* Martínez & Berta (Hymenoptera: Braconidae) for the biological control of *Cactoblastis cactorum* (Berg) in the United States



Prickly pear cactus showing necrotic tissue damage from burrowing cactus moth caterpillars.

Photo credit: <https://www.nps.gov/foma/learn/nature/pests.htm>

Background

The cactus moth, *Cactoblastis cactorum* (Berg) (Pyrilidae), is one of the best examples of successful biological control of weedy, invasive *Opuntia* Miller (Cactaceae) in Australia and many locations worldwide (Zimmermann et al. 2001). In Australia, the insect has cleared 25 million hectares (over 61 million acres) of land invaded by *Opuntia stricta* (Haw.) Haw., a plant native to the southeastern United States, and was treated as a celebrity (Dodd 1940). Based on these promising results, the cactus moth was later introduced to South Africa, Mauritius, and Hawaii (Julien and Griffiths 1998). In 1957, *C. cactorum* was introduced onto the Caribbean Island of Nevis to control native and non-native prickly pear cacti (*Opuntia* spp.) (Simmonds and Bennett 1966). Unfortunately, *C. cactorum* spread by human and natural means onto other islands, and the moth arrived in Florida in 1989 (Dickel 1991, Hight et al. 2002). With its unintentional arrival in the United States, this poster child of weed biological control lost its celebrity status and became a pest of North American *Opuntia* (Zimmermann et al. 2004).

Initial establishment, spread, and concern of an invasion by *Cactoblastis cactorum* in the United States were first reported by Habeck & Bennett (1990), Dickel (1991), and Pemberton (1995b). Funding for control efforts began after the publications by Johnson & Stiling (1996, 1998) and Zimmermann & Pérez-Sandi (1999). The rapid spread of *C. cactorum* throughout the Atlantic and Gulf coasts of the United States requires the development of immediate control measures. In the United States, the insect occurs along the Atlantic coast from North Carolina to Florida and the Gulf coast from Florida to Texas (Hight et al. 2002, Hight and Carpenter 2009, Rose et al. 2011). The moth has most recently been found just east of Corpus Christi, TX and inland to La Grange, TX (Rob Plowes, unpublished) and as far north as Brunswick County in North Carolina (Jarred Driscoll, NC Department of Agriculture and Consumer Services).

Cacti of the genus *Opuntia*, commonly called prickly pear, are one of the most important components of North American desert ecosystems. *Cactoblastis cactorum* seriously threatens 80+ native *Opuntia* species in the southwestern United States and Mexico (Stiling 2002). Wild *Opuntia* in this region provide nesting sites and food for a variety of wildlife and contribute to soil stability (Hight and Carpenter 2009). Cultivated *Opuntia* feature prominently in the landscape industry in AZ, NV, and CA, and to a lesser extent NM, and TX, with an estimated \$11.4 million retail value in AZ alone (Irish 2001, Anonymous 2018). The insect also threatens the commercial and agricultural cactus industry in Mexico, worth US \$233 million (SAGAR 2021). Continued unchecked expansion of this insect is alarming and may lead to catastrophic negative changes for western United States and Mexico arid environments and their native biological inhabitants.

Purpose and Need for the Proposed Action

The permit applicant's purpose for releasing *A. opuntiarum* is to reduce the serious threat that *C. cactorum* poses to native *Opuntia* species of the southeastern and southwestern United States and Mexico and to reduce the speed with which *C. cactorum* is spreading across the country. Current control measures for this pest have had limited success; infestations occur in expansive natural areas difficult for humans to find and/or access, and there are no existing and/or effective natural enemies of *C. cactorum* in all the invaded regions in the United States. Therefore, there is a need to identify and release an effective, host-specific biological control organism against *C. cactorum* that can be part of an area-wide and sustainable control strategy to suppress infestations of this pest. *Apanteles opuntiarum* has the potential to be an effective, host specific biological control agent against *C. cactorum* in the United States.

This release is essential due to (1) the serious threat that *C. cactorum* poses to endangered native *Opuntia* species of the southeastern and southwestern United States; (2) the speed with which *C. cactorum* is spreading across the country; (3) the need to develop an area-wide and sustainable control strategy to suppress infestations of this pest in expansive natural areas difficult for humans to find and/or access; and (4) the lack of existing and/or effective natural enemies of *C. cactorum* in all the invaded regions in the United States.

Target Organism: *Cactus Moth (Cactoblastis cactorum)*

Cactoblastis cactorum is native to Argentina, Uruguay, Paraguay, and southern Brazil, where it is distributed over a wide range of climates (Mann, 1969; Zimmermann et al., 2001). *Cactoblastis cactorum* was first detected in the United States in 1989 in the Florida Keys, collected as an adult at a light and as larvae from infested *O. stricta* (Habeck and Bennett, 1990; Dickel, 1991). It has since been reported in Georgia, Mississippi, Alabama, Florida, Louisiana, North and South Carolina, and Texas.

The female lays its eggs in the form of a chain, the first egg is attached to the end of a spine or spicule and succeeding eggs (140 or more) are stacked coin-like to form an egg-stick. When eggs hatch, the larvae crawl from the egg-stick onto the cladode or pad and burrow into it, usually within a few centimeters (cm) of the oviposition site. The larvae feed gregariously (as a group) moving from cladode to cladode as the food supply is exhausted. During feeding the frass (excrement of insect larvae) is pushed out of the pad and forms a noticeable heap on the ground. Fully developed larvae usually leave the plant and spin white cocoons in the leaf litter, in crevices in the bark of nearby trees, or in similar protected niches. Pupation occasionally occurs in the cladode. The moth emerges and the cycle is repeated (Habeck and Bennett, 1990).

Organism Proposed to be Released: *Apanteles opuntiarum*

Apanteles opuntiarum is native to Argentina and not known to occur elsewhere (Mengoni Goñalons et al. 2014, Varone et al. 2019). It was discovered and described by Martínez et al. (2012). The geographic range of *A. opuntiarum* in Argentina is the same as the distribution of *C. cactorum*, areas where plants of the genus *Opuntia* survive the hot, semiarid, and humid subtropical climates.

Apanteles opuntiarum is a tiny, **stingless** wasp. Like all parasitic wasps, the immature stages develop as parasitoids of arthropods where, in this case, feeding of the wasp larva inside the *Cactoblastis cactorum* host eventually kills the host. This insect poses no risk to humans, livestock, or wildlife.

Host Specificity Trials

Non-target host-range testing focused on species either closely related to *Cactoblastis cactorum* through phylogeny, shared ecological niche, as well as some safeguard considerations, following the selection process of Kuhlmann, Schaffner, and Mason (2006). Taxa that fit all three categories had first priority, those that fit two categories had second priority, and those that fit one category had third priority.

Apanteles opuntiarum were identified to be host-specific under laboratory no-choice host-specificity tests. Seventeen non-target species were tested. Only two larvae of the non-target *Melitara dentata* were parasitized, of 526 larvae exposed to wasps (N = 49 no-choice tests), and two larvae of the non-target *Amyelois transitella* (the agricultural pest, navel orangeworm) were parasitized, of 85 larvae exposed to wasps (N = 9 no-choice tests). Four male wasps emerged from one of the parasitized *M. dentata* larvae and zero emerged from

the other. Only one male wasp emerged from each larva of *A. transitella*. No-choice tests indicate very low levels of parasitism, behavior that disappeared in choice tests. There is no impact expected on native species.

Impact of *Apanteles opuntiarum* on *Cactoblastis cactorum*

In its native range of Argentina, *C. cactorum* is one of the major pests of the agricultural crop *O. ficus-indica*, which is not native to Argentina. In a study conducted in Argentina, *C. cactorum* was found at ~40% of plantations of *O. ficus-indica*. *Apanteles opuntiarum* was found at 44% of these infested sites (Varone et al. 2015). Based on life table studies conducted in Argentina, *A. opuntiarum* accounts for 15-20% of *C. cactorum* larval mortality (Varone et al. 2019).

Apanteles opuntiarum will likely be able to establish in most of the same regions in the United States where *C. cactorum* is currently found and expected to spread, based on ecological niche analysis (Pérez-De La O et al., 2020). Once established, the agent will suppress cactus moth populations wherever they occur and slow the spread of the pest westward. At this point, biological control is the only practical solution to target established and new *C. cactorum* populations in natural areas where host plants are widely distributed, rendering intensive management strategies too expensive. The introduction and establishment of *A. opuntiarum* will contribute to the suppression of *C. cactorum* in ecologically sensitive areas because it attacks larvae feeding inside the cactus cladode, targeting only these invasive caterpillars. *Apanteles opuntiarum* would also be able to reach areas difficult for humans to find and/or access. Sustainable and self-perpetuating, biological control agents can disperse and respond to pest population changes.

Literature cited

Anonymous. 2018. Economic contributions of Arizona's green industry. *in* A. F. O. o. U.-N. A. S. Service, editor.

Dickel, T. S. 1991. *Cactoblastis cactorum* in Florida (Lepidoptera: Pyralidae: Phycitinae). *Tropical Lepidoptera* **2**:117-118.

Dodd, A. P. 1940. The biological campaign against prickly pear. Commonwealth prickly pear board, Brisbane, Queensland, Australia.

Habeck, D. H., and F. D. Bennett. 1990. *Cactoblastis cactorum* Berg (Lepidoptera: Pyralidae), a phycitine new to Florida. Fla. Dept. Agric. & Consumer Serv. Division of Plant Industries, Entomology Circular **333**.

Hight, S., and J. Carpenter. 2009. Flight phenology of male *Cactoblastis cactorum* (Lepidoptera: Pyralidae) at different latitudes in the southeastern United States. *Florida Entomologist* **92**:208-216.

Hight, S., J. Carpenter, K. Bloem, S. Bloem, R. Pemberton, and P. Stiling. 2002. Expanding geographical range of *Cactoblastis cactorum* (Lepidoptera: Pyralidae) in north America. *Florida Entomologist* **85**:527-529.

Irish, M. 2001. The ornamental prickly pear industry in the southwestern United States. *Florida Entomologist* **84**:484-485.

Johnson, D., and P. Stiling. 1996. Host specificity of *Cactoblastis cactorum* (Lepidoptera: Pyralidae), an exotic *Opuntia*-feeding moth, in Florida. *Environmental Entomology* **25**:743-748.

Johnson, D., and P. Stiling. 1998. Distribution and dispersal of *Cactoblastis cactorum* (Lepidoptera: Pyralidae), an exotic *Opuntia*-feeding moth, in Florida. *Florida Entomologist* **81**:12-22.

Julien, M. H., and M. W. W. Griffiths. 1998. *Biological Control of Weeds. A World Catalogue of Agents and Their Target Weeds*. 4th edition. CABI, Wallingford, UK.

Kuhlmann, U., U. Schaffner, and P. G. Mason. 2006. Selection of non-target species for host specificity testing. *in* F. Bigler, editor. *Environmental impact of invertebrates for biological control of arthropods: methods and risk assessment*. CABI Bioscience, Delémont, Switzerland.

Mann, J. 1969. *Cactus-feeding insects and mites*. Smithsonian Institution Press, Washington, D.C.

Martínez, J. J., C. Berta, L. Varone, G. Logarzo, P. Zamudio, A. Zaldívar-Riverón, and R. G. Aguilar-Velasco. 2012. DNA barcodes and morphological identification of the southern South American species of *Apanteles* (Hymenoptera: Braconidae) parasitoids of cactus feeding moths (Lepidoptera: Pyralidae: Phycitinae). *Invertebrate Systematics* **26**:435-444.

Mengoni Goñalons, C., L. Varone, G. Logarzo, M. Guala, M. Rodriguero, S. Hight, and J. Carpenter. 2014. Geographical range and laboratory studies on *Apanteles opuntiarum* (Hymenoptera: Braconidae) in Argentina, a candidate for biological control of *Cactoblastis cactorum* (Lepidoptera: Pyralidae) in North America. *Florida Entomologist* **97**:1458-1468.

Pemberton, R. W. 1995b. *Cactoblastis cactorum*: An immigrant or introduction? *American Entomologist* **41**:230-232.

Pérez-De La O, N., S. Espinosa-Zaragoza, V. Lopez-Martínez, S. Hight, and L. Varone. 2020. Ecological niche modeling to calculate ideal sites to introduce a natural enemy: The case of *Apanteles opuntiarum* (Hymenoptera: Braconidae) to control *Cactoblastis cactorum* (Lepidoptera: Pyralidae) in North America. *Insects* **11**.

Rose, R., R. Weeks, and S. Usnick. 2011. *Cactus Moth, Cactoblastis cactorum*. 2011 Survey Plan for PPQ and State Cooperators. *US Department of Agriculture, Animal and Plant Health Inspection Service*, Washington, D.C.

SAGAR. 2021. (Secretaría de Agricultura, Ganadería y Desarrollo Rural) Anuario Estadístico de la Producción Agrícola de los Estados Unidos Mexicanos. Centro de Estadística Agropecuaria, MéxicoD.F. México.

Simmonds, F. J., and F. D. Bennett. 1966. Biological control of *Opuntia* spp. by *Cactoblastis cactorum* in the Leeward Islands (West Indies). . Entomophaga **11**:183-189.

Zimmermann, H., V. Moran, and J. Hoffmann. 2001. The renowned cactus moth, *Cactoblastis cactorum* (Lepidoptera: Pyralidae): Its natural history and threat to native *Opuntia* floras in Mexico and the United States of America. Florida Entomologist **84**:543-551.

Zimmermann, H., V. Moran, and J. Hoffmann. 2004. Biological control in the management of invasive alien plants in South Africa, and the role of the Working for Water programme. South African Journal of Science **100**:34-40.

Zimmermann, H. G., and M. Pérez -Sandi. 1999. A new insect pest on Opuntiae in wait for Mexico. Pages 333-341 in J. R. A. R. a. J. A. R. Agüero, editor. Proc. VIII Congreso Nacional y VI Congreso Internacional sobre Conocimiento y Aprovechamiento del Nopal, University of San Luis Potosí, Mexico.