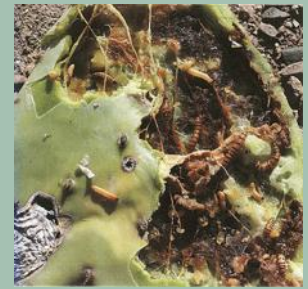




MISSISSIPPI STATE UNIVERSITY



Cactus Moth Update



Volume 2, Issue 4

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GRI Scientists Participate in *Cactoblastis cactorum* Field Surveys in South America

By Gary Ervin
Department of Biological Sciences

In December, GRI scientists Gary Ervin and Christopher Brooks completed a research expedition to Argentina and Uruguay to collect samples for ecological and genetic studies of *C. cactorum* (Fig. 1). USDA-ARS scientist Laura Varone (South American Biological Control Lab, Argentina) guided the trip, which was accompanied by Ph.D. student Paula Zamudio from the National University of Tucuman, Argentina (Fig. 2). Zamudio is working on a comprehensive morphological study of the genus *Cactoblastis*, and Varone is the primary scientist investigating *C. cactorum* biology in its native range.

Egg and larvae samples of *Cactoblastis* were collected from *Opuntia* species at seven locations in Uruguay and eight locations in Argentina from 51 locations inspected, most in the vicinity of Salto, Uruguay, and Concordia, Argentina. These samples should be processed during Spring 2011 to obtain genetic data for our current native range dataset, which was published in Marsico et al. (2010). Once we have genetic data from these new moth samples, we should be able to quickly produce new environmental models (e.g., Fig. 1) to determine whether the ex-

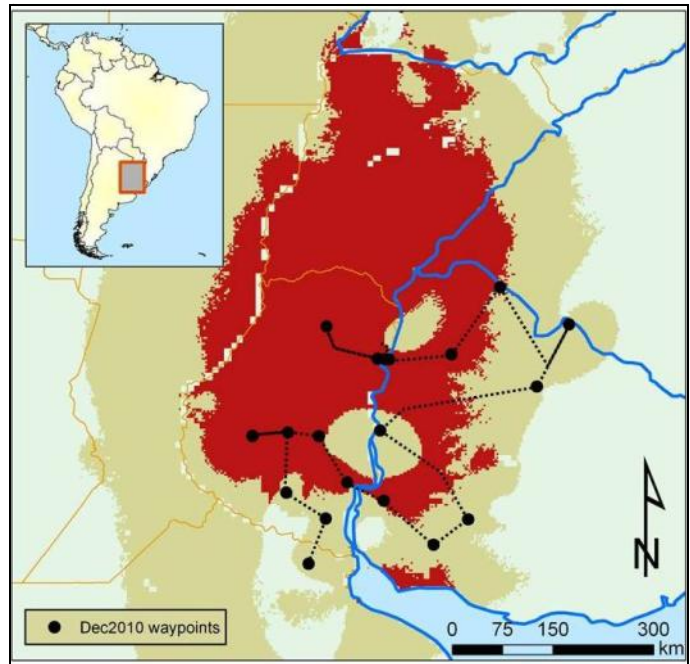


Fig. 1. Map of December 2010 *Cactoblastis cactorum* sampling trip in Argentina and Uruguay. Points represent cities and major intersections along our route. Shading represents predicted habitat suitability for the East Argentina genetic group of *cactoblastis*, with darker shading indicating higher probability of suitable habitat. We focused our sampling effort at defining the easternmost area of *C. cactorum* habitat and on increasing our genetic information for the eastern genetic haplotype group. Locator map indicates the portion of Argentina and Uruguay represented in the larger map.

panded sampling improves prediction quality outside the native range.

In addition to *Cactoblastis* sampling, we collected tissues from *Opuntia* species encountered on this trip for submission to Lucas Majure (Ph.D. student, University of Florida) to aid in determining the host species from

which our samples were collected (Figs. 2, left and 3). Although we know roughly the species of cacti that are present in the moth's native range, the importance of hosts that has been indicated by our collaborative studies with Argentine researchers requires we be as certain as possible as to host identities. Majure is developing

The latest on:

- Cactus moth reproduction
- The search for cactus moth
- Cactus moth online training
- Cactus Moth Detection and Monitoring Network
- Cactus moth genetics
- Other cactus moth research

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GRI Scientists Participate in *Cactoblastis cactorum* Field Surveys in South America, cont.



Fig. 2. Left: Ervin, Varone and Zamudio collecting *Opuntia* tissue near Ceibas, Argentina. Middle: Brooks inspecting *C. cactorum* damage on a pad of *O. ficus-indica* collected near Concordia, Argentina. Right: Ervin found the cactus moth queen emerging from a cactus pad in Buenos Aires.

an updated phylogeny of *Opuntia* species and plans to use our tissue collections in his work, which also will provide information on the *Opuntia* species diversity from our work in South America.

Following the South American research trip, Gary Ervin,

Christopher Brooks, and Richard Brown were invited participants in a symposium on *Cactoblastis cactorum* during the 2010 conference of the Entomological Society of America, in San Diego, CA. The symposium was organized by USDA-ARS scientists and included papers from scientists in MS, FL, GA, CA, and MD, as well as Canada, Mexico, Guatemala, and Argentina. Prior to the conference, all participants were led on a field survey of southern Califor-

nia cacti by Dr. Jon Rebman of the San Diego Natural History Museum (Fig. 4).

References
 Marsico, T. D., L. E. Wallace, G. N. Ervin, C. P. Brooks, J. E. McClure, and M. E. Welch. 2010. Geographic patterns of genetic diversity from the native range of *Cactoblastis cactorum* (Berg) support the documented history of invasion and multiple introductions for invasive populations. *Biological Invasions*, In press. DOI: 10.1007/s10530-010-9874-9

Fig. 3. An example of the diversity of *Opuntia* hosts observed during our December 2010 field research. At least six native South American species were likely observed during the trip.



Fig. 4. Richard Brown, far left, and others listen as Dr. Jon Rebman, San Diego Natural History Museum, describes cacti and other desert plants during a field trip organized as part of the *Cactoblastis* symposium at the Entomological Society conference, San Diego, CA.



Much More Cactus Moth Host Found During Additional Texas Surveys and Host Population Connectivity Studied

By Victor Maddox, Robyn Rose and Ken Bloem
Geosystems Research Institute and USDA-APHIS

Host and pest surveys were conducted in MO (October), MS (November), LA and TX (November and December) during the fourth quarter of 2010. Although a total of 144 host reports were collected in Missouri in October, most survey activity was conducted in south Texas along the border with Mexico (Fig. 1) and inland Texas to study host population connectivity.



Figure 1. Rio Grande canyon wall in distance and Mexico beyond south of Highway 90 between Shumla and Langtry, TX. (Photo by Victor Maddox).

trip was conducted to investigate connectivity between the gulf coast and the San Antonio, TX, area. Just over 151 host reports were collected during the trip, including 127 positive and 24 negative host reports.

Cactus moth was not found during the surveys and select host data was reported to USDA-APHIS daily during the

planned for early 2011.

Although *Opuntia engelmannii* Salm-Dyck ex Engelm. was the most common species identified, other *Opuntia* spp. were observed along the south Texas border (Figure 3). During the surveys, new CMDMN host counties and associate species were added to the CMDMN database, particularly from Texas. Host population connectivity issues are still being studied and will be presented to USDA-APHIS in 2011.



Figure 2. Sanderson, TX, sign on Highway 90 north of Big Bend National Park which illustrates the abundance of pricklypear along the southwest Texas border with Mexico. (Photo by Victor Maddox).

In November, a 6-day survey trip was focused on surveying for host and cactus moth in southwest Texas along the border (Fig. 1) from Eagle Pass to Sanderson, TX (Fig. 2), as well as, host connectivity areas between coastal and inland populations in south Texas. Just over 370 reports were collected during the trip, including 299 positive and 72 negative host reports. In late November and early December a 5-day host and cactus moth mapping

surveys. Complete data is being entered into the Cactus Moth Detection and Monitoring Network (CMDMN) database. Over 500 host reports were collected during the two trips to Texas. Based upon these surveys, the actual host number in the survey areas in south Texas is estimated to be in the hundreds of thousands. More survey trips are



Figure 3. *Opuntia strigil* Engelm. is one of several species observed during the fourth quarter surveys in Texas. This species occurs only in Texas and Mexico. (Photo by Victor Maddox).

Over 500 host reports were collected during the two trips to Texas. Based upon these surveys, the actual host number in the survey areas in south Texas is estimated to be in the hundreds of thousands.

Although much basic information on the cactus moth has been obtained during the past 80 years, an individual egg of *C. cactorum* has never been photographed nor compared with eggs of other cactus feeding species, in part because the eggs are deposited as an egg stick that is covered with secretions from the colleterial gland.

Eggs of Exotic and Native Species of Cactus Moths

By Gerry T. Baker and
Richard L. Brown
Department of Entomology

During research on the internal anatomy of the cactus moth, mature eggs in the ovariole of females of the cactus moth were discovered. Although much basic information on the cactus moth has been obtained during the past 80 years, an individual egg of *C. cactorum* has never been photographed nor compared with eggs of other cactus feeding species, in part because the eggs are deposited

as an egg stick that is covered with secretions from the colleterial gland.

Because it has been impossible to remove all these

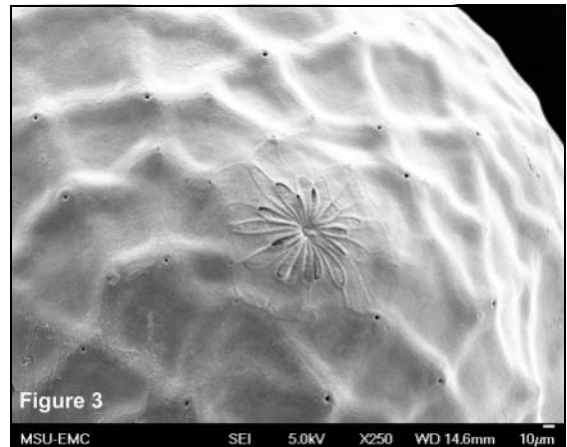


Figure 3. Micropylar area of *Melitara prodenialis* egg.

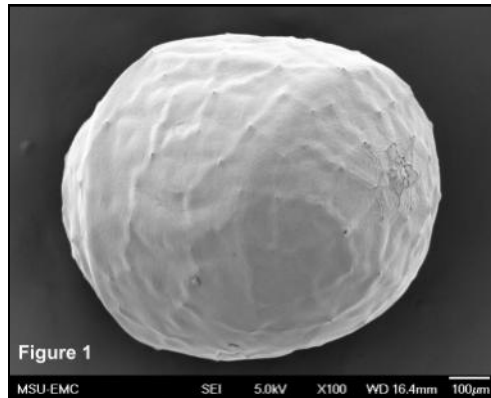


Figure 1. Egg of *Cactoblastis cactorum*.

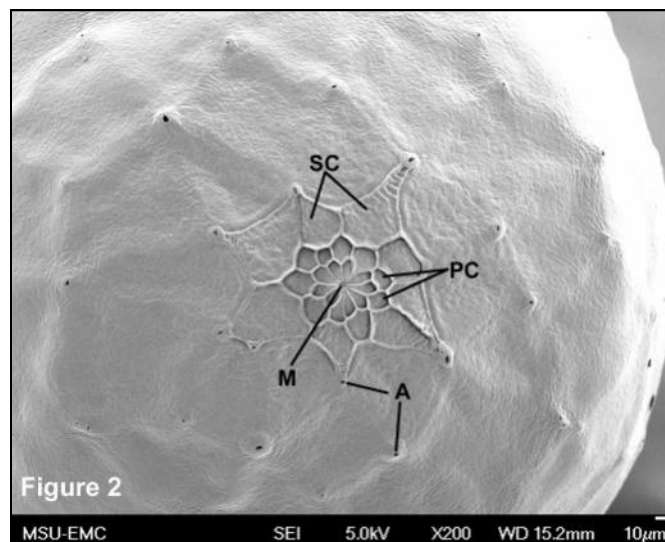


Figure 2. Micropylar area of *Cactoblastis cactorum* egg, A— aeropyles; M—micropyles; PC—primary cells; SC—secondary cells).

secretions from the eggs for adequate imaging, several females of both *C. cactorum* and *M. prodenialis* were dissected in Ringer's solution to remove the first egg (the most mature) from each ovariole. The extracted eggs were then proc-

essed and critically point dried for scanning electron microscopy.

The eggs of *C. cactorum* and *M. prodenialis* are globular and slightly flattened, but less so than after being oviposited in the egg stick. The ridges on the surface of *C. cactorum* eggs are not as distinct as those on *M. prodenialis*, and the chorionic surface of both species have many aeropyles for respiration. At high magnifications the surface of the chorion of both species has a rugose appearance. The most distinct differences in the chorion of the two species occurs in the micropylar region where sperm enter the egg.

The primary cells around the micropyle are delineated by very distinct carinae. The primary cells around the micropyle of *C. cactorum* are short, angular cells, whereas the cells of *M. prodenialis* are long and looping. The carinae fade and form the secondary cells around the primary ones in both species. A major difference with the secondary cells between the two species, besides their shape, is the presence of aeropyles on the raised areas of the apices of the cells.

The CMDMN online system has been in place for a few years now and has served the needs quite well. However, in an effort to keep up with current technology plans are being made for an overhaul of the underlying system and the website.

Cactus Moth Detection and Monitoring Network

By Cliff Abbott
Geosystems Research Institute

Surveying land to find cactus locations is easy...on the side of the road or in someone's front yard. However, cactus plants have the tendency to live and grow in the hard to reach places as well. Surveying through the woods, through swamps, or through river bed areas are not as easy to do. That level of surveying takes time and extreme caution. Because of the difficulty in surveying hard to reach areas, large cactus populations are missed. These missed populations may have infestations if they are in the leading edge.

Recently, we were notified of potentially large cactus populations along the Pearl River in south Louisiana and plans are being made to survey more extensively in that area in early 2011. Extensive surveying has been ongoing in Texas and cac-

us populations are estimated to be in the hundreds of thousands throughout Texas. More surveying is planned for 2011. The CMDMN online system has been in place for a few years now and has served the needs quite well. However, in

an effort to keep up with current technology plans are being made for an overhaul of the underlying system and the website. Plans for a more robust user account module, mapping module, and database interface are being planned.

Using the Cactus Moth Detection and Monitoring Network on Web-Enabled Mobile Devices

By Cliff Abbott
Geosystems Research Institute

Many people have mobile devices that are capable of taking pictures and grabbing GPS coordinates. This is a volunteer-base that can be a great asset in finding cactus locations and for monitoring the cactus moth. Tapping into this resource will

be a great step for CMDMN.

Efforts are underway in identifying the methods at which we can utilize the mobile device in the effort to fight the cactus moth. Among these methods is adapting the website to be more mobile-friendly. The CMDMN website provides a lot of cactus and moth informa-

tion, not to mention the survey system as well. We are currently researching the best way to provide all of that information to the mobile device in a way that will the volunteer to identify the cactus species, and possibility the moth larvae, as well as submit surveys to the system.

Collaborations

Cliff Abbott provided a short presentation to the Organization of Fish and Wildlife Information Managers, Cadiz, KY on Oct 19, 2010.

Cliff Abbott attended training on the Global Invasive Species Information Network at the NAISN Meeting, Boise, ID on Nov 15-17, 2010.

Richard Brown and **Sangmi Lee** (Fig. 1) attended the Cooperative Agricultural Pests Survey (CAPS) National Conference, December 1-3, 2010 and provided demonstrations and identification aids for the cactus moth and other exotic

Gary Ervin, Christopher Brooks, and **Richard Brown** were invited participants in a symposium entitled "The Multiple 'Personalities' of *Cactoblastis cactorum*: A Multi-Disciplinary Response to the Biological Impacts of the Moth's Geographical Wanderings" as part of the annual meeting of the Entomological Society of America, 12-15 December 2010 in San Diego, CA. The symposium was organized by USDA-ARS scientists and included papers from scientists in MS, FL, GA, CA, and MD, as well as Canada, Mexico, Guatemala, and Argentina.

Biological Control Lab, Argentina) and accompanied by Ph.D. student Paula Zamudio from the National University of Tucuman, Argentina. Zamudio is working on a comprehensive morphological study of the genus *Cactoblastis*, and Varone is the primary scientist investigating *C. cactorum* biology in its native range.

Victor Maddox provided a 5 min MSU cactus moth project update during a USDA teleconference hosted by USDA-APHIS on 5 Oct 2010.

Victor Maddox attended the Mississippi Cooperative Weed Management Area Board Meeting, 21 Oct 2010, MS Farm Bureau Board Room, Jackson, MS.

Victor Maddox attended the Fall Mississippi Exotic Pest Plant Council Meeting, 3 Nov 2010. Mississippi Department of Transportation Office, Hattiesburg, MS.

Victor Maddox provided a workshop on the Cactus Moth Detection and Monitoring Network for the Texas Parks and Wildlife Department in La Grange, TX, on 2 Dec 2010.

Victor Maddox provided a workshop on the Cactus Moth Detection and Monitoring Network for the Texas Parks and Wildlife Department in Pleasonton, TX, on 3 Dec 2010.



Figure 1. Sangmi Lee, left, and Richard Brown demonstrate identification methods for exotic species at the CAPS Conference.

species of Lepidoptera. More than 200 attendees from all states attended this conference.

Richard Brown collaborated with Maurice Duffel, USDA-APHIS, to provide identifications of cactus moths captured after initiation of SIT trials on Barrier Islands of Mississippi.

Gary Ervin and **Christopher Brooks** traveled to Argentina and Uruguay during December 2010 to collection additional samples and information on geographic distribution and host associations of *C. cactorum*. They were guided on this trip by USDA-ARS scientist Laura Varone (South American



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Publications and Presentations

Publications:

Brooks, C., & Ervin, G. N. (2010). Genetic Diversity of *Cactoblastis cactorum* in the Moth's Native Range and Implications for Future Spread. Entomological Society of America Annual Conference. San Diego, CA.

Abbott, C. F. (2010). The Invasive Plant Atlas of the Mid-South and the Cactus Moth Detection and Monitoring Network: Keeping Up With Technology. The Organization of Fish and Wildlife Information Managers 2010 Conference. Cadiz, KY: The Organization of Fish and Wildlife Information Managers.

Brooks, C. P., & Ervin, G. N. (2010). The global invasion of *Cactoblastis cactorum* (Berg). Ecological Society of America annual conference. Pittsburg, PA.

Brown, R.L. & Lee, S. Adult Lepidoptera Screening & Identification. National Cooperative Agricultural Pest Survey (CAPS) Conference. Kansas City, MO.

Simonsen, T., Brown, R., & Sperling, F. Evolution of cactus feeding in Pyralidae and phylogeography of *Cactoblastis cactorum* in the southeastern United States. 58th Annual Meeting of the Entomological Society of America. San Diego, CA.

Maddox, V. L. (2010). How Big is Pricklypear in Texas? August 2010 Cactus Moth Program Weekly Activity Report. USDA-APHIS, Pensacola, FL.

Marsico, T. D., Woodard, A. M., & Ervin, G. N. (2010). Novel defenses in invasion

resistance: Potential eavesdropping may cue inducible defenses against an invasive herbivore. Ecological Society of America annual conference. Pittsburg, PA.

Marsico, T. D., Woodard, A. M., & Ervin, G. N. (2010). Potential Eavesdropping May Cue Inducible Defenses Against an Invasive Herbivore. Entomological Society of America Annual Conference. San Diego, CA.

Marsico, T. D., L. E. Wallace, G. N. Ervin, C. P. Brooks, J. E. McClure, and M. E. Welch. (2010). Geographic patterns of genetic diversity from the native range of *Cactoblastis cactorum* (Berg) support the documented history of invasion and multiple introductions for invasive populations. Biological Invasions DOI: 10.1007/s10530-010-9874-9

Professional Presentations:

Maddox, V. L. (2010). Cactus Moth Detection and Monitoring Network Workshop: Texas Parks and Wildlife Department. Texas Parks and Wildlife Department Office, Pleasanton, TX.

Maddox, V. L. (2010). Cactus Moth Detection and Monitoring Network. Texas Parks and Wildlife Department Office, La Grange, TX.

Ervin, G. N. (2010). North Meets South Meets North Again: A Global Series of Species Introductions. Department of Biological Sciences, University of Alabama, Tuscaloosa, AL.

Ervin, G. N. (2010). Ecological genetics of the cactus moth *Cactoblastis cactorum* at home and abroad. US Geological Survey National Biological Information Infrastructure Invasive Species Working Group teleconference.

Maddox, V. L. (2010). Cactus Moth Detection and Monitoring Network Workshop: Fish and Wildlife Service. Aransas National Wildlife Refuge, Austwell, TX.

Woodard, A. M., Marsico, T. D., & Ervin, G. N. (2010). Evaluating Differential Defense Response In Two Native Cactus Species. Mississippi State University Biology Undergraduate Research Symposium. Mississippi State University.

Marsico, T. D., Ervin, G. N., Brooks, C. P., Counterman, B. A., Wallace, L. E., & Welch, M. E. (2010). Using next-generation sequencing approaches to investigate reciprocal recognition and response in plant-herbivore interactions. MidSouth Computational Biology and Bioinformatics Society, 7th annual conference. Arkansas State University, Jonesboro, AR.

Madsen, J. D. (2010). Developing GIS-based invasive species programs: From red-necks to remote sensing, terabyte servers, and parallel computing. National Biological Information Infrastructure, Biogeospatial Working Group Seminar. U.S. Geological Survey, Reston, VA.

www.gri.msstate.edu/cactus_moth