



MISSISSIPPI STATE  
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# Cactus Moth Update



Volume 1, Issue 2

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## The latest on:

- The spread of cactus moth hosts
- The search for cactus moth
- Cactus moth sensory structures
- Cactus Moth Detection and Monitoring Network
- Cactus moth genetics
- Other cactus moth research

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## Prickly Pear Cactus from Dixie to the Pacific Northwest

By Victor Maddox  
Geosystems Research Institute

An invasive species mapping trip in conjunction with the 36<sup>th</sup> Natural Areas Conference, Vancouver, WA, was conducted from Sept. 11-21, 2009. Host mapping was conducted in 13 western states including AR, CA, CO, ID, KS, MO, NE, NV, OK, OR, UT, WA, and WY. The roundtrip was 5,356 miles. Over 830 host reports were generated during the trip. Although most were negative host reports (host not present), many positive reports for *Opuntia* were recorded primarily from NE and KS. Most were natural populations of plains pricklypear (*Opuntia tortispina* Engelm. & J.M. Bigelow).

There is some confusion regarding the identification of *Opuntia tortispina*. And it has been listed conspecific with *Opuntia cym-*



Figure 2. Habitat where *Opuntia tortispina* Engelm. & J.M. Bigelow was found in western NE with limber pine (*Pinus flexilis* James) communities surrounded by grass dominated communities. (Image by Victor Maddox).

*chila* Engelm. & J.M. Bigelow in the Flora of North American ([http://www.efloras.org/florataxon.aspx?flora\\_id=1&taxon\\_id=242415182](http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242415182)) and conspecific with *Opuntia macrorhiza* Engelm. var. *macrorhiza* in PLANTS (<http://plants.usda.gov/java/profile?symbol=OPMAM3>). However, the morphology of the plants found is most similar to *Opuntia tortispina* (Fig. 1).

Fig. 1. *Opuntia tortispina* Engelm. & J.M. Bigelow in western NE with little bluestem [*Schizachyrium scoparium* (Michx.) Nash], sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), and soapweed yucca (*Yucca glauca* Nutt.). Native cactus moth (inset) was found at the same location. (Photo by Victor Maddox).



Native cactus moth (sample provided to Richard Brown, Department of Entomology, Mississippi State University) was found on *Opuntia tortispina* in W. NE (N41.16860 W104.03017) near the WY state line. Habitat was rocky (Fig. 2) and associate species included limber pine (*Pinus flexilis* James) (dominate tree species), little bluestem [*Schizachyrium scoparium* (Michx.) Nash], sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), soapweed yucca (*Yucca glauca* Nutt.), and western poison ivy [*Toxicodendron rydbergii* (Small ex Rydb.) Greene]. These scattered communities were surrounded by larger grass-dominated communities. Limber pine, little bluestem, sideoats grama, soapweed yucca, and western poison ivy are distributed over a large area in the western United States and it is not clear how closely *Opuntia tortispina* is associated within this range.

## Prickly Pear Cactus (cont.)

All data forms collected during the trip will be entered into the Cactus Moth Detection and Monitoring Network database. Host data from five new states (ID, OR, WA, WY and NE) is included in the data set. In

addition, data from new areas of five other states is also included in the data set including western MO, northern CA, northern NV, northern UT, and western CO. Montana and North Dakota will be the only

two remaining states in the NW without data forms in the CMDMN. This data should expand what the CMDMN currently knows about the host.

**“Although previous research has documented the response of various cactus moth sensilla to plant volatiles, no information is available on the types, distribution, and relative abundance of the various antennal sensilla in the cactus moth.”**

## Sensory Structures on the Antennae of Cactus Moth

**By Richard L. Brown**  
Department of Entomology

Typical of all Lepidoptera, the antennae of cactus moths, *Cactoblastis cactorum*, have sensory structures for detecting pheromones, locating host plants, and detecting environmental conditions. Six types of antennal sensillae are ubiquitous in Lepidoptera: 1) Sensillum trichodeum (pheromone receptors in males, plant volatile receptors in females), 2) Sensillum basiconicum (plant volatile receptors in females); 3) Sensillum auriculicium (plant volatile receptors in females); 4) Sensillum coeloconicum (olfactory); 5) Sensillum chaeticum (taste and mechanoreceptors); and 6) Sensillum styloconicum (temperature and humidity sensors). Although previous research has documented the response of various cactus moth sensilla to plant volatiles, no information is available on the types, distribution, and relative abundance of the various antennal sensilla in the cactus moth.

Research is in progress on the sensilla of female and male antennae of the cactus moth to determine the types of sensilla present, their relative abundance, and their distribution on the individual antennal subsegment (flagellomere). Scanning electron microscopy (SEM) has been combined with micro-

scope slide preparations of descaled antennae to obtain diversity and distribution of sensilla. Some sensilla, e.g., coeloconica and chaetica, are easily identified with a compound microscope, but others require use of the SEM for identification.

The number of flagellomeres (“segments”) were counted in the antennae from five individuals of each sex of the cactus moth. The number of flagellomeres range from 60 to 89 ( $\bar{x} = 76$ ) in males and 67-79

in females ( $\bar{x} = 73$ ) in females. Variation in number of flagellomeres was correlated with the forewing length. Cactus moth males and females have all six types of antennal sensilla, with sensilla trichodea represented by two types, A and B (Fig. 1). Examinations of SEM images and slide mounts have revealed that sensilla are restricted to the ventral half of each flagellomere whereas the remainder is covered by scales (Fig. 1). Examinations of slide mounts revealed that a female antenna averaged 3.6 sensilla coeloconica for each of 68 flagellomeres, whereas a male antenna averaged 4.9 sensilla coeloconica for each of 69 flagellomeres. These data suggest that this sensillum in the male is a more important receptor for olfaction of chemicals than in the female. Sensilla

chaetica, which are known to be gustatory receptors, are present in almost equal numbers (either one or two present on each flagellomere) among males and females. In females the sensilla chaetica are positioned at the apical end of the ventral surface of each flagellomeres. In males, these sensilla are irregular in position, sometimes occurring on the dorsal surface intermixed with scales. Sensilla styloconica, which respond to temperature and humidity, are present on the apical margin of each flagellomeres of the apical two-thirds of the antenna in each sex.

Additional antennae need to be examined to determine variation in distribution and number of sensilla. Additional scanning electron microscopy is needed to differentiate sensilla trichodea and sensilla basiconica. These data on diversity, abundance, and distribution of sensilla in the cactus moth will be compared with those for the native cactus moth, *Melitara prodenialis* to determine any differences between the two species for host location.

### Sensory Structures (cont.)

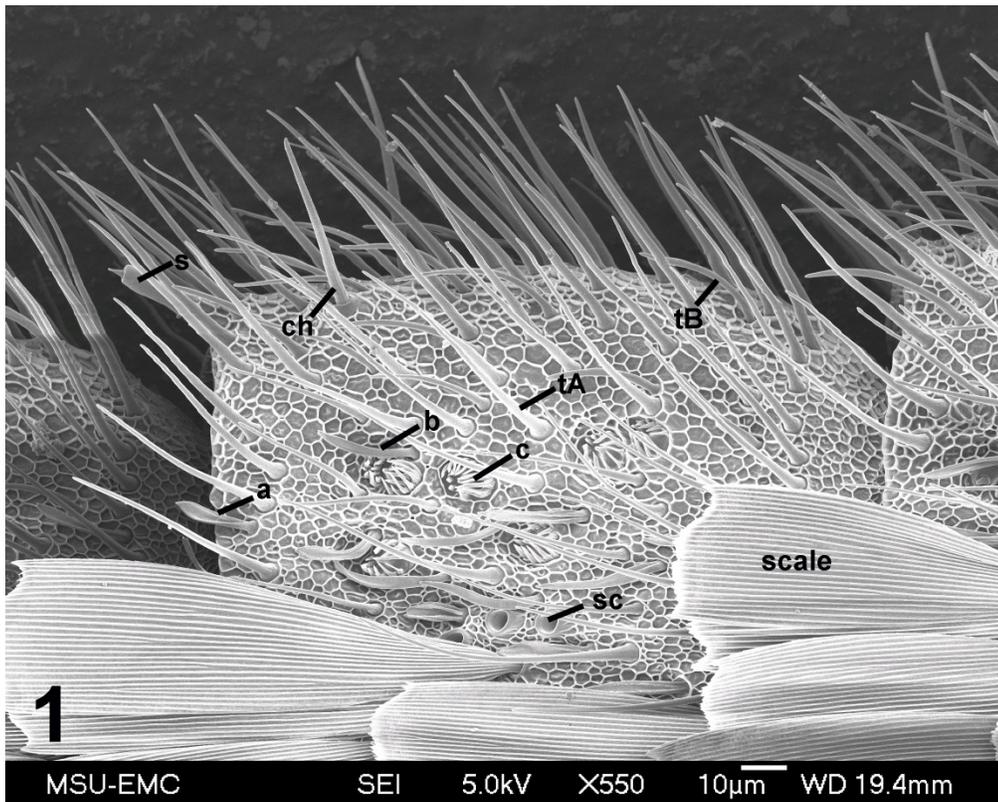


Figure 1. Sensilla on flagellomere near middle of female antenna of cactus moth, a – auricillum, b – basiconicum, c – coeloconicum, ch – chaeticum, sc - socket of scale, t – trichodeum, types A and B.

### Cactus Moth Detection and Monitoring Network Update

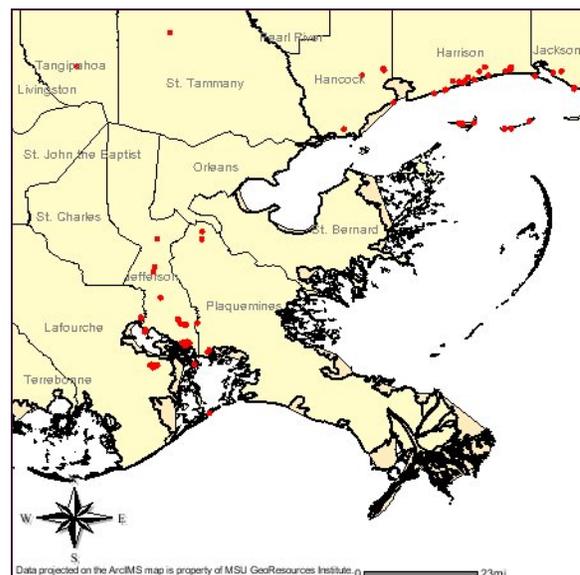
**By Clifton Abbott**  
Geosystems Research Institute

Surveys are continuing to be submitted into the Cactus Moth Detection and Monitoring Network. This quarter has seen an additional 1532 survey sites reporting both the presence and absence of pricklypear cactus populations across the nation. These surveys include the Southeast Louisiana Parishes where the cactus moth was recently detected.

The Cactus Moth Detection and Monitoring Network can be visited at [http://www.gri.msstate.edu/cactus\\_moth](http://www.gri.msstate.edu/cactus_moth).

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Figure 1. This CMDMN map shows the presence of *Opuntia* Populations in Southeast LA.



## *Opuntia* and *Cactoblastis* Habitat Models and Population Genetics



**Genetic analyses were completed for *C. cactorum* in its native range in Argentina, its invasive range in Florida, and for *Melitara prodenialis* across its native Floridian range.**

**By Gary N. Ervin**  
Department of Biological Sciences

Our proposed work for 2009-2010 encompasses three major areas of research – continued habitat modeling efforts based on our large data set from the *C. cactorum* native range, continued genetic studies in *Opuntia* and cactophagous moths, and experimental studies of growth performance of *C. cactorum* and native U.S. cactus moths on native southeastern US *Opuntia* species. The following is an update on progress towards our proposed deliverables for 2010.

### **A. Analyses of comparative growth chamber studies.**

We initiated a controlled laboratory experiment aimed at investigating unique defense responses from prickly pear hosts to feeding by *C. cactorum* (invasive moth) and *M. prodenialis* (native). We have completed one generation of *C.*

*cactorum* and are nearing the ends of one generation of *M. prodenialis* and a second of *C. cactorum*. Results of the first generation of *C. cactorum* were presented at a meeting in Tifton, GA in August. In addition to collecting data on moth growth and survival and cactus growth, we have preserved tissue samples from all stages of the experiments for use in future molecular analyses.

### **B. Analyses of genetic data resulting from Argentina sampling trips.**

We completed genetic analyses for *C. cactorum* in its native range in Argentina, its invasive range in Florida, and for *Melitara prodenialis* across its native Floridian range. These analyses have been incorporated into a manuscript that will be submitted in early October. They also were included in a presentation at the Tifton, GA meeting and will form the basis for continued collaborations with the USDA ARS scientists at Tifton and Buenos Aires, Argentina.

### **C. Calibration of environmental tolerance models for *Cactoblastis*, based on data collected in the two Argentina research trips.**

We have begun work to integrate habitat modeling studies with results we have obtained to date from our genetic analyses (i.e., modeling habitat for specific genotypes). We have two manuscripts in development based on this habitat modeling work, and these studies were included in the presentations and discussions at the Tifton, GA meeting. We also will be using these findings to help direct the collaborative work with USDA ARS scientists.



## Argentinean Scientists Visit MSU

By Gary Irvin  
Department of Biological Sciences

Gary Ervin and Travis Marsico, along with Christopher Brooks of the MSU Biology Department, were invited to visit the USDA Agricultural Research Service's Crop Protection and Management Research Laboratory in Tifton, GA, to participate in research collaborations related to the South American cactus moth research program. Also in attendance were USDA ARS scientists from Tifton (James Carpenter) and Tallahassee, FL (Stephen Hight), and from the USDA ARS South American Biological Control



Post-doctoral researcher Travis Marsico (far right) provides Guillermo Logarzo (middle) and Laura Varone (USDA ARS, Buenos Aires) an overview of his field research in Florida.



Varone and Logarzo checking out Mississippi pitcher plants (*Sarracenia alata*) at Sandhill Crane NWR.

Research Laboratory in Buenos Aires, Argentina (Guillermo Logarzo and Laura Varone). They are collaborating in the design of studies to examine the degree of isolation among *Cactoblastis cactorum* genotypes identified through ongoing genetic research at MSU.

Following the meeting in Tifton, Logarzo and Varone were invited to return to Mississippi with Ervin and colleagues. Tours were arranged for facilities at Mississippi State University, as well as natural and cultural areas in the state.

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ongoing genetic  
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MSU.

*Cactoblastis* workgroup at USDA-ARS Crop Protection and Management Research Laboratory, Tifton, GA, August 2009. From left: Brooks, Marsico, Ervin, Carpenter, Logarzo, Hight, Varone.



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## Publications July—September 2009

### Peer-Reviewed Journals

Simpson, A., Jarnevich, C., Madsen, J. D., Westbrooks, R., Fournier, C., Mehrhoff, L., Browne, M., Graham, J., & Sellers, E. (2009). Invasive species information networks: collaboration at multiple levels for prevention, early detection, and rapid response to invasive alien species. *Biodiversity*, 10(2), 5-13

### Conference Presentations

Maddox, V. L., Abbott, C. F., Madsen, J. D., & Westbrooks, R. (2009). New Developments with the Cactus Moth (*Cactoblastis cactorum* Berg.) Detection and Monitoring Network Efforts. 36th Natural Areas Conference. Vancouver, WA.

### Professional Presentations

Madsen, J. D., Brown, R. L., Ervin, G. N., Maddox, V. L., & Abbott, C. F. (2009). Update on the GRI Cactus Moth Detection Network. Invasive Species Working Group. Teleconference: National Biological Information Infrastructure, Invasive Species Information Node.

Ervin, G. N., T. D. Marsico, and C. P. Brooks. 2009. Reassessing expectations for *Cactoblastis cactorum* (Berg) spread in North America. Research Collaboration Workshop at the USDA ARS Crop Protection and Management Research Laboratory, Tifton, GA, August 13, 2009.

Marsico, T. D. and G. N. Ervin. 2008. Chew 'em up and spit 'em out: Prickly pear defenses elicited from native but not invasive moths. Research Collaboration Workshop at the USDA ARS Crop Protection and Management Research Laboratory, Tifton, GA, August 13, 2009.

### Awards

Simonsen, T.J., R.L. Brown, and F.A.H. Sperling. 2008. Tracing an Invasion: Phylogeography of *Cactoblastis cactorum* (Lepidoptera: Pyralidae) in the United States based on Mitochondrial DNA. Awarded Best Article of 2008 by the Entomological Society of America, October 1, 2009.

[www.gri.msstate.edu/cactus\\_moth](http://www.gri.msstate.edu/cactus_moth)