Turfgrass and Environmental Research Online

…Using Science to Benefit Golf

Researchers at the University of Florida are investigating how well a parasitic fly, *Ormia depleta*, imported from Brazil, can serve as part of a biological control strategy for mole crickets in Florida and surrounding southern states.

Volume 1, Number 9
July 1, 2002

PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 215 projects at a cost of $21 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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A Parasitic Fly that Kills Mole Crickets

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SUMMARY

University of Florida research is investigating how a parasitic fly, *Ormia depleta*, imported from Brazil, may offer a level of biological control of mole crickets in Florida and surrounding states. Developments in this project include:

- A southern strain of the parasitoid fly *Ormia depleta* from 30ºS in Brazil is now in culture at the University of Florida Entomology & Nematology Department. There is no current evidence that the fly exists south of 30ºS in South America.
- Despite releases in North Carolina, Georgia, Louisiana and Texas, there is yet no evidence that stock of this new strain of the fly has become established in states north of Florida. Releases will continue.
- The new strain is slightly better adapted to development and survival at lower temperatures, but there is yet no evidence that it can pass the winter in diapause. Investigation continues.
- *Ormia depleta* adults depend upon insect-produced honeydew for energy, not on nectar from plants. This long-sought information offers hope that established populations of the fly, such as exist in central and southern Florida, can be enhanced to provide improved local control of pest mole crickets in a process similar to "butterfly gardening."

From coastal North Carolina south to Florida and west to Texas, mole crickets are major problems on golf courses. Huge sums of money are spent on pesticides every year to control them, and this seems only to give temporary relief from the problem. What would it take to get some level of permanent control?

Not all mole crickets are pests (3). Although the northern mole cricket (*Neocurtilla hexadactyla*) gets into turf, it seldom becomes numerous enough to do any damage. At least one of the reasons for that is because it is native to the eastern USA and has native natural enemies that keep its numbers in check. These natural enemies include a wasp (*Larra analis*) and a beneficial nematode (*Steinernema neocurtillae*) that seem to attack only this species of mole cricket. The services of these parasites are free wherever they occur naturally and provide permanent control.

The tawny mole cricket (*Scapteriscus vicinus*), southern mole cricket (*Scapteriscus borellii*), and short-winged mole cricket (*Scapteriscus abbreviatus*) are not native to the USA. All three of these pests arrived about 100 years ago and left their natural enemies in their South American homelands. The University of Florida Mole Cricket Research Program began to investigate and import those natural enemies in the 1980s. Currently, two of those imported natural enemies are established year-round in the Gainesville, Florida area. Together they provide about 95% control of tawny and short-winged mole crickets (2). Numbers of tawny and southern mole crickets in the Gainesville area are about 95% less than they were in the 1980s due to action of another wasp (*Larra bicolor*) and another beneficial nematode (*Steinernema scapterisci*) from South America.

Will Hudson and two Brazilian colleagues wait to catch mole crickets swimming to shore in a pool in a sand pit near Pelotas, Brazil in December, 1998. Sand containing mole crickets has just been shovelled into the water, and mole crickets must swim to shore or drown.

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An *Ormia depleta* pupa next to a dead adult mole cricket. The mole cricket was killed by an *Ormia depleta* larva that then became this pupa. Up to five fly larvae may develop successfully in an adult mole cricket, and the process is always fatal to the mole cricket no matter the number of fly larvae.

What is remarkable about these imported wasps and nematodes is that they now occur all around the Gainesville area and provide area-wide control, free. Year by year, the area occupied by this wasp and nematode keeps increasing naturally, so that the area where mole crickets are controlled expands.

This article is about a third biological control agent, a fly called *Ormia depleta* that was imported by the University of Florida Mole Cricket Research Program in 1987 and released in 1988. By having a third biological control agent for mole crickets, the overall level of control for mole crickets may be improved. In addition, this fly may help establish biological control of mole crickets in states north of Florida, such as the Carolinas, where mole crickets are also a serious problem.

The Fly: *Ormia depleta*

The initial stock of flies imported to Florida came from Piracicaba, a subtropical city at about 23°S in Brazil. Rearing methods were devised (9), and flies were initially released at three localities: Gainesville (north Florida), Bradenton (central Florida), and Miami (south Florida). Establishment of populations occurred at all three places. Research sponsored by the Florida Turfgrass Association in 1990-1991 which included 28 participating golf courses, allowed for releases to be made at these golf courses in 16 counties covering all regions of Florida.

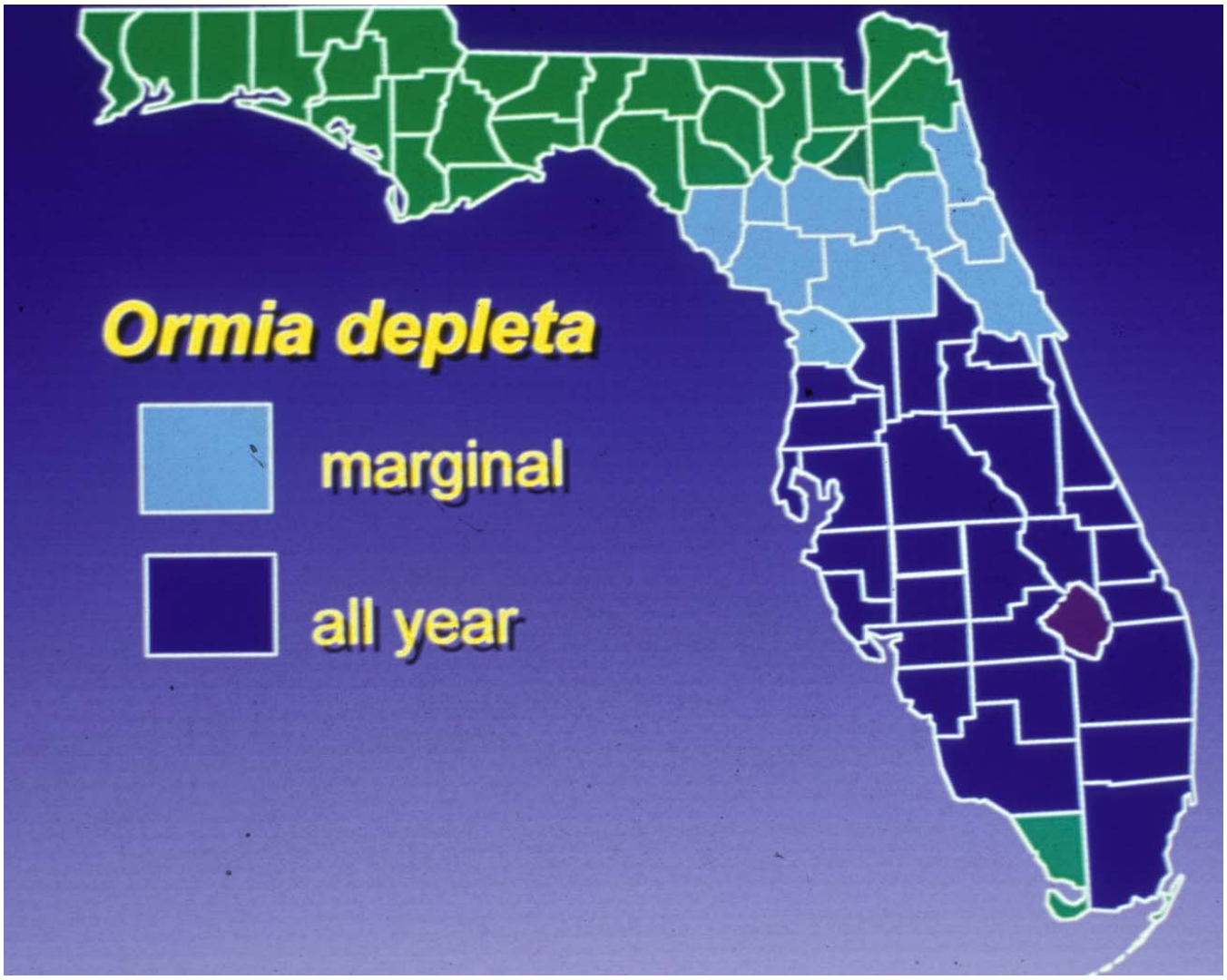
By the end of 1994, a continuous population of this fly had been established in 38 contiguous peninsular counties (4), but not farther north. The fly seemed to be poorly adapted to survive the winters north of about 28°N. This seems reasonable since it had come from a subtropical area (7).

Lack of expansion of the *Ormia depleta* population in north Florida suggested that its origin was too tropical, and that it could not survive winters in north Florida because it was unable to diapause. Diapause is a condition (like hibernation) in which individuals enter dormancy during winter (or other periods when resources are not available). It was hoped that additional flies could be collected from farther south in South America, in an area with colder winters, where the local population of flies can diapause. These hardier flies could then be used to expand biological control of mole crickets in the U.S. to states north of Florida.

How New *Ormia depleta* Were Obtained

In 1998, the USGA funded a project that would explore the southernmost part of Brazil for a stock of *Ormia depleta*, bring that stock back to quarantine in Florida, and provide flies for release in other southern states. Despite extensive efforts to obtain the flies in 1998, the necessary permit was not processed in time by the Brazilian government, and no flies were brought back to the United States at that time. However, Dr. Howard Frank, University of Florida, returned to Brazil early in February, 1999. He was able to collect seven gravid (pregnant) females and remove hundreds of larvae from these flies. Laboratory-reared mole crickets in Gainesville were inoculated with these larvae, and a culture was started.

The new (Osório) strain of *Ormia depleta* has been maintained in culture since. The flies have been reared using laboratory-reared short-winged mole crickets as hosts. When generations of flies were produced that contained more than



Although releases were made in southern, central, and northern Florida, *Ormia depleta* seemd to be poorly adapted to survive winters north of about 28^{o}N.

10% gravid females, the "surplus" (those that were not essential to maintain the culture) was shipped to other states for release. In 2000-2001, shipments of flies were made to collaborating entomologists in North Carolina, Georgia, Louisiana, and Texas for release in those states.

Each shipment consisted of either approximately 200 fly pupae or six to ten gravid female flies. Recipients were expected to release the flies and after a few months, begin monitoring the release area for establishment of a population. To date, no recipient has reported establishment of the flies. Nonetheless, attempts to establish populations in other states continue. Additional flies were shipped to Louisiana in May, 2002.

Discoveries about the Fly

In the laboratory, adult flies failed to survive long unless they were provided with artificial plant nectar (a mixture of sugars). It had been expected that adult flies in the wild need nectar from some unknown plant or group of plants. Identifying those plants was difficult because the flies are active only at night. One attempt made by the University of Florida Mole Cricket Research Program was to identify pollen grains attached to the bodies of field-trapped *Ormia depleta* (old strain) in Florida in hopes of identifying plants from which adult flies obtain nectar.

A second attempt to understand the flies' diet was made by entomology graduate student Craig Welch. He trapped adult flies at Bradenton

Ormia depleta pupa (two views).

(central Florida), took samples of their gut contents, and analyzed the sugars present by chromatography, a technique that allows each sugar present to be identified. Surprisingly, the main sugar present was melezitose (8). This sugar is not normally present in plant nectars, but is the principal component of honeydew. Honeydew is the sugary excretion of homopterous insects (aphids, mealy bugs, etc.). This means that the success of using this type of biological control depends on having honeydew-excreting insects in the area.

The principle is the same for butterfly gardening where, if we want to enhance butterfly populations locally, we must provide the plants from which butterflies obtain nectar. This work is continuing and is investigating what homopterous insects on what plant hosts can be used to enhance *Ormia depleta* populations locally. In other words, how can we provide those resources in the landscaping of golf courses that will lay the foundation for biological control of mole crickets without causing other problems such as unsightly insect-infested plants?

The famed Doral golf course in Miami was one of the sites where *Ormia depleta* flies were released in 1990. Steve Kuhn, then superintendent, thought the fly had achieved about 90% control of pest mole crickets there. Craig Welsh's research findings offer an explanation of that high level of success. Doral has a rich landscape of tropical and subtropical plants which can support homopterous insects (aphids, mealy bugs, etc.) throughout the year. It is likely that these newly released flies had the honeydew sources need for their diets from the homopterous insects living on those tropical and subtropical plants of the golf course landscape.

Future research

The simplest and least expensive research is to determine whether the new strain of *Ormia depleta* can undergo diapause. If this new fly strain can do so, it will immediately be useful in other states, and releases will continue in other states until new populations of flies are established there. If the new strain cannot diapause, then one option is to determine whether it can be produced in adequate numbers for annual inoculative release each spring in other states. However, it will take improvements in rearing methods for both mole crickets and the fly, as well as improvements in the proportion of flies becoming gravid before such a strategy becomes viable.

It might be possible to produce a diapausing strain of the fly by genetic engineering, but this would undoubtedly be a very expensive option because the genetics of this fly have not yet been investigated. However, in view of the importance of mole crickets as a serious golf course pest, this should not be ruled out.

Wherever populations of the fly have become established, there is a strong and inexpensive option of enhancing their populations by providing honeydew sources. It is hoped that by finding the right plants to support honeydew-producing insects, enough parasitic flies can be produced to effectively and permanently control mole crickets. Current research is aimed at this possibility in hopes of benefiting hundreds of golf courses affected by mole crickets.

Acknowledgments

USGA funding made possible collection of the new strain of *Ormia depleta* from southern Brazil, its maintenance in culture in Florida, and shipment of stock of it to other southern states. Dr. Luiz Salles (EMBRAPA, Pelotas) provided essential help in southern Brazil. E. Buss and F. Slansky kindly reviewed an early draft of this manuscript.

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