CARIBBEAN FOOD CROPS SOCIETY

46

Forty-six
Annual Meeting 2010

Boca Chica, Dominican Republic
Vol. XLVI

PROCEEDINGS

OF THE

46th ANNUAL MEETING

Caribbean Food Crops Society
46th Annual Meeting
July 11 – 17, 2010

Boca Chica, Dominican Republic

"Protected Agriculture: A Technological Option for the Competitiviness of the Caribbean"

Edited
by
Wanda I. Lugo and Wilfredo Colón

Published by the Caribbean Food Crops Society

ISSN 95-07-0410

Copies of this publication may be obtained from:

Secretariat, CFCS
P.O. Box 40108
San Juan, Puerto Rico 00940

or from:

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Agricultural Experiment Station
Jardín Botánico Sur
1193 Calle Guayacán
San Juan, Puerto Rico 00926-1118

Proceedings of the Caribbean Food Crops Society. 46:50-57. 2010

TOWARDS ERADICATION OF GIANT AFRICAN SNAIL *ACHATINA FULICA* BOWDICH IN TRINIDAD AND TOBAGO

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ABSTRACT: The giant African snail (*Achatina fulica*) is a serious plant pest and is listed in the world's worst 100 invasive alien species. It is reported to feed on about 500 species of plants. In October 2008 the pest was discovered in Trinidad at Alyce Glen, in the Diego Martin Valley, which is in the northwest of the island. Delimiting surveys indicated that the pest was confined to an area < 1.0 km^2; therefore, eradication strategies were implemented in November 2008. A four-pronged approach was initiated to eradicate *A. fulica*, including surveillance, collection and destruction of snails, application of snail baits and public education. Additionally, recommendations were made to declare *A. fulica* a "Notifiable Pest" by legislation. More than 1400 snails were collected in November and December 2008 and between May and August 2009, the pest was found at three other locations (Goodwood Gardens, Blue Range and Westmoorings) within the Diego Martin Valley, where the collection of snails and baiting continued. Approximately 5833 snails were collected over a 17-month period, from November 2008 to March 2010. More than 1000 properties including drains, empty lots and parks were surveyed. Island-wide surveillance indicated that the snail was contained in the Diego Martin Valley. About 10,000 cumulative properties were treated with 2.0 tonnes of snail bait containing 3.0% metaldehyde, some properties more than 28 times. By March 2010 no snails were being sighted, all of which could be due to the severity of the drought period and the action taken. The eradication programme is promising success. Monitoring and public awareness are ongoing exercises.

Keywords: eradication, giant African snail, Trinidad, *Achatina fulica*

INTRODUCTION

The giant African snail (GAS), *Achatina fulica* Bowdich (Mollusca: Achatinidae), is a serious plant pest which is recognized as one of the worlds worst 100 invasive alien species (AQIS, 2008; Global Invasive Species Database, 2010). The snail attacks over 500 species of economic plant species but has a preference for breadfruit (*Artocarpus* sp.), cassava (*Manihot esculenta*), cocoa (*Theobroma cacao*) and most species of legumes and cucurbits (Mead, 1979; Lambert, 1999).

Achatina (Lissachatina) fulica originated in East Africa and is now widely distributed throughout the Indian and Pacific Basins. In the Americas, it is found in Ecuador, Venezuela and Brazil and on many Caribbean islands, including Guadeloupe (1984), Martinique (1988), Marine Galante and Saint Martin (1995), Dominica (2007), Antigua (2008) (Robinson and Fields, 2010). The pest was discovered in Trinidad in October 2008. The eggs are pale yellow or cream in colour, oval in shape, and 4 to 5 mm in diameter. They are laid in clutches of 100 to 400 three to four times per year, even more than 500 per clutch, depending on maturity of the snail and environmental conditions. Most of the eggs are laid during the wet season in soil debris, depressions, and under objects. Eggs hatch in 1 to 17 days. The average life span of *A. fulica* is four to five years, but they may live up to nine years in captivity (Robinson and Fields, 2010). *Achatina fulica* has the potential to rapidly multiply and establish itself in a relatively short time in a new environment. *Achatina fulica* is nocturnal, more active in the rainy season and more abundant after heavy rains. It can be seen at night, late evening, and early morning, when they feed. During the day it hides in cool sheltered areas and can be found in bricks and

crevices on walls and other concrete surfaces, in plant detritus, and within the plant canopy and under plants. Symptoms of its presence include defoliation, extensive rasping of plant material, slime trails and ribbon-like faeces (David Robinson, personal communication). *Achatina fulica* may aestivate during dry weather conditions and will emerge from aestivation when conditions become humid and wet to feed and multiply. It is hermaphrodite and copulation is reciprocal to produce viable eggs. Sperm can be stored for more than a year after a single mating and a single fertilized adult snail can establish a whole colony (Robinson and Fields, 2010).

Several factors are responsible for *A. fulica* to survive and multiply in Trinidad. There is evidence to suggest that it was imported illegally into the country in an upscale community located in a northwest valley in the Northern Range. Since its discovery in October 2008 at Alyce Glen, *A. fulica* was found at Goodwood Gardens, Westmoorings, and Blue Range, all within the Diego Martin Valley. The soil has a high content of calcium carbonate and year round shrubs, lawns and trees are well maintained. There is high rainfall and humidity during the wet season and there appear to be no predators or natural enemies of the snail in the environment. Although crucifers, cucurbits, and legumes are frequently attacked (Poucher, 1975), no such plants have been observed to be damaged by the snail in the Diego Martin Valley. Some damage was observed in *Heliconia* sp. and *Spathiphyllum* sp. In Guadeloupe, damage was reported on sugar cane seedlings, cucumber, yam, dasheen, banana and papaya, whereas in St. Lucia, papaya, mango, breadfruit, and some ornamentals were damaged. In Barbados, there were unconfirmed reports of damage to breadfruit, sweet potato, cabbage and cucumber (Robinson and Fields, 2010).

Achatina fulica can become a nuisance to households and housing communities. It multiplies in such large numbers that it may not be possible to walk a pathway without crushing the snail. Living snails leave ribbon-like faeces and slime trails on walls, floors and concreted pathways defacing them, and dead and decomposing snails leave an obnoxious scent on properties.

Achatina fulica is a vector of the parasitic nematode *Angiostrongylus cantonensis*, the rat lungworm, which causes eosinophilic meningitis in humans. This nematode also affects livestock. *Achatina fulica* is also a vector of bacteria such as *Aeromonas hydrophilia* and *Salmonella*, which can cause several diseases in humans. The pest is a known vector of plant pathogens, for example *Phytophthora* spp. which cause black pod rot of cocoa and affect other crops such as coffee, banana and papaya.

The management of *A. fulica* can be costly since it is listed as a major agricultural pest. USDA (1982) has estimated that an annual loss of $US 11 million in 1969 would have occurred if this mollusc had not been controlled. Outbreaks of *A. fulica* have been successfully eradicated in Australia and Florida, USA. In 1977, an outbreak was successfully eradicated in Gordonvale, Queensland, Australia, and in 1984 in the Currumbin Valley through an extensive surveillance and baiting programme. In Florida, nine major residential areas in Dade and Broward counties were infested with giant African snail, which was successfully eradicated in 1975 at a cost of $US 1.0 million.

At the first meeting of the Technical Working Group (TWG) on *A. fulica* it was determined that this pest be treated as a priority. The TWG is part of a network of Plant Health Directors in the region that includes the Inter-American Institute for Cooperation in Agriculture (IICA), the Food and Agriculture Organization (FAO), and the USDA-APHIS. The network was set up by the CARICOM Secretariat to assist member countries in coping with plant pests.

With the discovery of *A. fulica* in Trinidad, it became obligatory that this country take action to mitigate the effects of the pest. The objectives of this study, therefore, were to eradicate *A. fulica* since it was confined to the Diego Martin Valley, and to fulfill the requirements to determine pest-free status for *A. fulica* in Trinidad and Tobago.

METHODOLOGY

A four-pronged approach was used against *A. fulica*, including surveillance, collection and destruction of snails, application of snail baits and public education. Additionally, a National Task Force against giant African snail was formed, and recommendations were made to declare *A. fulica* a Notifiable Pest. Samples of snails collected were also screened for *Angiostrongylus cantonensis*.

Delimiting Surveys

Delimiting surveys were conducted to determine the boundaries of the four infested areas which were termed Core Zones. Protection and Public Outreach Zones were also established in accordance with USDA APHIS New Pest Response – giant African snail (2005).

Collection of snail/application of snail baits

Every plot of land in each of the core zones (including households, empty lots, abandoned lots, parks, road edges, drains and rivers) within a 200-m radius (core zone) from the index case was surveyed. Beyond the core zone (protection zone) random checks were made 50 m apart in all directions. At each location, snails were sought under leaf litter, in discarded boxes, on walls and shrubs, in drains, brick holes and crevices. *Achatina fulica* found (dead and alive) were counted, then bagged, labelled and returned to the laboratory. Snail baits containing 3.0% metaldehyde were applied according to manufacturer's recommendations to all areas within the core zone fortnightly.

Monitoring Surveys

Monitoring surveys were also conducted fortnightly to determine changes in the population over time and to assess the efficacy of the implemented programme. Five residential plots were randomly selected within the core zone at Alyce Glen to undertake snail population studies. Five pieces of plywood (30 x 30 cm) were randomly placed in each of the five plots to create a cool, dark and shaded environment to attract *A. fulica.* Snail bait containing 3.0% metaldehyde was applied according to the manufacturer's recommendations to the entire property and under the plywood traps every fortnight thereafter. Baiting began 13 November 2008. Before application of bait to each of the plots, all live and dead snails were collected, counted, bagged, labelled and removed. Data collected fortnightly were counts of live and dead snails under the traps and also from the rest of the infested plots.

In July/August, the same procedure was implemented at Goodwood Gardens, Westmoorings and Blue Range, except that plywood traps were not used because there were no snails found under them at Alyce Glen, furthermore a few home owners refused to have traps on their property.

Rainfall data were obtained from Trinidad and Tobago Meteorological Services, Piarco.

Public Education

Information on *A. fulica* was disseminated through several avenues: brochures, factsheets and posters, television, newspapers, town meetings, seminars, digital boards, and the Ministry's website http:www.//agriculture.gov.tt. A telephone hotline was also established to monitor and detect *A. fulica*. This telephone line was dedicated to receiving calls on snail sightings and to allow for emergency response.

Testing for *Angiostrongylus cantonensis*

Nine samples (a sample consists of 6 to 9 GAS) of *A. fulica* were sent to the Veterinary Laboratory to test for the rat lungworm, *A. cantonensis*.

Notifiable Pest Status for *A. fulica*

A request was made of the Honourable Minister of Agriculture, Land and Marine Resources to have *A. fulica* declared a Notifiable Pest under Act 13 of 1975.

RESULTS AND DISCUSSION

Delimiting Surveys

Delimiting surveys conducted in Diego Martin at known sites of infestation confirmed that *A. fulica* existed within a 1.0-km² area at each of the four sightings. These areas of known infestation were termed "Core Zones" outside of which the Protection and Public Outreach Zones were identified.

Collection of snails/application of snail bait

Approximately 5833 snails (*A. fulica*) were collected over a 17-month period from November 2008 to March 2010 (Table 1). Most times after baiting there was a greater amount of dead snails than live snails. In March 2010 no live snails were recovered from Diego Martin (Table 2).

Table 1. Number of giant African snails (GAS), *Achatina fulica*, collected at Diego Martin, November 2008 – March 2010

Year	No. of GAS
October – December 2008	1349
January 2009 – March 2010	4484
Total	5833

Table 2. The total number of *Achatina fulica* collected from January 2009 – March 2010

Months	Live	Dead	Total (Live/Dead)	Rainfall* mm
Jan 2009	5	325	330	108.9
Feb 2009	3	87	90	171.8
Mar 2009	0	46	46	28.4
Apr 2009	0	23	23	18.7
May 2009	0	1	1	72.9
Jun 2009	0	8	8	110.5
July 2009	143	62	205	324.1
Aug 2009	480	113	593	340.8
Sep 2009	104	606	710	113.5
Oct 2009	121	321	442	122.9
Nov 2009	372	811	1183	192.9
Dec 2009	114	330	444	57.1
Jan 2010	18	313	331	17.6
Feb 2010	7	60	67	2.1
Mar 2010	0	11	11	4.4
Total	1367	3117	4484	

*Source: Meteorological Office, Piarco, Trinidad

During the period of March 2009 to June 2009, no live snails were found. These results showed promising success of the programme at Alyce Glen. However, by July the snail had been sighted at three other locations within the Diego Martin Valley. Snails were also reported from previously inaccessible properties at Alyce Glen, the initial location of infestation (core zone).

There appears to be a correlation between the number of snails collected and rainfall. The increase in the number of snails between July and December 2009 coincided with increase in rainfall during that period and decreased during the drier months from January to March in 2009 and 2010 (Table 2).

The decline in the number of live snails by January to March 2010 may be attributed to the intensive baiting and collection activities. Each property was baited an average of 16 times over an eight-month period whereas others were baited over 28 times. More than 1000 properties including drains, vacant lots, and parks, were surveyed and approximately 10,000 cumulative properties were treated with 2.0 tonnes of snail bait containing 3.0% metaldehyde.

The dry weather conditions also may have contributed to snail decline since *A. fulica* is known to aestivate during unfavourable weather conditions. In February 2010 the Meteorological Office reported that Trinidad and Tobago was experiencing drought conditions.

Monitoring Surveys

The results of the monitoring surveys from July/August 2009 to March 2010 for the four core zones collectively are summarized in Table 3.

Table 3. Total *Achatina fulica* population dynamics from July 2009 to March 2010, Trinidad

Months	Live	Dead	Total (Live/Dead)	Rainfall mm
July 2009	31	3	34	324.1
Aug 2009	135	6	141	340.8
Sep 2009	22	415	437	113.5
Oct 2009	118	185	303	122.9
Nov 2009	8	3	11	192.9
Dec 2009	48	11	59	57.1
Jan 2010	6	17	23	17.6
Feb 2010	7	17	24	2.1
Mar 2010	0	6	6	4.4
Total	375	663	1038	

The total number of snails collected from July to October 2009 increased from 34 to 303 during these wet months, and thereafter declined during the drier months. According to Mead (1979) snail activity is highest during rainy weather and slows down or stops during dry periods. However, the decline in snail numbers could also be attributed to the baiting and collection activities, which could give an indication of the effectiveness of the eradication programme.

Public Education

Fifteen thousand (15,000) brochures and fact sheets on *A. fulica* were distributed in the core, protection and public outreach zones at Diego Martin. In addition, posters were placed on billboards and at strategic locations in all counties, and another 5000 brochures were distributed to county offices for general distribution.

Five seminars and two town meetings were held to train stakeholders on identification of *A. fulica* and to increase public awareness. A full-page advertisement was placed in the three daily newspapers in August/September 2009, and a 30-second advertisement was aired on the three television stations from September to December 2009.

There were also advertisements on two digital boards; one at the entrance to the Diego Martin Velley and the other at the airport. As a result of advertisements from August to December 2009, there was a peak in hotline calls to 249 in September (Figure 1). The total number of calls received was 852; 841 of which were investigated. Twenty-three or 2.7% of the calls investigated was positive for *A. fulica* (Table 4) and were located within the core zones. All other calls outside of Diego Martin were negative, all of which would indicate that the snail was still confined to the Diego Martin Valley.

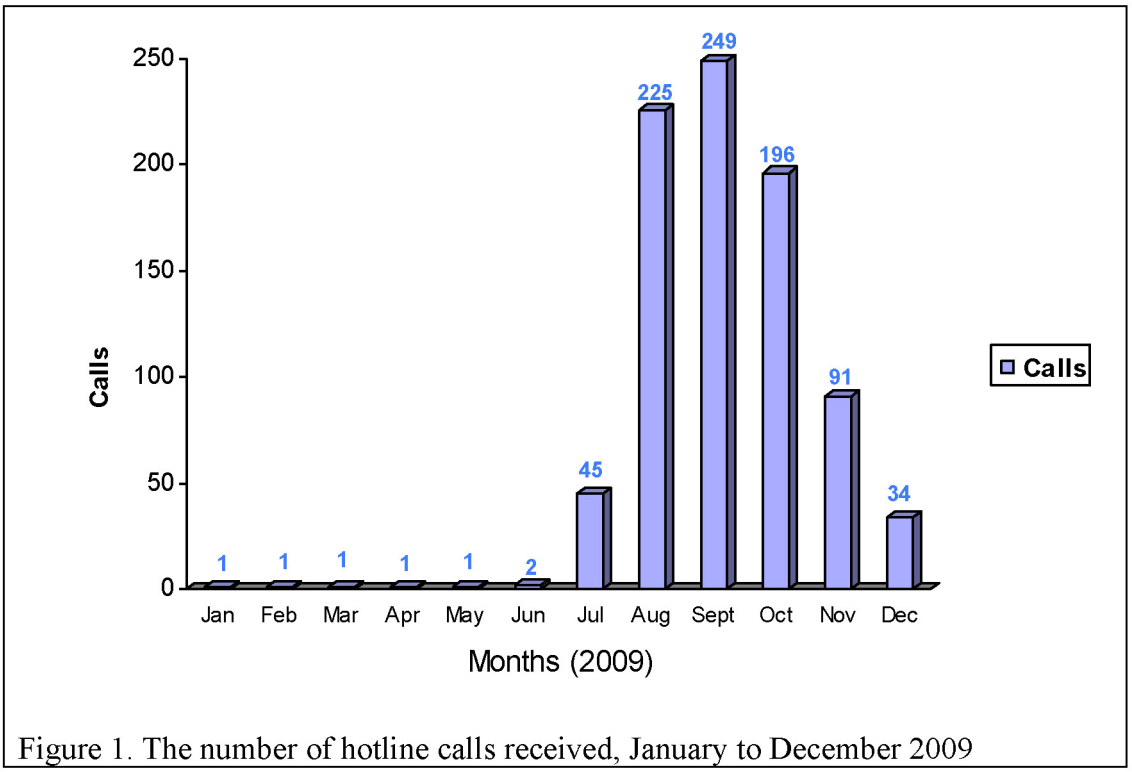

Figure 1. The number of hotline calls received, January to December 2009

Table 4. The number of hotline calls received and investigated in 2009, Trinidad

	2009				
County/Location	Calls received	Calls Investigated	Calls positive for GAS	Calls negative	*Calls unknown
St. George West:					
- Petite Valley	82	81	11	42	28
- Diego Martin	267	261	9	192	60
- Westmoorings	66	66	3	41	22
St. George West- other areas	208	207	0	146	61
St. George East	115	115	0	82	33
St. Andrews/ St. David	2	2	0	1	1
Caroni	34	32	0	26	6
Victoria	67	66	0	49	17
St. Patrick East	2	2	0	1	1
St. Patrick West	7	7	0	5	2
Nariva/Mararo	2	2	0	2	0
Total	852	841	23	587	231

* No snails were observed at these properties

Testing for *Angiostrongylus cantonensis*

The rat lungworm, *Angiostrongylus cantonensis*, has not been found on *A. fulica* in Trinidad from the samples submitted to the veterinary laboratory. However, a suspected S*trongylus* sp. has been found, but confirmation is being sought at a specialized laboratory in Atlanta, Georgia.

Notifiable Pest Status

In March 2010, the Honourable Minister of Agriculture, Land and Marine Resources declared *A. fulica* a Notifiable Pest. Under the law, citizens are now obligated to report all sightings of *A. fulica* on their properties.

This study is preliminary in nature since it requires a period of two to four years of monitoring after the last snail sighting to declare an area to be pest-free (USDA-APHIS, 2005). Eradication efforts are therefore ongoing towards achieving pest free status for *A. fulica* in Trinidad and Tobago.

ACKNOWLEDGEMENTS

The author is grateful to the Director Research, Ms. Cynthra Persad, and to Deputy Director Research, Crops, Dr. Mario Fortune, for their kind cooperation during the programme. Many thanks to the team leaders, Mrs. Petal Ram, Mr. Mukash Ramdhanie, Mr. Hamlet Alexander, Mr. Amel Baksh, Mr. Paramdath Siew, Mrs Yasodra Ali, Mr. Allan Balfour and their teams for excellent work done. The assistance of Mrs. Sumattie Gosine and Ms. Anjanie Ramlogan in coordinating hotline calls is greatly appreciated. Thanks also to Ms. Marlene Roberts and Mr. Julian Nicholas for data entry and typing the manuscript.

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