# Effect of Temperature and Egg Laying Depths on Giant African Land Snail (Gastropoda: Achatinidae) Viability

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# Effect of temperature and egg laying depths on giant African land snail (Gastropoda: Achatinidae) viability

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Giant African land snail, *Lissachatina fulica* (Bowdich) (Gastropoda: Stylommatophora: Achatinidae) is an important invasive pest currently present in Miami-Dade and Broward counties of Florida. It feeds on hundreds of plant species that include vegetables and ornamentals, and it can transmit disease to plants and animals, including humans (Capinera 2011). The Florida Department of Agriculture and Consumer Services-Division of Plant Industry (FDACS-DPI), has been working to eradicate this pest since it was first detected in Florida in 2011.

*Lissachatina fulica* is found widely in East Africa, and is abundant along forest edges (Raut & Barker 2002). Due to their tolerance to a wide range of temperatures, giant African land snails are a highly invasive pest in many parts of the world. Review of prior literature suggests that the optimal temperature range for growth and reproduction is 22 to 28 °C (Raut & Ghose 1984). Temperatures above 28 °C are said to initiate aestivation, but the snail can survive temperatures near 45 °C (Raut & Ghose 1984). This snail is also tolerant of cold weather, because it is known to be active below 10 °C and to hibernate at 2 °C (Raut & Barker 2002; Mead 1979; Raut & Ghose 1984). Giant African land snails have been reported to survive temperatures as low as 0 °C (Raut & Ghose 1984).

This experiment was conducted in Sep 2015 to better understand the risk of the giant African land snail spreading to other regions of Florida from Miami-Dade County. The objective of this study was to determine the range of temperature this species can survive. There were 12 treatments with 6 replications each. Six juvenile snails, 20 to 40 mm in height (measured parallel to the axis of coiling from the tip of the spire to the most distant point of the aperture edge), were subjected to sets of warm and cool temperatures. The warm temperatures were 32, 34, 36, 38, 40 and 42 °C. The cool temperatures were 10, 8, 6, 4, 2 and 0 °C. In Gainesville (Alachua County), the temperature has never gone as high as 42 °C or gone below 0 °C for a duration longer than 14 h in any of the last 5 yr (2011-2015 weather data from Florida Automated Weather Network, https://fawn.ifas.ufl.edu/). Considering this weather pattern, replications for the experiment were chosen to be subjected to each temperature point for a period of 14 h in the incubator. After the 14 h period, the snails were kept at room temperature for 24 hr to give them opportunity to recover. Snail mortality was 10% at 6 °C, 60% at 4 °C and 100% at 2 and 0 °C. Similarly, snail mortality was 30% at 40 °C and 100% at 42 °C (Fig. 1). Those snails that survived at first appeared dead, but they recovered when subjected to room temperature. Raut & Ghose (1984) found that giant African land snail can survive temperatures from 0 °C to 45 °C but 22 °C to 32 °C was ideal for reproduction. This information could be useful to determine the geographic range that would allow survival of giant African land snail. Although prolonged cool temperatures are unlikely to be of concern for the infestation in Miami, we are concerned with the risk of giant African land snail introduction into other, cooler regions of the United States.

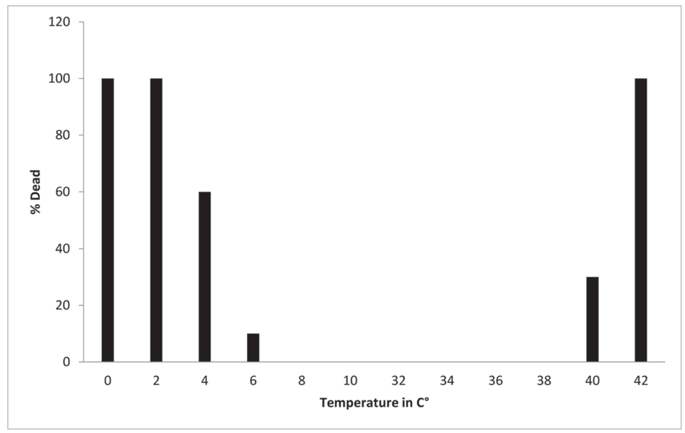


**Fig. 1.** Percent mortality of *Lissachatina fulica* at different temperature extremes.

Naturally laid giant African land snail eggs are typically deposited only 1.0 to 2.5 cm deep below the substrate surface, but eggs that are artificially buried deeper also can survive and hatch. In Jun 2016 a study was conducted to determine the minimum depth that giant African land snail eggs can be buried in soil, such that they are unable to hatch and emerge. The main objective of this study was to ensure that yard debris collected from infested properties and destined for disposal will be buried at an appropriate depth with no risk of neonate emergence. In preliminary trials (unpublished), eggs hatched and emerged from burial depths up to 38 cm. In this study, there were 6 treatments (43, 51, 58, 66, 74, and 81 cm) with 5 replications in each. Transparent plastic tubes that were 7.6 cm wide and 99 cm long were used to contain the eggs and snails. Each tube received 50 eggs. Tubes had drainage holes on the bottom to prevent the pooling of water that could drown the eggs. Eggs first were placed on top of 5.0 cm of moist soil to prevent them from drying out before hatching. Moist soil was then loaded to the different burial depths above the initial 5.0 cm, and the soil was misted with water as needed to maintain humid conditions. Screen mesh covered the top to ensure aeration of the soil and prevent mold. Eggs were observed without disturbing the soil daily to monitor hatching. The eggs were maintained at 74.4 °C, which is a favorable temperature for the snails. A period of 3 mo was allowed for hatching, after which the soil was carefully examined to determine total egg hatch and survival.

We determined that 42 to 64% of eggs hatched from all soil depths and at least some snails attained the surface in all tubes tested (Fig. 2). Because eggs hatched and hatchlings emerged from soil up to 81 cm deep,

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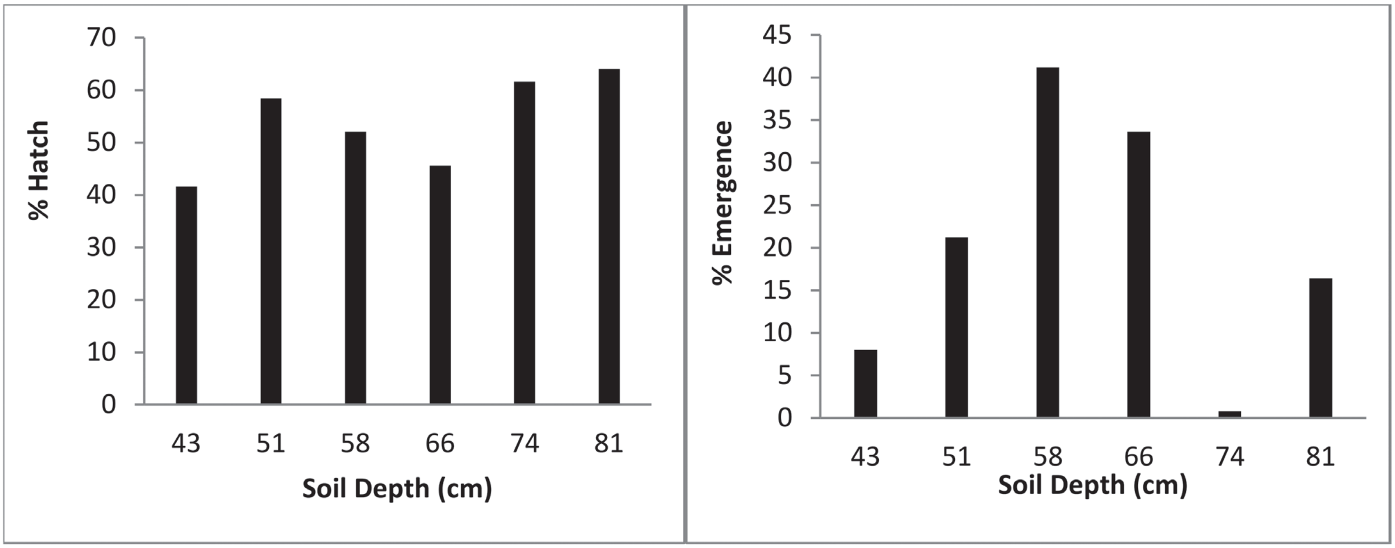


**Fig. 2.** Percent hatch and emergence of *Lissachatina fulica* from different soil depths.

the maximum depth tested, we failed to identify the minimum soil depth at which eggs can be buried to prevent hatching and emergence. In the preliminary study, snails were observed to survive under soil without food for 97 d. The eggs were placed directly on the bottom of the tube without soil or drain holes in the preliminary trial and first hatch date was recorded. The hardy nature of the eggs and neonates, the cryptic coloration of the young snails, and their nocturnal behavior have proven to be challenging for the detection and eradication process of this snail. The result shows that careful and protracted monitoring for neonates at a property with no observed snail activity is extremely important in helping to determine if it is indeed clear of infestation.

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## Summary

Giant African land snail, *Lissachatina fulica* (Bowdich), is currently found in 2 counties in Florida in the continental USA. Five years after their initial sightings, eradication efforts are still underway. A study was conducted to determine the upper and lower temperatures that giant African land snail can tolerate and survive. We observed 100% mortality at 2 °C and at 42 °C. Another study was conducted to ensure that dead snails and eggs collected during the eradication program will be buried at an appropriate depth with no risk of neonate emergence. We observed that hatching snails could dig through at least 81 cm of soil, but the maximum depth of soil from which they could emerge was not successfully determined.

Key Words: invasive; *Lissachatina fulica*; eradication; biology

## Sumario

El caracol terrestre africano, *Lissachatina fulica* (Bowdich), se encuentra actualmente en 2 condados de la Florida en los EE. UU. Cinco años después de ser vista por primera vez, los esfuerzos de erradicación aún están en marcha. Se realizó un estudio para determinar la temperatura mas alta y baja que el caracol terrestre africano puede tolerar y sobrevivir. Observamos un 100% de mortalidad a los 2 °C y a los 42 °C. Se realizó otro estudio para asegurar que los caracoles muertos y los huevos recolectados durante el programa de erradicación se enterrarán a una profundidad adecuada sin riesgo de emergencia de los recién nacidos. Observamos que los caracoles nacidos podrían excavar al menos 81 cm de suelo, pero no se determinó con éxito la profundidad máxima del suelo desde la cual podrían emerger.

Palabras clave: Invasivo; *Lissachatina fulica*; erradicación; biología

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