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The horntail snail (*Macrochlamys indica*): a new invasive pest in Florida

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The horntail snail (*Macrochlamys indica* Benson) was recently detected in Miami-Dade County. This snail is considered of quarantine importance in the United States because it can potentially host parasitic nematodes of medical importance and become an agricultural pest (Grewal et al. 2003; Cowie et al. 2009; Jayashankar and Murthy 2015). A program to survey, control, and eradicate the horntail snail has been implemented by the Florida Department of Agriculture and Consumer Services (FDACS).

This document attempts to compile the available literature on the horntail snail. It belongs to the genus *Macrochlamys* (family Ariopphantidae), which has over a hundred described species distributed from South to Southeast Asia and southern China (Pholyotha et al. 2018). It occurs in India, Sri Lanka, Bangladesh, Nepal, Pakistan, Europe and Brazil (Raut and Ghose 1984; Biswas et al. 2015; Jayashankar et al. 2015; Agudo-Padron 2018). In Bangalore, India, populations are higher in urban settings than in agricultural areas (Jayashankar et al. 2015).

Information regarding the pest and vector status of the horntail snail in those areas is scarce. It feeds mostly on seedlings, and fallen and decomposed leaves (Raut and Ghose 1983, 1984; Jayashankar et al. 2015). It is considered a minor pest in some localities in India, where it feeds almost exclusively on moss growing on damp brick walls (Jayashankar et al. 2015). The horntail snail, however, can feed on various plants, including vegetable, fruit and ornamental crops. In caged studies, preferred vegetables included cucurbits, beans, lettuce, okra and cabbage, while papaya was the preferred fruit crop. Ornamental plants such as chrysanthemum, china rose hibiscus, marigold, and roses were also considered preferred hosts in caged studies (Raut and Ghose 1983, 1984). In general, younger snails feed on tender plant tissue and avoid the leaf petioles and veins, while adults consume all plant parts (Raut and Ghose 1983).

The horntail snail association with nematodes has not been studied in detail. Only one study mentions its association with non-parasitic *Rhabditis* sp. nematodes in West Bengal, India (Cowie et al. 2009; Jayashankar and Murthy 2015). However, closely related species, such as *Macrochlamys resplendens* and the Giant African Snail (*Achatina fulica*), are known hosts of *Angiostrongylus* nematodes that can cause Eosinophilic Meningitis in humans (Grewal et al. 2003). Therefore, the possibility that the horntail snail could host nematodes of medical importance cannot be ruled out.

The biology of horntail snails was studied under laboratory and field conditions in Bangalore, India. Relative humidity is the most important factor affecting the population dynamics of this species (Raut and Ghose 1979, 1984). When the humidity in the environment is below 46%, the horntail snail enters a dormancy state, called aestivation. Aestivation varies with geographic latitude and can range from two to eight months. During this period, the snails remain hidden, inactive and lose weight (Raut and Ghose 1979, 1984). Under natural conditions, in southern India, the horntail snail has an eight-month aestivation period, is active during the monsoon period, and a single individual can live up to four years. The size of adult snails varies with age and the shell length can range from 10 to 21 mm (Raut and Ghose 1984) (Figure 1). Young snails require 130 days to reach sexual maturity. Optimum mating conditions are temperatures ranging from 21-30ºC and humidity higher than 86%. Copulation usually takes place after a rain event and the gestation period ranges from 10-17 days.

In India, egg-laying starts in its second year (Fig 1). Eggs are laid in clutches under loose soil. Adult snails need approximately 10-24 minutes to deposit an egg clutch and on average remain in the nest 11 minutes after that (Raut and Ghose 1984). Eggs are round, translucent, and 3-3.5 mm in size. The number of egg clutches and eggs per clutch varies with the age of the female. Two-year old snails oviposit up to four egg clutches per year with an average of 36 eggs per clutch. Three and four-year old snails oviposit six and four clutches per year, with an average of 69 and 89 eggs per clutch, respectively. The egg clutches are laid at 12-49 day intervals and the egg incubation period ranges from eight to twelve days. After egg hatching, young snails remain inactive for 14-20 hours and do not feed until the fourth or fifth day (Raut and Ghose 1984). The snail, however, might not have the same reproductive and feeding habits in the new area of invasion.

Under laboratory conditions with temperature ranging from 21 to 32ºC and 90% RH (no aestivation), the horntail snail's life span ranges from 15 to 19 months. Snails oviposit up to five clutches per year with an average of 16 eggs per clutch. Under these conditions, young snails require 10 months to reach sexual maturity (Unknown author).

Like other land snails, the horntail snail has low natural long-distance dispersal and movement of plants and landscape materials provide a major mechanism to move snails to new locations (Bergey et al. 2014). The low long-distance mobility of land snails also offers the opportunity to eradicate local populations (Roda et al. 2016). Early detection and monitoring of horntail snails in the field can be crucial for its successful control/eradication. Actions that can be taken to monitor snail populations:

1. Train personnel working on ornamental, vegetable and tropical fruit production in Miami-Dade on when and how to monitor for snail populations.
2. Search for snails at night, when they are active, especially after rainfall.
3. During the day, search for snail trails, shells, and plant damage.
4. Search for snails in debris piles, bricks, wall crevices and near seedlings or succulent plants. Wet and humid areas are very important to search near air-condition units, pumps, and any areas that remain moist.
5. Remove hiding places such as boards, stones, debris, weedy areas, leafy branches growing close to the ground, dense ground covers, etc.
6. If possible, create a less humid environment by adjusting the irrigation frequency and intensity.

If you find the horntail snail in your property you must contact the local extension office and the Florida Department of Agriculture and Consumer Services – Division of Plant Industry (FDACS-DPI). DPI helpline 1-888-397-1517. Properties where the horntail snail has been detected are required to hold orders and quarantine for at least 30 days, sign a compliance agreement and follow the treatment protocol with metaldehyde (>3.5%) according to FDACS recommendations. For more information go to the current

FDACS Pest Alert document: https://www.fdacs.gov/content/download/93400/file/horntail-snail-pest-alert.pdf.

Disclaimer: The above information is solely based on the available international literature and not on research conducted by UF/IFAS.

Figure 1. Horntail snails of different ages vary in size and oviposition rates (Raut and Ghose 1984).

Snail age	Shell diameter (mm)	Number of egg clutches/ breeding season	Av. Number of eggs per clutch
1st year 	10 - 11	NA	NA
2nd year 	10-14	4	36
3rd year 	14-18	6	69
4th year 	18-21	4	89

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