



REPORT OF INVASION BY *LISSACHATINA FULICA* (EUPULMONATA, ACHATINOIDEA, ACHATINIDAE) IN A RESIDENTIAL COMMUNITY IN THE SEMIARID REGION OF BRAZIL

INFORME DE INVASIÓN POR *LISSACHATINA FULICA* (EUPULMONATA, ACHATINOIDEA, ACHATINIDAE) EN UNA COMUNIDAD RESIDENCIAL DE LA REGIÓN SEMIÁRIDA DE BRASIL

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Recibido: 11 de febrero de 2026

Aceptado: 11 de mayo de 2026

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Abstract

The giant African snail, *Lissachatina fulica* (Bowdich, 1822), is considered one of the most worrisome invasive invertebrates throughout the world. The present study reports the presence of *L. fulica* in a semiarid region in the western portion of the state of Paraíba in northeastern Brazil and describes body size variation among individuals as well as preferences for different plant substrates. A total of 128 individuals of *L. fulica* were studied in a gated residential community located in a highly urbanized area of the municipality of Cajazeiras associated with 11 plant species. Eighty-five (63%) of these individuals belonged to size class 1. Adult individuals prevailed over subadults associated with cultivated plant species. The snails were mainly associated with the following shrubs/trees: *Musa* sp., *S. trifasciata*, and *C. indicum*. Smaller individuals were mainly associated with *Ixora* sp., whereas larger individuals were associated with *Musa* sp., *C. indicum*, and *A. altalis*. The ultimate control of *L. fulica* should be enforced at nurseries before plants are placed in communities.

Key words: Gastropoda, giant African snail, invasive species, northeastern Brazil.

Resumen

El caracol gigante africano, *Lissachatina fulica* (Bowdich, 1822), se considera uno de los invertebrados invasores más preocupantes del mundo. El presente estudio informa sobre la presencia de *L. fulica* en una región semiárida de la parte occidental del estado

de Paraíba, en el noreste de Brasil, y describe la variación del tamaño corporal entre los individuos, así como las preferencias por diferentes sustratos vegetales. Se estudió un total de 128 individuos de *L. fulica* en una comunidad residencial cerrada ubicada en una zona altamente urbanizada del municipio de Cajazeiras, asociados a 11 especies de plantas. Ochenta y cinco (63%) de estos individuos pertenecían a la clase de tamaño 1. Los individuos adultos prevalecieron sobre los subadultos asociados a especies de plantas cultivadas. Los caracoles se asociaron principalmente con los siguientes arbustos/árboles: *Musa* sp., *S. trifasciata* y *C. indicum*. Los individuos más pequeños se asociaron principalmente con *Ixora* sp., mientras que los más grandes con *Musa* sp., *C. indicum* y *A. altalis*. El control definitivo de *L. fulica* debe implementarse en los viveros antes de colocar las plantas en las comunidades.

Palabras clave: Caracol gigante africano, especie invasora del noreste de Brasil, Gastropoda.

Introduction

The giant African snail – *Lissachatina fulica* (Bowdich, 1822) – is an invasive land snail widely distributed in tropical and subtropical ecosystems throughout the world, well adapted to urban and rural areas (Eston et al., 2006; Raut & Backer, 2008; Albuquerque et al., 2008; Fontanilla et al., 2014). This snail has typically nocturnal habits, a highly voracious generalist diet, a prolific hermaphroditic reproductive strategy, and is tolerant to a broad range of environmental conditions (Eston et al., 2006; Aquino, 2010).

L. fulica is considered one of the most worrisome invasive invertebrates (Lowe et al., 2004; Prasad, 2004; GISD, 2020) due to its ability to adapt to both preserved and anthropic environments, often reaching high population densities (Fischer & Colley, 2005; Silva & Aleluia, 2010; Alves et al., 2017; Eduvirgem & Ferreira, 2019). It is a devastating agricultural pest (Albuquerque et al., 2008; Silva & Aleluia, 2010; Valim & Bim, 2017) and voracious competitor for food resources, exerting negative impacts on native fauna and flora (Silva & Aleluia, 2010; Alves et al., 2017; Valim & Bim, 2017).

This achatinid is distributed throughout the Brazil (Thiengo et al., 2007; Arruda & Santos, 2022), with records from coastal (Albuquerque et al., 2008; Fischer et al., 2008;

Fischer & Costa, 2010) to inland regions of the country and also is spread throughout the semiarid region of Brazil (Leão et al., 2011; Madella & Auricchio, 2014), mainly associated with urban areas (Madella & Auricchio, 2014; Silva et al., 2020). Evidence of invasion and harm has also been found in conservation areas, placing native biota at risk (Fischer & Colley, 2005; Eston et al., 2006; Pivello et al., 2024).

The invasion route is probably due to the accidental human transport of food and ornamental plants containing eggs and/or individuals from other regions (Thiengo et al., 2007; Arruda & Santos, 2022). However, knowledge from scientific studies on the impact caused by this species in the *Caatinga* (xeric forest) biome and adjacent ecosystems remains scarce.

This study aims to report the presence of *L. fulica* in the municipality of Cajazeiras (state of Paraíba, northeastern Brazil) and describe the shell size variation among individuals based on preferences for different plant substrates at the study site.

Material and Methods

Study area

The municipality of Cajazeiras (06°53'24" S, 38°33'43" W) is located in the semiarid region of the state of Paraíba in northeastern Brazil, 475 km from the state capital, João Pessoa. The municipality has an area of 563 km² (11.741 km² of urban area) and a population of 62.576 residents, corresponding to the eighth most populous municipality in the state (IBGE, 2022-2024) (Figure 1).

Cajazeiras has a predominantly warm, dry, tropical climate, with temperatures ranging from 12° to 30°C and annual rainfall ranging from 227.1 to 1961 mm. The dry season typically spans from August to December, whereas the rainy season spans from January to June, with an average annual rainfall of 880.6 mm (Saraiva & Caracristi, 2022). Typical vegetation of the *Caatinga* biome includes cacti, bromeliads, and *Mimosa* spp. (xerophytic and deciduous) (Beltrão et al., 2005; Leal et al., 2005; Gariglio et al., 2010; Brito, 2012; Saraiva & Caracristi, 2022).

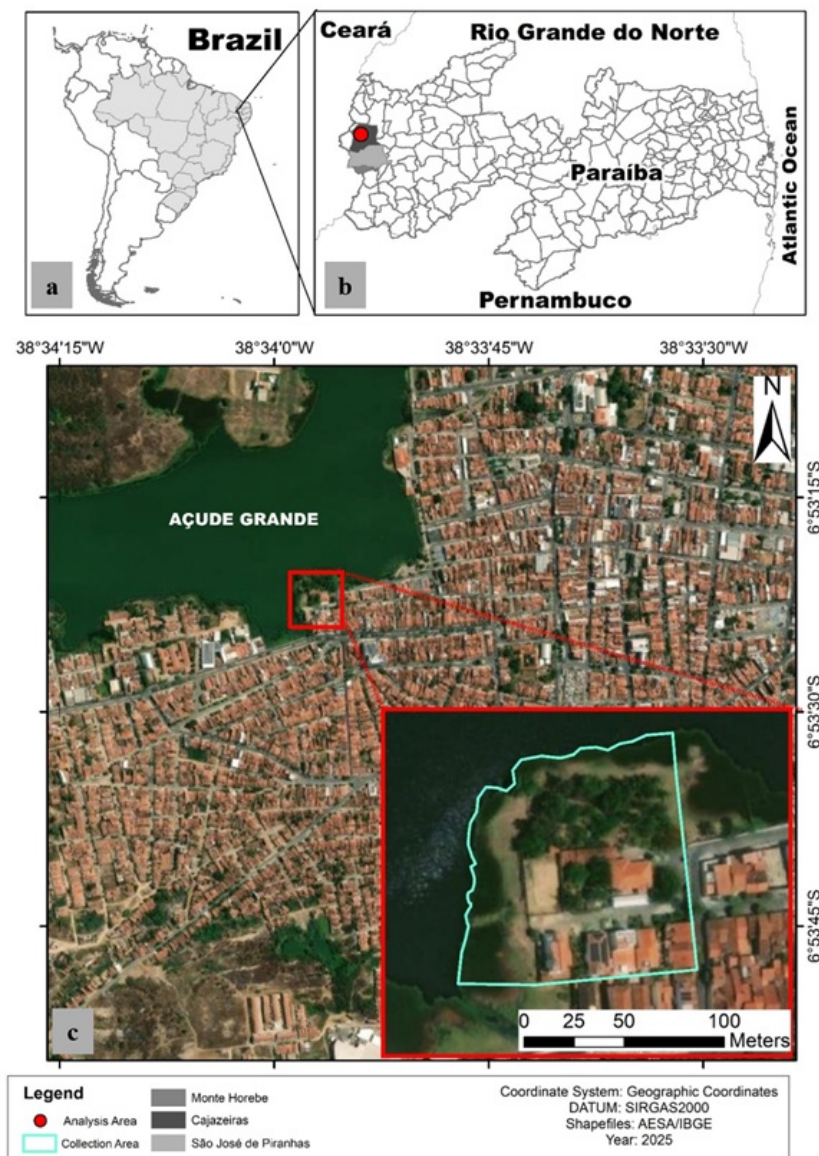


Figure 1. Map of study area: **a)** South America highlighting Brazil, **b)** State of Paraíba highlighting municipality of Cajazeiras (point in red - approximate location of study area), **c)** Study area highlighted in red (residential gated community highlighted in blue).

The area of record is a gated residential community of five houses located in the highly urbanized area ($06^{\circ}53'21''\text{S}$, $38^{\circ}33'57''\text{W}$) of the municipality, bordered to the north by the reservoir denominated “Açude Grande” (Figure 1c). Each of the five houses has a planned outdoor garden area for displaying and cultivating ornamental plants. There is also a large collective area predominantly composed of fruit trees. The seedlings of

shrubs and trees cultivated within the community come from inland regions of the state of Paraíba and are mainly brought from the municipalities of João Pessoa and Bananeiras, both in the state of Paraíba.

The following shrubs and trees are among the species cultivated in the study area: pineapple plant (*Ananas comosus*), Barbados cherry shrub (*Malpighia emarginata*), tuberose plant (*Polianthes tuberosa*), strawberry guava shrub (*Psidium cattleianum*), banana plant (*Musa* sp.), sugarcane (*Saccharum* sp.), spider plant (*Chlorophytum comosum*), snake plant (*Sansevieria trifasciata*), orange shrub (*C. maxima* × *C. reticulata*), lime shrub (*Citrus limonum*), oxeye daisy (*Leucanthemum vulgare*), "mini lacre" (*Ixora* sp.), Surinam cherry shrub (*Eugenia uniflora*), pomegranate shrub (*Punica granatum*), rose plant (*Rosa odorata*), seriguela plant (*Spondias purpurea*), and sorriso de maria plant (*Chrysanthellum indicum*), herbaceous and shrubby plants; coconut tree (*Cocos nucifera*), African tulip tree (*Spathodea campanulata*), weeping fig tree (*Ficus benjamina*), Royal poinciana (*Delonix regia*), arboreal plants: breadfruit tree (*Artocarpus altilis*), guava tree (*Psidium guajava*), pink trumpet tree (*Handroanthus heptaphyllus*), jabuticaba tree (*Plinia cauliflora*), mango tree (*Mangifera indica*), nim tree (*Azadirachta indica*), olive tree (*Olea europaea*), pitomba tree (*Talisia esculenta*), and tamarindo tree (*Tamarindus indica*) (annex 1 a-f).

Methodological approach and data analysis

On June 25, 2019, the study area was visited to verify the existence of snails associated with vegetation. Hundreds of *L. fulica* individuals were found among the plants even after massive extermination of the snails conducted by the residents, who collected specimens, which were then deposited in a container and incinerated. On June 29 and 30, 2019, and on April 20 and 21, 2020, a careful active search was carried out throughout the area of the gated community beginning at 3:30 pm (2 h effort by two researchers), recording the location and behavior of individuals associated with different types of substrates. Living individuals were quantified and measured with a ruler to determine life stages by size classes of shell length, according to Silva & Aleluia (2010): class 1 [≤ 40 mm: young]; class 2 [41–60 mm: subadult]; and class 3 [≥ 61 mm: adult].

Living individuals were photographed *in situ* on different substrates and associated with the vegetation. The plants used by *L. fulica* individuals as resting sites and, likely, as food sources were studied.

Abundance (N) [number of individuals by size class and by type of substrate (plant species)] and relative frequency [ratio between the abundance of the species (n) in each size class and total sum of individuals (T), expressed as percentage] were calculated using the formula: $Fr = \frac{n}{T} \times 100$. Subsequently, the variations among the three body size classes (Class 1: ≤ 40 mm; Class 2: 41-60 mm; Class 3: ≥ 61 mm), the relationship between the size of the snails and the plant species, and the interaction between size classes vs. plant species were investigated.

Results

A total of 128 individuals of *L. fulica* (measuring 11 to 84 mm) were found at the study site associated with 11 plant species (annex 1–2). Eighty-five (63%) of these individuals belonged to size class 1 (≤ 40 mm; young) (annex 2 a-d, f) (figure 2). Adult individuals (class 3: ≥ 61 mm, (annex 2 g–k) (figure 2) prevailed over subadults (class 2: 41-60 mm, (annex 2e) (figure 2)

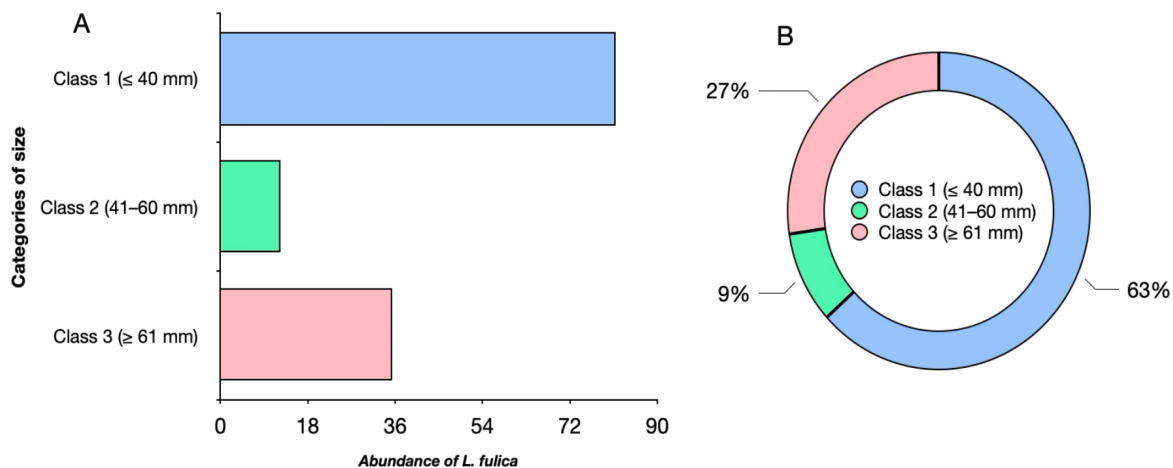


Figure 2. Abundance (A) and relative frequency (B) of *Lissachatina fulica* based on size classes of individuals collected in Crispim residential community, Cajazeiras, Paraíba, northeastern Brazil.

The snails were mainly associated with the following shrub/tree plants: *Musa* sp. (N = 19, Fr = 15%, annex 2 j–k), *S. trifasciata* (N = 18; Fr = 14%, annex 2 b–c), and *C. indicum* (N = 17; Fr = 13%) (Figures 3–5). A smaller number of individuals (N < 5) were found on the arboreal plants *M. indica*, *C. nucifera*, and *A. indica* (annex 2a).

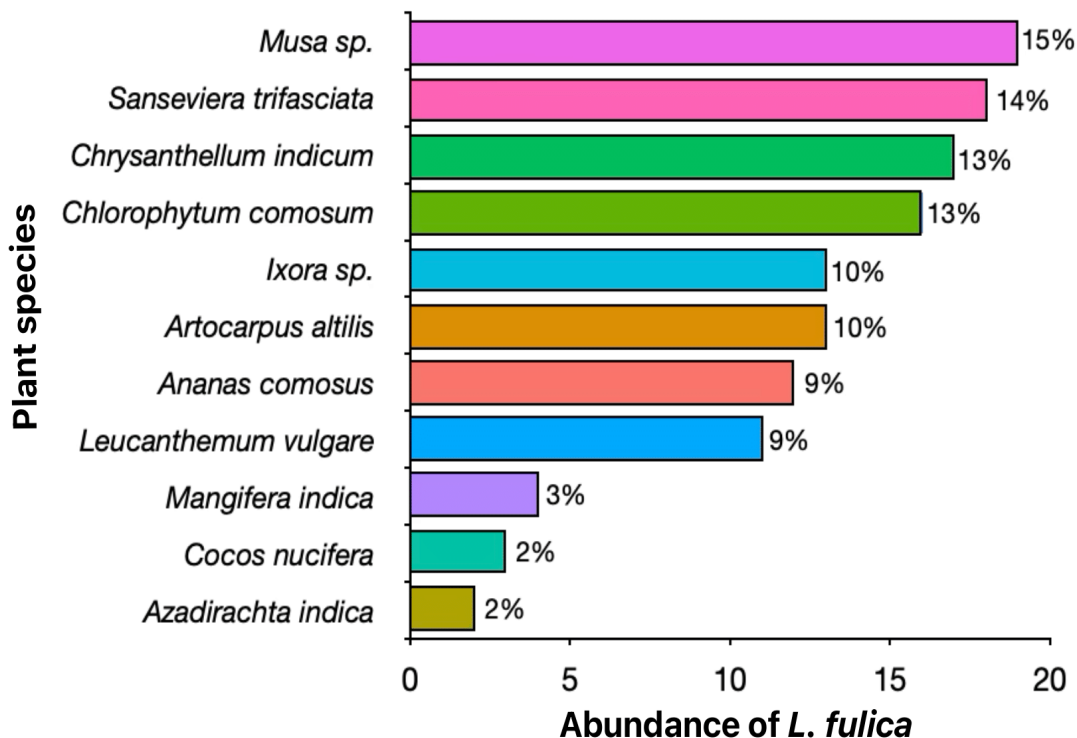


Figure 3. Abundance and relative frequency (%) of *Lissachatina fulica* associated with plant species in Crispim residential community, Cajazeiras, Paraíba, northeastern Brazil.

The analysis of *L. fulica* by body size class revealed that the largest number of individuals were in class 1 on virtually all plant species, accounting for more than 60% of the total abundance. Individuals in class 2 were the least abundant, corresponding to 6–23% of the sample. This class also had a more restricted distribution pattern, being associated with few plant species (*Musa* sp., *C. indicum*, *S. trifasciata*, and *A. altilis*) (Figures 4–5).

Discussion

In sync with other studies, we show that different growth stages have been found mainly in gardens (Fischer et al., 2006; Oliveira et al., 2008; Madella & Auricchio, 2014; Arruda & Santos, 2022), causing severe harm to ornamental and food plants (Fischer & Costa, 2010; Fischer & Nering, 2010; Fischer et al., 2010), even with no trace of the species in the surrounding habitats in certain cases (Arruda & Santos, 2022).

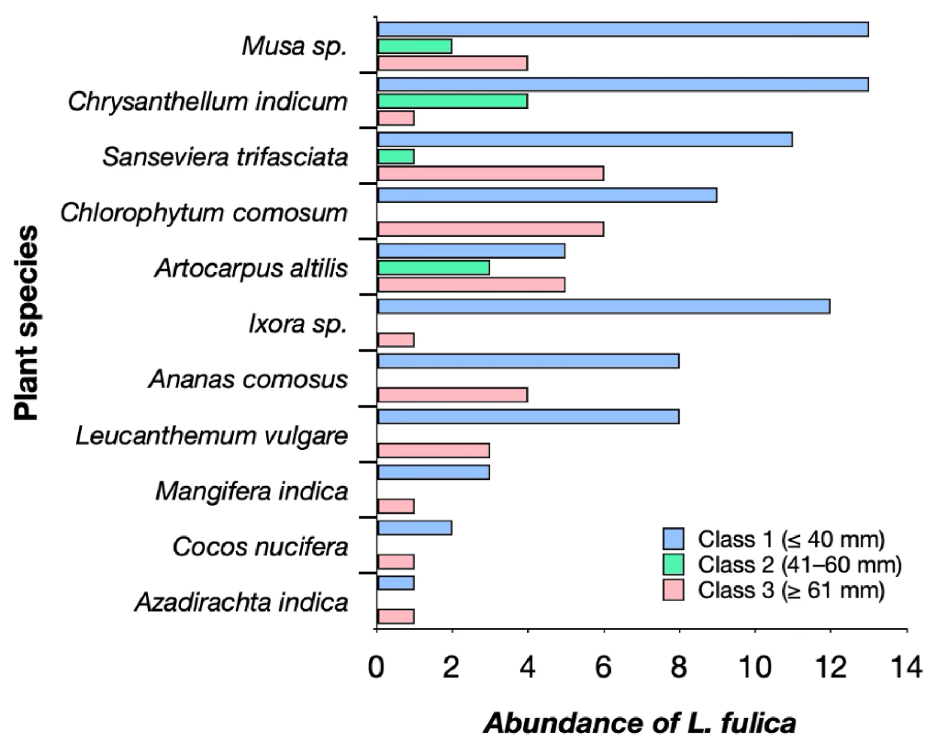


Figure 4. Abundance of *Lissachatina fulica* among body size classes associated with plant species in Crispim residential community, Cajazeiras, Paraíba, northeastern Brazil.

L. fulica was actively sought and not observed outside the study site. This lends strength to the hypothesis that the species arrived at the gated residential community through multiple passive transports associated with the seedlings of ornamental and food plants, which are feeding, resting, and sheltering sites for snails and their eggs. The residents at the study site carried out an intense, urgent collection of individuals, which were then burned. The manual control (collection) of individuals is recognized as the most common and efficient method for eliminating infestations of *L. fulica* (Simião & Fischer, 2004; Colley, 2010). Grassy areas in the gated residential community containing

numerous individuals were burned to reduce the number of animals and prevent the dispersal of snails into the environment. Otherwise, the snails in the gated community would have rapidly spread to the surrounding environment. The species has accelerated population growth that directly affects landscapes due to its voracity for green biomass (Eston et al., 2006; Zenni & Ziller, 2010).

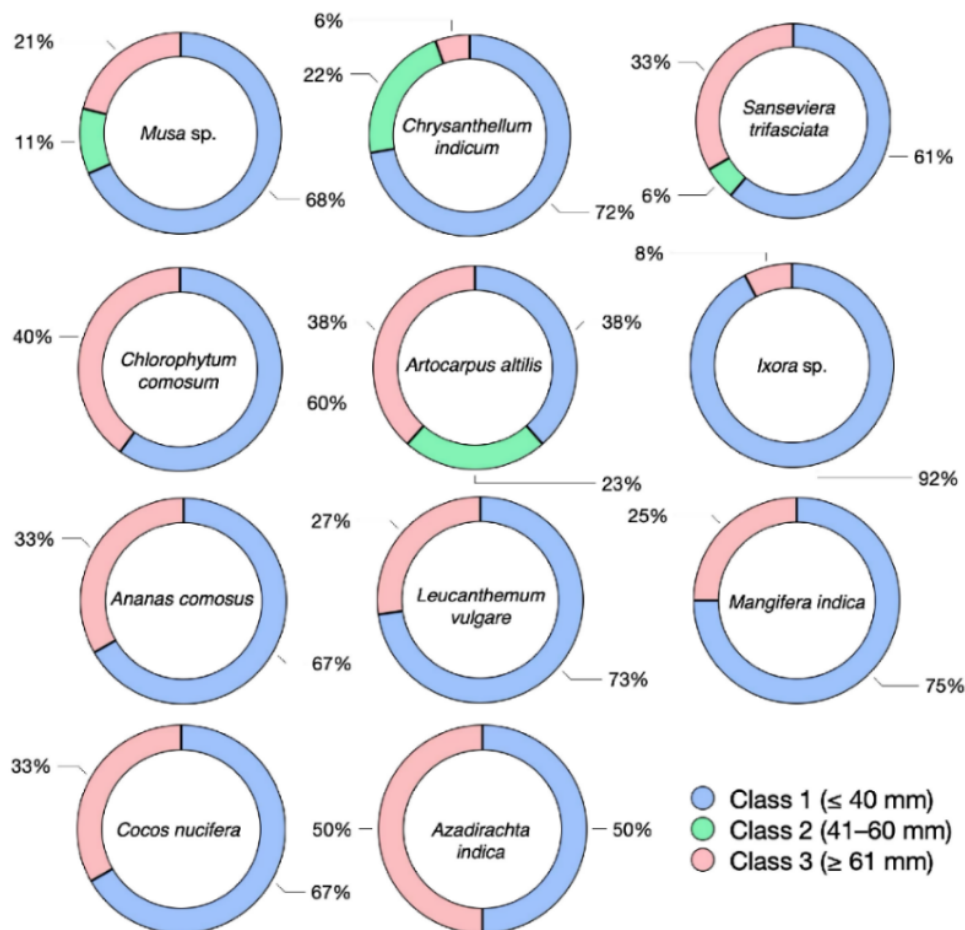


Figure 5. Relative abundance by size class of *Lissachatina fulica* associated with plant species in Crispim residential community, Cajazeiras, Paraíba, northeastern Brazil.

Lissachatina fulica is recorded here for the first time associated with the following plant species: *A. indica*, *C. comosum*, *C. indicum*, *L. vulgare*, and *M. indica*. These species are not on the list of vegetable or ornamental garden plants most seriously attacked by *A. fulica* in Brazil (Thiengo et al., 2007). On the other hand, *A. comosus*, *A. altilis*, *C. nucifera*, *Ixora sp.*, *Musa sp.*, and *S. trifasciata* are among the plant species

previously recognized as having suffered damage from the giant African snail (Fischer & Colley, 2005; Albuquerque et al., 2008; Raut & Backer, 2008). Annex 2(a) shows one of the few *L. fulica* individuals found on the trunk of the toxic plant *A. indica*, with no evidence of consumption of parts of the plant. Fischer & Colley (2005) also recorded *L. fulica* using *S. trifasciata* (another toxic plant) as a resting site in the state of Paraná (southeastern Brazil). In contrast, this same toxic plant was recorded as being susceptible to feeding damage by the African snail in regions outside Africa (Raut & Backer, 2008). Individuals can either die or tolerate the ingestion of phytotoxic compounds without mortality (Fischer & Nering, 2010).

In this study, individuals were found in the resting period on the leaves, stems, and the base of plants (annex 2a-i), with the exception of a few individuals that began to crawl away after handling (annex 2 c, f, j, k). According to Fischer & Nering (2010), these mollusks remain buried or suspended motionless on plants during the day, although young individuals wander over different substrates. *Lissachatina fulica* exhibited voracity for native/non-native, ornamental/edible vascular plants (Teles et al., 1997; Eston et al., 2006; Fischer et al., 2006; Colley, 2010; Fischer & Nering, 2010) [e.g., *A. comosus*, *C. comosum*, *C. indicum*, *Ixora* sp. and *Musa* sp. (annex 1 b, c-e, annex 2 j, k), mainly those that also served as resting sites in the gated residential community. This species can feed on a large number of plants, mainly sprouts and young plants (Eston et al., 2006; Valim & Bim, 2017). Some studies have indicated that *L. fulica* has a feeding preference for exotic succulent plants (Fischer & Colley, 2005) and organic plant matter in different stages of decomposition (Fischer et al., 2006; Oliveira et al., 2008).

Musa spp. is recognized as one of the most susceptible crop plants to feeding damage by *L. fulica* (Fischer & Colley, 2005; Thiengo et al., 2007; Albuquerque et al., 2008; Colley, 2010; Fischer & Nering, 2010; Present Study: Figures 19-20) as well as other achatinids (Raut & Backer, 2008). Fischer & Colley (2005) also recorded *L. fulica* associated with a number of plant species, mainly exotic species on Rasa Island in the municipality of Guaraqueçaba in the state of Paraná, southeastern Brazil, many of which were in a resting state on the base of plants and leaves, especially *Musa* sp. Previous studies have reported the feeding preference of the giant African snail for vascular plants belonging to the genera *Ixora* and *Musa* (Fischer & Colley, 2005; Albuquerque et al., 2008;

Colley, 2010). The latter is also recognized for providing an important resting place due to the accumulation of plant parts in the soil (Fischer & Colley, 2005; Colley, 2010) and for having been devastated by the pest in agricultural areas (Teles et al., 1997).

The population structure of *L. fulica* has been studied in a few municipalities in Northern and northeastern Brazil based on the biometric determination of shell length classes, which reflect the young, subadult, and adult life stages (Oliveira et al., 2008; Silva & Aleluia, 2010; Santos et al., 2022). Similar to our findings, Oliveira et al. (2008) and Santos et al. (2022) also reported the predominance of juvenile snails (shell length ≤ 40 mm) in regions of the states of Macapá (northern Brazil) and Alagoas (northeastern Brazil), respectively. Oliveira et al. (2008) found no adult individuals (shell length ≥ 61 mm) at the study sites investigated, whereas Silva & Aleluia (2010) found a predominance of individuals with shell lengths ranging from 41 to 60 mm in neighborhoods of the city of Salvador in Bahia state (northeastern Brazil).

Lissachatina fulica is an invasive agricultural pest that has caused serious harm throughout the world, particularly in tropical regions. Despite its wide distribution in different phytogeographic domains in Brazil, this snail continues to expand its occurrence due to passive anthropogenic transport, causing devastating impacts in gardens and agricultural regions. Even under semi-arid climate conditions, the individuals who entered the gated residential community successfully occupied the gardens due to the existence of favorable microclimate and ecological conditions. According to the residents, individuals of *L. fulica* declined substantially due to the control method. The remaining individuals still need to be vigilantly combatted to effectively eradicate the species from the study area as soon as possible. Contacting those responsible for nurseries that supply plant seedlings to the study site and explaining the problem of the passive transport of snails is a fundamental aspect in the primary line of defense to prevent *L. fulica* from reaching community gardens.

Acknowledgments

We are grateful to the residents who allowed us access to their homes to collect specimens for this study. Marcelo F.G. Brito is grateful to CNPq for the research grant (#307286/2025-8). We thank the editor and the reviewers for their helpful comments.

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Annexes



Annex 1. Main food and ornamental plants from Crispim residential community in which individuals of *L. fulica* were found in association with soil, and on leaves or stalks: a) General view of garden containing *Artocarpus altilis*, *Cocos nucifera*, and *Musa* sp. trees, b) *Ananas comosus*, c) *Sansevieria trifasciata* and *Ixora* sp., d) *Chlorophytum comosum*, e) *Chrysanthellum indicum*, f) *Leucanthemum vulgare*.



Annex 2. Individuals of *Lissachatina fulica* associated with different substrates: a) *Azadirachta indica*, b) and c) – *Sansevieria trifasciata*; d) – h) *Leucanthemum vulgare*, i) Ground, j) and k) *Musa sp.*