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REVIEW ARTICLE

A REVIEW ON BIOLOGY AND MANAGEMENT OF GIANT AFRICAN SNAILS

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ABSTRACT

The Giant African snail (*Achatina fulica* Bowdich) is classified under the Phylum Mollusca and the Class Gastropoda. This species is notorious for its detrimental impact on agricultural crops in areas where it is found, making it one of the largest and most harmful land snail pests globally. Its widespread distribution is attributed to several factors, including a high reproductive biological rate, aggressive feeding behavior, insufficient quarantine measures, and human-assisted movement. This review discusses the detrimental effects of snail infestations on agriculture, their biology and management.

KEYWORDS

Giant African snail; *Achatina fulica,* Mollusca, Biology

1. INTRODUCTION

The Giant African Snail, native to East Africa, is a notorious invasive pest that endangers agriculture by voraciously consuming over 500 plant species—ranging from soybean and cotton to papaya—resulting in substantial crop losses, as observed in regions like Marathwada, India. Its rapid reproductive cycle, marked by prolific breeding and a capacity to adapt to diverse environmental conditions, accelerates its spread and displacement of native species, thereby amplifying the risk to food security and ecosystem balance. Consequently, robust and ecofriendly management strategies are urgently required to mitigate its economic and ecological impacts and to preserve agricultural productivity and biodiversity

1.1 Taxonomy of giant African snail

FAO (1989) has described *Achatina fulica* as follows:

- Authority: Bowdich (1822)
- Classification Kingdom: Animalia
- Phylum: Mollusca Class: Gastropoda
- Order: Pulmonata
- Family: Achatinidae
- Genus: Achatina
- Species: fulica

1.2 Origin

The survival of land snails in harsh environmental conditions relies on a combination of physiological, morphological, and behavioral adaptations. These adaptations are crucial for understanding the specific habitat needs of different species and predicting how they will respond to environmental changes (Chukwuka 2014). The introduction of *Achatina fulica* outside its native range began in the early 1800s, spreading to Ethiopia, Somalia, Mozambique, and Madagascar. Its first occurrence outside Africa was in West Bengal, India, via Mauritius in 1847. The snail has since spread throughout the Asia-Pacific region, including countries like Bangladesh, China, Fiji, India, Indonesia, Japan, Malaysia, New Zealand, the Philippines, and others, with its range continuing to expand. (Raut and Barker, 2002). *Achatina fulica*, commonly known as the giant African land snail, is native to the east coast of Africa (Pilsbry 1904 and Lange 1950). Its natural range stretches from Natal and Mozambique in the south to Kenya, southern parts of Ethiopia, and Somalia in the north (Raut and Barker 2002). The species extends inland up to 250-830 kilometers, with the most extensive spread inland occurring in the northern part of its range (Lange 1950).

1.3 Human Introduction

Literature suggests that part of the distribution of *Achatina fulica* within Africa might be due to human interference (Verdcourt, 1961 in Raut and Barker, 2002). The deliberate or accidental introduction by humans has played a significant role in spreading this species beyond its original habitat.

1.4 East African Coastal Areas

The species has been reported as introduced in Madagascar and various other islands along the east coast of Africa (Bequaert, 1950; Raut and Barker, 2002).

1.5 West Africa

Over time, *Achatina fulica* has become part of the snail fauna in West Africa. Reports have confirmed its presence in countries such as Côte d'Ivoire, Togo, Nigeria, and Ghana (Ademolu 2013).

1.6 Palearctic Region

In a notable discovery, an *Achatina fulica* shell was identified in Morocco, marking the first report of this species from the Palearctic region (van Bruggen, 1987).

1.7 Extent of damage

The Giant African Snail (GAS), *Achatina fulica* Bowdich is one of the most notorious pest in the world because of its economic, ecological and medical importance (mead 1979). These land snails are abundant in the high rainfall areas of tropical countries. *Achatina fulica* is a major crop pest consumes over 500 plant species (Raut and Barker 2002). *Achatina fulica*, the giant African invader snail is spurting out in enormous numbers affecting the native species, crop, plantation as well as the health of all

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living beings.

1.8 Factors of influence

The population dynamics of *Achatina fulica*, the giant African land snail, are influenced by a variety of factors. Key environmental factors include temperature and humidity with warm climates and high humidity levels promoting their growth and reproduction. Rainy seasons further enhance their activity and reproduction rates. Suitable habitats, such as urban gardens, agricultural fields, and natural forests, provide the necessary shelter, moisture, and food for larger populations. Their diet consists of a wide range of plant materials, including vegetables, fruits, and decaying organic matter, with abundant food sources supporting larger populations. *Achatina fulica*is hermaphroditic, allowing rapid reproduction and the laying of hundreds of eggs in a single clutch. Climate is a strong predictor of the growth and impact of *Achatina fulica* (Raut and Barker 2002). Other abiotic factors playing important roles in growth and reproduction of land snails are light, photoperiod and temperature (Cook A 2001). There positive correlation with minimum temperature and rainfall in snails population (Pallavi HS 2018). Highest snail population during second fortnight of October and lowest during March in betelvine ecosystem. Highly significant positive correlation with rainfall (r = 0.652**) and minimum relative humidity (r = - 0.407**) exerted negative and highly significant association with population build up of snail (Chandaragi 2014). Maximum and minimum relative humidity were found to be positively and significantly correlated with snail population (r = 0.619** and 0.611**). Rainfall was showed a positive correlation with snail population (r = 0.252) (Priti Kumari 2015). The giant African land snails *Achatina fulica* Bowdich occuring in Kolkata, West Bengal, India undergo aestivation with the advent of adverse conditions by the end of October or early part of November, each year (MS Rahman and SK Raut 2010). According to the researcher, abiotic factors such as the chemical composition of the soil, may also influence the development of A.fulica and the establishment of its populations (Fischer and Colley 2005). Overall, the combination of environmental, biological, and human-related factors contributes to the success of *Achatina fulica*as an invasive species in many regions.

1.9 Morphology

The adult snail is around 7cm (2.8 in) in height and 20cm (7.9 in) or more in length. The shell has a conical shape, being about twice as high as it is broad. The color of shells varies greatly and is influenced by nutrition. The fleshy portion of the shell through which the foot emerges is called the mantle, and it has a pale yellowish colour. Their head has two sets of tentacles, one of which is longer than the other. The smaller pair is used for sniffing and touching its surroundings, while the eyes are on the longer pair which has trouble focusing and is extremely sensitive to light. *Achatina fulica* shell has seven to twelve whorls a strongly conical spire that is noticeably shortened but hardly pushed out at the apex, and a moderately inflated body whorl. The snails mantle cavity functions like a lung. With eyes at the tips of its posterior tentacles, it possesses two sets of retractable tentacles. A fully grown snail weighs between 200 and 600g on average, and it moves at a pace of 0.003 km/h. In order to protect itself, the huge African snail draws its body back into its shell and then plugs the opening with mucus when something bothers it. By producing a calcium compound that dries once it comes into touch with air, it create a protective layer (Bhattacharyya 2014).

1.10 Biology

1.1.1 Hermaphrodite

Despite having both male and female parts that can produce both sperm and eggs (Didier 2019), snails however need a partner in order to reproduce. This is known as hermaphrodite behavior. Furthermore, cross-fertilization can occur between any two sexually mature individuals that are mutually receptive (Mead 1961).

1.1.2 Mating

As they are nocturnal, giant African snails move around at night foraging for different kinds of plants. Snails spend much of their time alone, except when mating. They use vibrations they detect and scents they release to communicate. Courtship can last up to half an hour, pair of snails raise the sole of their feet off the ground and bring them together. They vigorously caress each other with their massively extended tentacles while rocking their bodies back and forth. Two individuals approach each other sideways during mating so that their genital openings are opposed. One intermediate organ emerges through the genital opening and is forced into the others vagina and vice versa (Bhattacharyya 2014).

1.1.3 Life stages

The incubation period for giant African snail eggs varies between 7 to 10 days. The giant African snail undergoes three juvenile stages (J1, J2, J3) which are determined by the number of rings developed their developmental periods are 25-30 days, 33-40 days and 44-48 days respectively. The adult giant African snail can be identified by the presence of 6-7 rings on its shell. The adult stage lasts approximately 65-70 days. The entire life cycle takes about 150-160 days and their lifespan has been recorded to be between 2 to 3 years (Kumar 2021).

1.1.4 Aestivation and hibernation

Achatina fulica experiences a lengthy period of dormancy during which it does not consume food or water. There is significant evidence suggesting that the duration of this inactive phase is closely linked to temperature. The period of aestivation lasts approximately 5 to 10 months while hibernation typically takes place during the winter months. (Bhattacharyya 2014).

1.1.5 Nature of damage

As a macrophytophagous herbivore, *Achatina fulica* is capable of harming various types of plant matter including fruits and vegetables. Occasionally, it consumes sand, tiny stones, remnants of carcasses and even concrete to obtain calcium for its shell. In unusual cases, these snails may eat one another. (Bhattacharyya 2014). First time causing damage to ornamental plants and vegetables in Bangalore was reported by (Veeresh 1979). *Achatina fulica* can act as a vector for parasites of medical and veterinary importance such as the rat lungworm, Angiostrongylus cantonensis which can cause serious health issues in humans and animals (Sreenivasa 2016).

1.1.6 Managements of Achatina fulica

The management of the giant African snail (*Achatina fulica*) involves a combination of cultural, biological, and chemical methods.

1.1.7 Cultural methods

Dense ground cover and lush vegetation create ideal moisture conditions, providing shelter and habitat where snails and slugs can flourish, posing a threat to crop growth alongside weedy fence lines. Maintaining proper hygiene, controlling weeds, and eliminating hiding spots can gradually mitigate this issue, and these practices also enhance the effectiveness of baiting. In areas where *Achatina fulica*is prevalent, avoiding minimal tillage and straw-retention methods is beneficial as these practices not only support snail survival but also increase the vulnerability of seedlings to damage. Soils with higher organic matter content tend to be more appealing to snails. Unnecessary planting between trees and vines may also create a shelter for the snails. Keeping the environment clean and dry to discourage snail activity. Removing decaying plant material, debris, and other hiding places can make the area less attractive to snails. Rotating crops and planting less susceptible species can help reduce snail damage. Some crops are less attractive to snails, and rotating them can disrupt the snails' life cycle. Applying mulch around plants can help retain moisture and reduce the need for watering, which can make the environment less favorable for snails.

1.1.8 Biological methods

Birds and Mammals: Anas Linnaeus species, Centropus chlororhynchus Blyth (green-billed coucal) and Gallus domesticus (Linnaeus), (domestic chicken) these predatory birds were reported by (Mead 1961). Mammals like Canis aureus Linnaeus (jackal) and Herpestes edwardsi Smith (Indian grey mongoose) reported by Green, Rattus argentiventer (Robinson and Kloss) (rice field rat) and Rattus tiomanicus (Miller) (Malaysian wood rat) by Limm, Suncus murinus (Linnaeus) (large musk shrew) reported by Peterson, Bdeogale crassicauda Peters (bushy-tailed mongoose) by Williams and Mungos mungo (Gmelin) (banded mongoose) reported by (Kasigwa 1983 and Peterson 1957; Williams 1951 and Green et al 1910; Limm et al 1966).

Predatory Beetles: Certain beetles such as carabid beetles, prey on the eggs and juveniles of *Achatina fulica.* The beetle that is most well-known for preying on *Achatina fulica* is the Indian glowworm, Lamprophorus tenebrosus (Walker) (Lampyridae) which is found exclusively in (Malaya et al 1919).

Parasitic Nematodes: Parasitic nematodes *Achatina fulica* like Phasmarhabditis hermaphrodita can infect and kill the other snails but *Achatina fulica* is highly resistant to P. hermaphrodita, which could be due to an immune response dependent on the snail shell to encapsulate and kill invading parasitic nematodes (Williams and Rae 2015).

Chemical methods: Considering the potential impact on non-target organisms and the environment is necessary while adapting the chemical methods to control the snail populations in agricultural ecosystem. Metaldehyde is found to be effective against the giant African snails reported by (Priti Kumari 2011 and Basavaraju 2001; B.T. Sreenivasa et al 2019). Efficacy of Methomyl and Thiodicarb was reported by (Roobak

Kumar 2018). The researcher discovered that copper sulfate resulted in complete mortality within one week of treatment for the giant African snail (Kakoty and Das 1987). Shilpa and Mallappa, who noted the efficacy of CuSO4 poison bait against *Achatina fulica* and C. semirugata, respectively (Shilpa 2013 and Mallappa 2014). Efficacy of Cartap hydrochloride shown by (Priti Kumari 2011). N'guessan Olivie revealed that the glyphosate has a negative effect on shellfish growth (N'GUESSAN 2022). Analysis of histograms reveals an inhibitory effect of glyphosate on the shell growth of Achatina achatina snails.

2. Conclusion

The Giant African Snail (*Achatina fulica*) is one of the most notorious agricultural pests in the world. Its voracious appetite extends to over 500 plant species, including essential food crops such as cassava, maize and vegetables, leading to significant yield losses and economic damage for farmers. This pest is particularly challenging to manage due to its high reproductive rate with each snail capable of producing up to 1200 eggs annually, resulting in rapid population growth. Additionally, the Giant African Snail poses public health risks as a vector of the rat lungworm, which can cause eosinophilic meningoencephalitis in humans. Controlling this pest is crucial not only for safeguarding food security and minimizing economic losses but also for protecting public health and preserving local ecosystems. Effective management of *Achatina fulica* through chemical, biological, and eco-friendly methods is essential to mitigate its impact and maintain agricultural productivity and environmental balance.

Data Availability

The data that support the findings of this study are available in the article and its online supplementary material.

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