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A Review on Biology and Management of Achatina fulica

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Abstract

The Giant African snail (Achatina fulica Bowdich) belongs to the Phylum Mollusca and the Class Gastropoda. This species is well-known for its negative effects on agricultural crops in regions where it is present, rendering it one of the largest and most damaging land snail pests worldwide. Its extensive distribution can be attributed to various factors, such as a high reproductive rate, voracious feeding habits, inadequate quarantine protocols, and human-facilitated dispersal. This review examines the harmful impacts of snail infestations on agriculture, along with their biological characteristics and management strategies.

Keywords: Giant African snail; Achatina fulica; Mollusca, Biology

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. Giant African snail possess higher reproductive rate and 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

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

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Origin

The persistence of land snails in extreme environmental conditions depends on a blend of physiological, morphological, and behavioral adaptations. These adaptations are essential for comprehending the specific habitat requirements of various species and anticipating their responses to environmental changes Chukwuka et al, (2014).

The introduction of the Giant African snail beyond its native habitat commenced in the early 1800s, extending to Ethiopia, Mozambique, Somalia, and Madagascar. Its initial appearance outside of Africa occurred in West Bengal, India, through Mauritius in 1847. Since then, the snail has proliferated across the Asia-Pacific region, encompassing nations such as Bangladesh, China, Fiji, India, Indonesia, Japan, Malaysia, New Zealand, the Philippines, among others, with its distribution continuing to grow. (Raut and Barker, 2002).

Achatina fulica, often referred to as the giant African land snail, originates from the eastern coast of Africa (Pilsbry, 1904; Lange, 1950). Its natural habitat spans from Natal and Mozambique in the south to Kenya, the southern regions of Ethiopia, and Somalia in the north (Raut and Barker, 2002). This species can be found inland up to distances of 250-830 kilometers, with the greatest inland distribution observed in the northern section of its range (Lange, 1950).

Human Introduction: The distribution of Achatina fulica across Africa may be attributed to human intervention (Verdcourt, 1961 in Raut and Barker, 2002). Both intentional and unintentional introductions by humans have significantly contributed to the expansion of this species beyond its native environment.

East African Coastal Areas: The species has been documented as having been introduced in Madagascar and several other islands situated along the eastern coast of Africa. (Bequaert, 1950; Raut and Barker, 2002).

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

Palearctic Region: In a significant finding, a shell of Achatina fulica was discovered in Morocco, representing the first documentation of this species in the Palearctic region. (van Bruggen, 1987).

Extent of damage

The Giant African Snail (GAS), scientifically known as Achatina fulica Bowdich, is recognized as one of the most infamous pests globally due to its significant economic, ecological, and medical implications (Mead, 1979). These terrestrial snails predominantly inhabit regions with high rainfall. Achatina fulica poses a serious threat to agriculture, as it feeds on more than 500 species of plants (Raut and Barker, 2002). The giant African snail, Achatina fulica, is proliferating in vast quantities, adversely impacting native species, crops, plantations, and the health of all living organisms.

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 plays important role on 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 is a positive correlation between minimum temperature and rainfall in the population of snails (Pallavi HS, et al, 2018). The highest population of snails was observed during the second fortnight of October, while the lowest was recorded in March within the betelvine plantation. A highly significant positive correlation with rainfall (r = 0.652**) and a negative yet highly significant association with minimum relative humidity (r = -0.407**) were noted in relation to the population increase of snails (Chandaragi, M. and Patil, 2014). Both maximum and minimum relative humidity showed a positive and significant correlation with the snail population (r = 0.619** and 0.611** respectively). Rainfall also exhibited a positive correlation with the snail population (r = 0.252) (Priti Kumari, et al, 2015). The giant African land snails, Achatina fulica Bowdich, found in Kolkata, West Bengal, India, undergo aestivation in response to adverse conditions that arise at the end of October or the beginning of November each year (MS Rahman, SK Raut, 2010). Fischer & Colley (2005) discovered that abiotic factors, including the chemical composition of the soil, also affect the development of the Giant African snail. In summary, the interplay of environmental, biological, and human-related factors plays a significant role in the success of Achatina fulica as an invasive species across various regions.

Morphology

The mature snail reaches a height of approximately 7 cm (2.8 in) and a length of 20 cm (7.9 in) or greater. Its shell exhibits a conical form, measuring roughly twice its height in comparison to its width. 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's* 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 snail's 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 et al., 2014).

Biology

Hermaphrodite:

Despite possessing both male and female reproductive components capable of generating both sperm and eggs (Didier et al., 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).

Mating:

Due to their nocturnal nature, giant African snails are active during the night, searching for various types of plants. These snails typically lead solitary lives, with the exception of mating periods. They communicate through vibrations they sense and scents they emit. The courtship process may extend to thirty minutes, during which a pair of snails elevates the soles of their feet off the ground and brings them into contact. 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's intermediate organ emerges through the genital opening and is forced into the other's vagina, and vice versa (Bhattacharyya et al., 2014).

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; The developmental phases last for 25-30 days, 33-40 days, and 44-48 days, respectively. The adult giant African snail is characterized by having 6-7 rings on its shell. The adult phase endures for roughly 65-70 days. The complete life cycle spans approximately 150-160 days, and their lifespan has been documented to range from 2 to 3 years (Kumar et al., 2021).Aestivation and hibernation:

Achatina fulica undergoes an extended dormancy phase in which it refrains from eating or drinking. Substantial evidence indicates that the length of this inactive period is strongly associated with temperature. Aestivation generally lasts around 5 to 10 months, whereas hibernation usually occurs during the winter season. (Bhattacharyya et al., 2014).

Nature of damage

As a macrophytophagous herbivore, Achatina fulica has the potential to damage various plant parts, including fruits and vegetables.. (Bhattacharyya et al., 2014). (Veeresh et al., 1979) documented for the first time that Achatina fulica causes harm to ornamental plants and vegetables in Bangalore. Furthermore, it can serve as a vector for medically and veterinary significant parasites, such as the rat lungworm, Angiostrongylus cantonensis, which poses serious health risks to both humans and animals (Sreenivasa et al., 2016).

Managements of *Achatina fulica*

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

Cultural methods:

Thick ground cover and abundant vegetation establish optimal moisture conditions, offering refuge and habitat for snails and slugs to thrive, which presents a risk to crop development near 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.. 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.

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 (1910), *Rattus argentiventer* (Robinson and Kloss) (rice field rat) and *Rattus tiomanicus* (Miller) (Malaysian wood rat) by Limm (1966), *Suncus murinus* (Linnaeus) (large musk shrew) reported by Peterson (1957), *Bdeogale crassicauda* Peters (bushy-tailed mongoose) by Williams (1951) and *Mungos mungo* (Gmelin) (banded mongoose) reported by Kasigwa et al. (1983).

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, Ceylon, and India, Paiva (1919).

Parasitic Nematodes: Parasitic nematodes, such as Phasmarhabditis hermaphrodita, have the ability to infect and eliminate other snail species; however, Achatina fulica exhibits a significant resistance to P. hermaphrodita. This resistance may be attributed to an immune response that relies on the snail's shell to encapsulate and destroy invading parasitic nematodes (Williams and Rae, 2015).

Chemical methods:

Considering the potential impact on non-target organisms and 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), Basavaraju *et al.* (2001), B.T. Sreenivasa et al., (2019). Efficacy of Methomyl and Thiodicarb was reported by Roobak Kumar *et al*., (2018). Kakoty and Das (1987) discovered that copper sulfate resulted in complete mortality within one week of treatment for the giant African snail. Shilpa (2013) and Mallappa (2014), who noted the efficacy of CuSO4 poison

bait against *Achatina fulica* and C. semirugata, respectively. Efficacy of Cartap hydrochloride shown by Priti Kumari (2011). N'guessan Olivier N'GUESSAN et al., (2022) revealed that the glyphosate has a negative effect on shellfish growth. Analysis of histograms reveals an inhibitory effect of glyphosate on the shell growth of *Achatina achatina* snails.

Conclusion

The Giant African Snail (Achatina fulica) is recognized as one of the most infamous agricultural pests globally. 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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