The Maldives National Journal of Research
Vol. 12, No. 2, December 2024 pp. 7-18

RESEARCH REPORTS

A Review of the Biology and Ecology of the Invasive Giant African Snail (*Achanita fulica*): Its Impact on Horticulture Crops and Effective Pest Management

NADHIYA ABDULLA

The Maldives National University

ABSTRACT *Terrestrial gastropods, such as snails and slugs, pose a significant threat to the global agriculture due to their adaptive nature. The giant African snail (Achanita fulica), introduced to the Maldives, thrives tropical climate, with high reproduction capacity, feeding on over 500 types of plants. In Laamu Atoll, Maldivian farming communities are struggling to control this pest, which is causing a significant damage to crops such as cucurbits, papaya, leafy vegetables, and banana plants. Despite various intervention initiatives by government agencies, including cultural, chemical and biological methods, the pest remains a serious problem. This review aims to integrate information on the bio-ecology of the giant African snail, the nature of damage it causes, and the favourable factors for its proliferation, with special emphasis on effective management tactics of this particular gastropod pest focusing on Maldivian context. It also proposes a collective pest management model to effectively manage the control of giant Africa snail.*

Key Words: Giant African snail (Achanita fulica), Bio-ecology, Effective management, Gastropod pest, Farmers

Introduction

The growth and development of the Maldivian agriculture sector are constrained by the limited availability of natural resources such as land, water, and nutrient-rich soil. Along these challenges, farming communities are now further challenged by an increase in plant and crop pest diseases, exacerbated by the import of plant materials for agricultural activities and tourism (Shafia & Hunter, 2000). Although the agricultural sector contributes a relatively small percentage to the nation's economic growth, it plays a vital role in sustaining the livelihoods of farming communities by providing employment opportunities, food, nutrients and other economic empowerment (Abdulla, 2020). Ensuring the continuity of farming communities by addressing their challenges and constraints is therefore essential.

According to the Ministry of Agriculture and Animal Welfare (MoAA), AgroNational Corporation reports, and research studies conducted in collaboration with international donor agencies, the major pests affecting agricultural crops in the Maldives include sucking pests (such as whiteflies, aphids, and thrips), hispid beetle, and rats. Other pests include scale insects and coconut mites. Although there is no recent research study or report documenting an outbreak of terrestrial

ISSN 2308-5959/20241231

gastropods in the Maldives, there has been an observed increase in slug and snail' population in various island communities, attributed to the rise in pet trade which has facilitated the spread of invasive alien species (Abdulla, 2020).

Farmers as well as locals have reported outbreak of, *Achanita fulica*, particularly during the rainy and wet seasons, damaging crops at the seedling stage as well as at the fruiting stage. Outbreaks of snails and the nuisance of this pest is experienced by many island communities in both the Northern and Southern Atolls (Abdulla, 2020). While there is no official record of the financial losses incurred by farmers due to these outbreaks, locals have resorted to handpicking and the application of salt to combat the pest. Recently, farmers have begun using chemical such as metaldehyde, copper sulphate, borax, and iron sulfate to combat the pest based on information provided by the MoAA. However, farmers have expressed concerns about their inability to completely control the pest, as it frequently re-emerges and causes new outbreaks. This underscored the need for effective and efficient management of giant African snail to prevent it becoming a serious pest particularly in new areas of invasion.

Given the recurring outbreaks of the giant African snail species in Maldivian communities along with its nuisance in terms of crop damage, it is important to review and understand the morphology and biology of the giant African snail, as well as sustainable management measures. Farmers in Asian and African countries suffer substaintial losses to their agricultural crops and community infrastructure due to the uncontrolled growth of this snail. While the Maldives may not have experienced such extensive damage, to the community to, small family farming communities, already constrained by limited land and fertile soil, are further impacted by seasonal outbreaks of this pest. In some countries, this species is considered illegal to import, and strict measures are taken to prevent its introduction due to its highly invasive nature (Rekha et al., 2015).

This review integrates information on the gastropod pest, giant African snail, with a focus on eco-friendly management specific to the Maldivian context, aiming for sustainable control of this pest nationally.

Morphology and Biology of the African Grey Snail

The giant African snail (*Achanita fulica*), commonly known as the land snail, is native to African countries but has been transported to other regions through soil and other mediums like pets and plants (Olusi.et. al., 2021). These snails, considered invasive species, can grow up to 8 inches long and 5 inches wide. Giant African snail is categorised as hermaphrodites, meaning any two individual snails can reproduce together through reciprocal copulation, where the sperm of one snail fertilizes eggs laid of another (Das et al., 2022). The snail eggs hatch within 7-15 days, and the snails reach reproducing stage of life within 12 months (Kumar, 2020). Unlike other invasive pests, giant African snail produces large number of eggs which can remain in the soil until favourable conditions arise and can live up to nine years (Leite et al., 2022). Being nocturnal, these snails spend most of their daytime hiding under stones, soil, or decaying organic matter, which helps them adapt to various environmental conditions and reduce body moisture loss (Roda et al., 2016).

This pest snail has the capacity of aestivation and hibernation, allowing them

to survive temperatures ranging from 0°C and 45°C, making them well suited to the Maldivian environment (Gabetti et al., 2023). These snail species, consumes variety of leafy greens, including lettuce, spinach, cucumbers, melon, grapes, and bananas (Roda et al., 2016). They cause substantial damage to farms, plantations, and gardens and are found in various environments, including urban areas, agricultural fields, forests, and wetlands, amplifying their destructive impact (Rekha et al., 2015). Giant African snails and their eggs are also observed buried in soft soil near water bodies, between plant roots, and in other moist places (Rasal, 2022). Their diet includes over 500 types of plants, posing a significant threat to the agricultural industry (Brisely, 2022).

A threat to the Maldivian Farming Communities

There is a significant risk of spreading this invasive species throughout the Maldives. Maldivian family farmers conduct farming activities in open land areas surrounded by thick vegetative growth (Abdulla, 2020). Farmers do not till their cropping land or burn crop plant remain, often ploughing them into the soil, which allows snail eggs and young snails survive and thrive. Construction materials, harvested crops (often unwashed/uncleaned), including fruits, vegetables, and ornamental plants, are transported between island communities without proper quarantine measures, facilitating the spread of the species (Abdulla, 2020).

Although there is no official record or data available, interventions in Laamu Atoll farming communities indicate that most farmers lack knowledge about the invasiveness of this pest and the threat it poses to human health and farmland. They are generally unaware of measures to prevent the spread of this pest other than handpicking and spraying soapy water. These reasons as well as the high reproductive nature of giant African snail and the favorable Maldivian climatic conditions (temperature range of 22°C to 32°C) further increase the risk of spreading this species across the Maldives (Morrison & Hay, 2010).

Neighbouring countries such as India have already experienced giant African snail outbreak, causing significant destruction to the farming crops and livelihoods. For instance, in 2022, giant African snail spread uncontrollably in the Kottayam district of Kerala which had a devastating impact on the farming communities (Bhagyasree, 2023). Similarly, a research study carried on the outbreak of giant African snail in the forest of West India shows that these species have spread over a large area at an alarming rate damaging fragile landscapes (Rasal et al., 2022). Similarly, there was an outbreak of the same species in Nepal in the warmer mid-hill districts causing damage to a wide variety of cultivated plants causing significant economic loss (Adhikari et al., 2020). In Bangladesh, rice farmers and rural farming communities suffer huge annual losses due to the fast growth and invasive nature of this pest (Mukul et al., 2020). Even developed countries such as the UK have reported crop damage and annual losses of GBP 100 million due to this pest (BaRua, Williams, & Ross, 2021). According to Bhattacharyya et al. (2014), giant African snails damages four categories of plants including: flowers and ornamental plants; vegetable plant; crops such as breadfruit and cassava; and teak wood, which the snail damages at the development stage; and crops that the snail directly and indirectly damages. Although it is easy to identify which type of plants they damage most, it is very difficult to understand or estimate the extent

of damage these snails caused these plants, as this depends on the size of the snail and the age of the plants (Bhattacharyya et al., 2014).

Farmers Experience with Giant African Snail in Laamu Atoll

Laamu Atoll is a significant area for agricultural activities, with over 200 farmers growing crops like bananas, papayas, watermelons, and cucumbers (AgroNat, 2020., cited in Abdulla et al., 2022). Majority of these farmers grow banana, papaya, watermelon as well as cucumber in open land areas. Reports indicate that 90% of the Maldivian population relies on these crops for their main source of nutrients (MoAA, 2019). However, the Maldivian farming communities only produce 3% of the national demand, making the country heavily import-dependent. In 2022, the Maldives import of these specific crops exceeded more than 90% of the amount that they were able to produce (Abdulla et al., 2022). Alongside natural resource challenges, pests and plant disease are common issues faced by these farming communities. The Maldivian water hen (Kan'bili/ Amaurornis phoenicurus) and the house crow (Corvus splendens) are among the bird species causing significant crop damage which leads to decreased agricultural production (Ash and Shafeeg, 1994).

Data Collection and Analysis

The study was conducted in Laamu Atoll, known for its significant agricultural activities and numerous registered contract farmers. Focus group discussions (FGDs) were organized in collaboration with AgroNational Corporation, involving 120 farmers who had previously attended training sessions on plant and pest disease control. The FGDs, conducted across two weeks, utilised semi-structured questions refined by agricultural experts. The discussions were held in local community centres such as school and council halls. Each session lasted more than 30 minutes and was moderated by trained facilitators and an agronomist from AgroNational Corporation. Thematic analysis was used to identify key themes and sub-themes, providing insights into the challenges and potential solutions for plant and pest disease control in the region. Data was analysed using Microsoft Excel, focusing on specific themes and sub-themes identified during the FGDs.

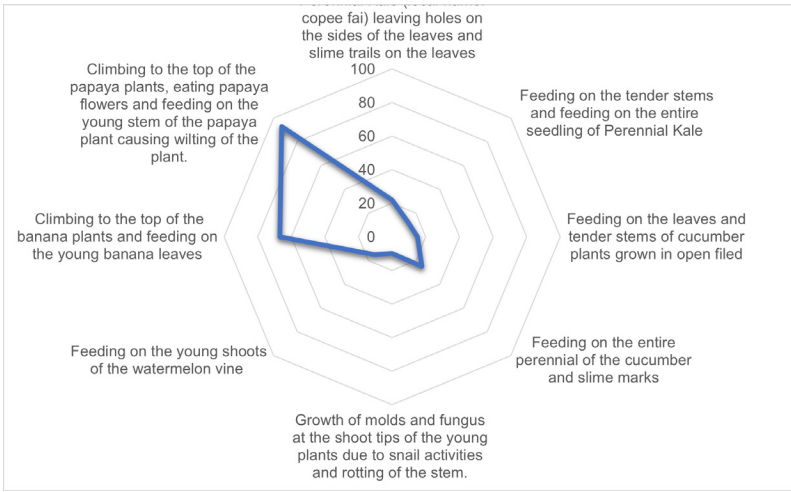
The data was analysed using Microsoft Excel, focusing on specific themes and sub-themes identified during the FGDs.

Results

Focus group discussions (FGDs) with over 120 farmers from Laamu Atoll, who cultivate fruits such as papaya, watermelon, cucumber, and leafy vegetables, revealed the extensive damage and nuisance caused by giant African snails. Farmers expressed their concerns over the uncontrollable nature of this pest and the damages caused by these snails. Figure 1 shows the most common concerns shared by the interviewed farmers, highlighting the most common difficulty faced by these snails is climbing to the top of the papaya plants, eating papaya flowers

and feeding on the young stem of the papaya plant causing wilting of the plant.

Figure 1. The frequencies of different feeding activities of Achanita fulica infestation observed in Laamu Atoll



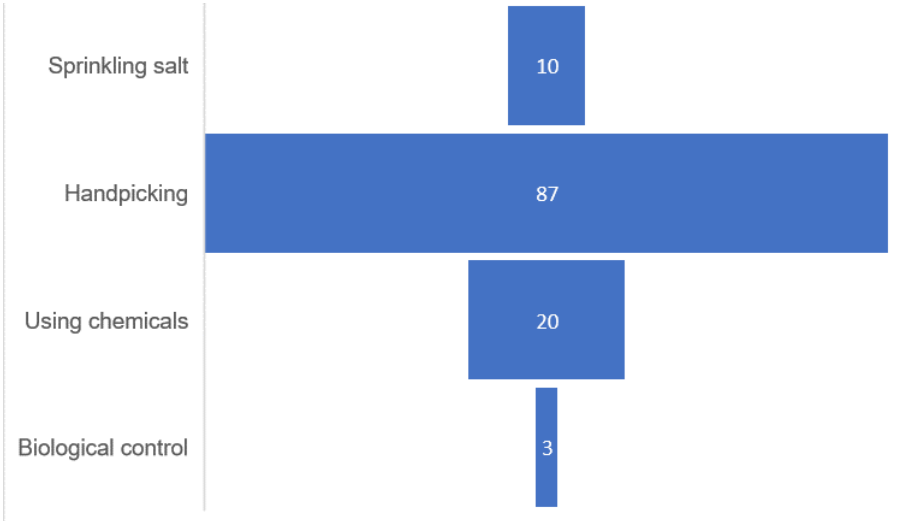
Farmers also have raised concern about the survival strategies they have observed among these snails. One of the alarming concerns raised was that over the years, the feeding habits of these snails have evolved. They have shifted from feeding on low-growing plants to climbing and feeding on taller plants such as papayas and bananas (figure 2).

Figure 2. Giant African snail (Achanita fulica) infestation observed in Laamu Atoll

(a) (b) (c)

Despite efforts to control the pest using salt, soapy water, and handpicking, farmers reported continued economic losses. The majority of farmers practice handpicking without proper protective measures such as gloves, and disposing of the snails in empty fields (figure 3). To tackle this, the MoAA conducted training and provided information on controlling these species, but the issue persists with seasonal outbreaks of the snail species. According to farmers it did not completely address the issue as they keep facing the outbreak of snail seasonally. Some farmers reported that they have started rearing ducks to reduce the snail population, as ducks feed on the snails when they are on the move.

Figure 3. Different pest control methods used by the farmers to control giant African snail (Achanita fulica) and their frequencies



This recount from the farmers clearly indicates a need for sustainable management solutions. It highlights that the control measures recommended to farmers by government agencies are inadequate, as farmers rarely practice them and overwhelmingly favor chemical control options. Moreover, the extensive use of insecticides and molluscicides, readily available in the market, poses a significant environmental cost.

Literature points not only to the harmful impact of this pest on crops, vegetables, and ecosystems but also to serious health-related issues caused by snail infestation. Giant African snails have the potential to serve as an intermediary host for parasites that affect both humans and mammals, posing a threat to indigenous species (Cazarin-Oliveira et al., 2022). A research study carried on seventy samples of giant African snails showed that these snails act as vectors for zoonotic diseases, which can be transferred to human through unwashed or uncooked snail-infested vegetables and fruits. In severe cases, this can lead to meningitis in both humans and animals (Olusi.et. al., 2021). Studies also show that these snails carry multiple parasites such as rat lungworm, roundworm, and Aeromonas hydrophilia

(Correoso, 2017).

Sustainable Management of Giant African Snail

Controlling giant African snail is a difficult and costly process which can only be achieved through collaborative efforts from all stakeholders, including government agencies, local authorities, and the communities. Preventing the spread of this species requires measures such as strict quarantine and surveillance by the relevant authorities when importing agricultural products such as planting material and organic manure or cow dung.

While it may be difficult to implement, it is important to ensure measures are taken to prevent the spread of this species within the island communities through transportation. (Djeddour et al., 2021). At the policy level it is important to identify potential introduction pathways, develop risk assessments, and implement a clean certification scheme for traded plants, especially from snail-contaminated areas (Djeddour et al., 2021).

Reportedly, there are sudden outbreaks of giant African snails among the communities during damp and rainy seasons. Understanding the factors leading to such outbreaks will help the communities take collective measures to prevent breeding grounds and snail population explosions. Below are sustainable management measures that can be taken at individual, community, and stakeholder levels to control giant African snail outbreaks.

- **Sustainable Management of Giant African Snail**

At the community level, locals should implement a combination of cultural, biological, and chemical control methods to manage giant African snail outbreaks effectively. While many farmers currently practice cultural methods such as handpicking, the disposal of handpicked snails often fails to fully address the issue. Snails discarded in empty areas can lead to survival and reinfestation through eggs or live snails thriving in new locations. Therefore, it is crucial for locals to incinerate the snails after handpicking them (Nelson, 2012).

Farmers can also deploy traps around their farmland to attract the snails, as recommended in MoAA leaflets. To prevent snail reproduction and thriving in farmland, it is important to regularly remove weeds, debris, and fallen fruits that serve as hiding places for snails. Additionally, farmers can use non-chemical methods such as use of cooking salt along with household bleach in a container with a fitted cover. This method allows snails to drown within 24 hours, after which they can be safely discarded (Nelson, 2012).

Another technique used in South Asian and European communities in controlling giant African snail is using Tangle Guard Paper Tree Wrap, which can be applied to plants such as papaya and banana. This method prevents snails that attempt to climb plant stems, causing them to stick to the paper and perish (Nelson, 2012). Similarly, in India farmers use Anona glabra cuttings in nursery beds which repels the snails and deters them from feeding on young seedlings such as cucumbers and

papaya plants (Nelson, 2012).

Chemical control methods are outlined in the MoAA training and their leaflets, providing farmers guidance on what chemicals to use and how to mix and apply it in their farmlands. Chemical control methods are less encouraged compared to cultural and biological methods due to their potential environmental impact. However, in cases where chemical control is necessary application over a three-month periodto completely eradicate snail populations from their farms and surrounding areas. To increase the effectiveness of this method it is crucial to continue monitoring and handpicking any snails that reappear (Nelson, 2012). Developed countries such as UK has banned the use of chemical molluscicides, in controlling slugs and snails, due to their adverse effects on non-target organisms and the environment (BaRua, Williams, & Ross, 2021).

Biological control methods have shown significant success in controlling this pest in some countries experiencing outbreak of this pest (Gerlach et al., 2020). Turbellarian flatworm: Platydemus monokwari is a black coloured worm which the Maldivian farmers previously used to control snails. However, a drawback of this method is its potential to deplete earthworm populations in the soil, which can negatively impact soil fertility, particularly in regions already facing nutrient-poor soil issues (Justine et al., 2014). Alternatively, some farmers have introduced chickens and ducks to their farms, which naturally feed on snails without the need for chemical interventions However, farmers and locals must ensure that the snails are not sprayed with chemicals or pesticides which might harm these birds (Gerlach et al., 2020).

- **Pest Management Model for Sustainable Management of Giant African Snail**

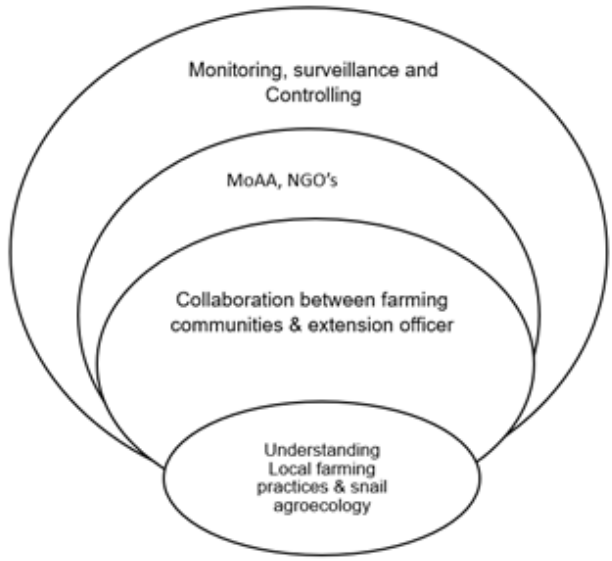
To effectively manage this snail outbreaks, the previously discussed control measures must be implemented collaboratively and collectively. Success in reducing the snail population hinges on diminishing juvenile snails and neonates over time (Ramdwar, 2018). Therefore, implementing a sustainable snail management model is crucial, involving local farmers, farming communities, extension officers, and the MoAA.

This model (shown in figure 4), is an adaptation from successful practices in snail-infested regions such as the orange grove farming district in Trinidad West Indies and considers the agroecological requirements of snails and tailors control measures accordingly. It also includes training and extension services for farmers to equip them with the knowledge and skills required to implement effective control measures (Ramdwar, 2018).

According to the findings presented, it must be a collective effort involving local farmers, communities, and government authorities in monitoring and controlling giant African snails in the Maldives farmlands, especially in areas where this species is infested. It is important to understand the agroecological requirements of snails, along with the population dynamics, to implement correct pest control strategies and minimising economic losses in agricultural production (Abd-Elhaleim et al., 2022). Additionally, continuous monitoring systems must be established to

evaluate the efficacy of these strategies and further refine control measures.

Figure 4. Giant African snail management collective model (Adapted from Ramdwar, 2018)



Conclusion and Recommendations

In conclusion, the measures described are based on information already prepared by the Ministry of Agriculture and Animal Welfare and shared among the farming communities. However, to effectively effectively control the spread of the giant African Snail species, this information needs to be disseminated to a broader audience, including all the island communities, schools, and institutions, so that the general public is aware and can take action when they spot this pest.

The spread of snail is not only through agricultural farming activities but also occurs among urban residents engaged in gardening. Therefore, it is crucial to carry out environmental education programs to raise public awareness about the importance of controlling this pest. Along with the proposed snail management model, it is important to implement policy initiatives to prevent the introduction of this pest to other island communities and to strengthen existing measures to prevent the entry of such invasive species into the Maldives from other countries. Successfully controlling invasive species has become an increasingly important challenge, and accordingly, understanding the biological factors of the pest that are likely to affect the success of control efforts is critical. National-level symposia and workshops are necessary to facilitate concerted implementation of activities to control and mitigate the pest.

In addition to these efforts, research-based activities need to be conducted

to understand the extent of damage the giant African snail causes to farming communities in terms of crop loss. This can be a useful measure to assess the economic impact of the snail on farming communities and the broader community, which can further inform control measures to prevent such losses and damages. Moreover, studies should be carried out to identify the activities of farmers and communities during the monsoon or damp season that leads to snail outbreaks. This information will be crucial for effectively controlling the outbreak of giant African snail infestations.

References

Abd-Elhaleim, S. M., Weshahy, K., Emam, H. M., & Ali, R. F. (2022). Population dynamics of abundant three terrestrial snail species in horticultural fields at Beheira and Giza Governorate, Egypt. *Pakistan Journal of Biological Sciences, 25(8)*, 765-775.

Abdulla, N. (2020). Pestel analysis of Maldivian agricultural system to improve agricultural management. Матеріали VIII науково-практичної Інтернет-конференції "Розвиток форм і методів сучасного менеджменту в умовах глобалізації". Дніпро: ДДАЕУ, 5–8. https://drive.google.com/drive/folders/1sjLGlw7QSnCgNtgn4iP61_YFUn7CEFli

Abdulla, N., Vasylieva, N., & Volovyk, I. (2022). Production optimization for sustainable agriculture and efficient contract farming in the Republic of Maldives. *Bulgarian Journal of Agricultural Science, 28(4)*, 579–590.

Agro National Corporation. (2020). Contract farming report. Retrieved from https://agronational.mv/en/resources/reports?- year=2021

Ash, J.S. and Shafeeg, Ali (1994) Birds of the Maldive islands, Indian Ocean, *Forktail 10(3)*. https://static1.squarespace.com/static/5c1a9e03f407b482a158da87/t/5c1fb491f950b7ec9afa7cfc/1545581719038/Ash-Maldives.pdf

Barua, A., Williams, C. D., & Ross, J. L. (2021, June 10). Literature review of biological and bio-rational control strategies for slugs: current research and future prospects. *Insects, 12(6)*, 541. https://doi.org/10.3390/insects12060541

Bhagyasree, B. (2023). India: one health in action - fighting the giant snail menace in Kerala. World Bank Blog.

Cazarin-Oliveira, L. C., Fraga, L. P., Lombardi, M. V., Volkweis, F. S., & Martins-Silva, M. J. (2021). Update on the occurrence and dispersion of the Achatina (Lissachatina) fulica Bowdich, 1822 (Mollusca, Gastropoda) snail within the Distrito Federal, Brazil. *Heringeriana, 15*, 87-95. http://revistas.jardimbotanico.ibict.br/

Correoso, M., Coello, M., & Espinosa, E. (2017). Pomacea canaliculata in Ecuador a recent pest with multiple implications. *ResearchGate*. https://www.researchgate.net/publication/320716641_Pomacea_canaliculata_in_Ecuador_a_recent_

pest_with_multiple_implications

Gabetti, A., Maganza, A., Prearo, M., Riina, M.V., Nodari, S., Rizzioli, B., Mangini, V., Di Tizio, L., Acutis, P. L., Dondo, A., Esposito, G., & Pastorino, P. (2023). First report of giant African snail (Lissachatina fulica) in a protected area of the Cottian Alps, Northwest Italy. *Sustainability.* https://doi.org/10.3390/su15118633

Gerlach, J., Barker, G. M., Bick, C. S., Bouchet, P., Brodie, G. D., Christensen, C. C., Collins, T. M., Coote, T., Cowie, R. H., Fiedler, G. C., Griffiths, O., Florens, F. B. V., Hayes, K. A., Kim, J., Meyer, J., Meyer, W. M., Richling, I., Slapcinsky, J., Winsor, L., & Yeung, N. W. (2020). Negative impacts of invasive predators used as biological control agents against the pest snail Lissachatina fulica: the snail Euglandina 'rosea' and the flatworm Platydemus manokwari. *Biological Invasions.* https://doi.org/10.1007/s10530-020-02436-w

Justine, J., Winsor, L., Gey, D., Gros, P., & Thévenot, J. (2014). The invasive New Guinea flatworm Platydemus manokwari in France, the first record for Europe: time for action is now. *PeerJ*. https://doi.org/10.7717/peerj.297

Leite, J. C. V. A., Rosa e Silva, M. A., Santos, J. A. A., & Faria, R. X. (2022). Natural products as a control measure of the Achatina fulica (Gastropoda: Achatinidae). *Brazilian Journal of Biology, 84*. https://doi.org/10.1590/1519-6984.260065

Morrison, W., & Hay, M. E. (2010). Feeding and growth of native, invasive and non-invasive alien apple snails (Ampullariidae) in the United States: Invasives eat more and grow more. *Biological Invasions.* https://doi.org/10.1007/s10530-010-9881-x.

Nelson, S. (2012). Injuries caused by the giant African snail to papaya. (Miscellaneous Pests No. MP-6). University of Hawaii. Honolulu, HI. 7.

Olusi, T. A., Babatunde, O. S., & Adeniji, M. (2021). Survey of the African giant land snail (Archachatina marginata), intermediate host of intestinal parasites in Akure Metropolis, Ondo State. *Bull Natl Res Cent, 45(1)*, 183. https://doi.org/10.1186/s42269-021-00647-2.

Rasal, V. (2022). Ecological invasion of the giant African snail Lissachatina fulica (Bowdich, 1822) in a semi-arid forest of western India. *Biodiversity Observation, 26.* https://journals.uct.ac.za/index.php/BO/article/view/876

Ramdwar, M. (2019). Farmers' experiences with the giant African snail infestation: A case study in the orange grove farming district, Trinidad West Indies. *International Journal of Social Science Studies, 7(1)*. https://doi.org/10.11114/ijsss.v7i1.3972

Rekha, S. R., Munsi, M., Neelavara, A. A. (2015) Effect of climate change on invasion risk of giant African snail (Achatina fulica Férussac, 1821: Achatinidae) in India. *PLoS ONE, 10(11*), e0143724. https://doi.org/10.1371/journal.

pone.0143724

Roda, A., Nachman, G., Weihman, S., Yong Cong, M., & Zimmerman, F. (2016). Reproductive ecology of the giant African snail in South Florida: implications for eradication programs. *PLoS One, 11(11)*, e0165408. https://doi.org/10.1371/journal.pone.0165408