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Giant african snail, *Achatina fulica* (Férussac, 1821): an environmental and public health problem in the northwestern of Paraná State, Brazil

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ABSTRACT. *Achatina fulica*, known as Giant African Snail (GAS), was introduced in Brazil as a substitute for the European escargot, *Helix aspersa maxima*. However, its cultivation was abandoned and the mollusk became an invasive species, found throughout Brazil and causing damage to health and the environment. In this context, this study analyzed the knowledge of the population about the damage caused by GAS, seeking to reveal a regional scenario on this issue. This exploratory and cross-sectional study was conducted by means of a questionnaire applied to 150 people, which obtained sociodemographic characteristics of respondents and specific responses about the knowledge and handling of GAS. The results showed that most of the respondents know the snail and are concerned about the transmission of diseases and losses in agricultural crops, but few recognize this pest as the basis of environmental imbalance. It is suggested to implement actions seeking the dissemination of such knowledge and the awareness of the population about the impact of this mollusk on the environment.

Keywords: mollusk, introduced species, environment, social study.

Caramujo africano, *Achatina fulica* (Férussac, 1821): um problema ambiental e de saúde pública no Noroeste do Paraná, Brasil

RESUMO. *Achatina fulica*, conhecida como caramujo gigante africano, foi introduzida no Brasil como um substituto do escargot europeu, *Helix aspersa maxima*. Contudo, seu cultivo foi abandonado e o molusco transformou-se numa espécie invasora, presente em todo o território brasileiro, provocando danos à saúde e ao meio ambiente. Assim, objetivou-se, com este trabalho, analisar o conhecimento da população sobre os danos causados pelo caramujo gigante africano, buscando evidenciar um cenário regional sobre esta problemática. A pesquisa teve caráter exploratório e transversal e foi realizada por meio da aplicação de um questionário para 150 pessoas, por meio do qual foram obtidas as características sociodemográficas dos respondentes e respostas específicas sobre o conhecimento e o manuseio do caramujo africano. Os resultados deste estudo mostraram que a maioria dos respondentes conhece o caramujo africano e se preocupa com a transmissão de doenças e com os prejuízos em culturas agrícolas, porém poucos reconhecem essa praga como base de desequilíbrios ambientais. Sugere-se que ações sejam implementadas, buscando a disseminação desses conhecimentos e a conscientização da população sobre o impacto desse molusco no meio ambiente.

Palavras-chave: molusco, espécies introduzidas, meio ambiente, estudo social.

Introduction

The land snail *Achatina fulica* (Férussac, 1821), known as Giant African Snail (GAS), is native to the Central Northeast coast of Africa and is found on all continents (Prasad, Singh, Senani, & Medhi, 2004; Mata & Mata, 2012; Almeida, 2016). It was introduced in Brazil in the end of 1980s as an option for the consumption of escargot, however, the commercial and marketing failure generated surplus populations released in natural ecosystems, agricultural and urban areas, which resulted in ecological, health and agricultural threats.

The problems caused by this snail led to the enactment of Normative Instruction 73 of August 18th, 2005, based on Law 5,197 and the commitments set by the Convention on Biological Diversity, which considered that *A. fulica* did not belong to the Brazilian wildfauna and therefore

representing an exotic invasive species harmful to native wild species, the environment, agriculture and public health (IBAMA, 2005).

According to the International Union for Conservation of Nature (IUCN, 2010), this introduced snail is considered a threat to agriculture and the environment, whereas without natural enemies they reach the plantations, squares and gardens, consuming the flora found in those places. In agreement with Prasad et al. (2004), the giant snail is capable of consuming 500 different types of plants, including ornamental plants and agricultural crops, besides consuming pebbles, sand, bones and even concrete, causing high impacts.

In several aspects, whether environmental, health and agricultural, this species has been increasingly recorded in the national territory. After the introduction, the African snail has spread through all the Brazilian states and because it is true hermaphrodite, resistant to the weather variations, to diseases, and has high rates of proliferation, feed on a wide array of vegetables and able to bury themselves in the soil to hibernate during the hottest periods of the year, hinder the actions of chemical, biological and physical control (Prasad et al., 2004). However, the resistance of this invasive species to these forms of control also depends on the stage of development of the mollusk (Fischer, Simião, Colley, Milléo, & Rubio, 2005).

Some of the types of control are known by scientists (Prasad et al., 2004; Souza, Alves, & Alves, 2007), but the actual damage and the most effective forms of control for the eradication of this invasive snail are still unknown.

Thus, this study aimed to analyze the degree of knowledge of a group of individuals about the GAS, seeking to reveal a regional scenario on this subject.

Material and methods

This exploratory and cross-sectional study had the participation of 150 individuals of both sexes, between 15 and 60 years old, who were visiting an agro-environmental event, in the northwestern state of Paraná, with participation of rural producers, the urban population and students of different areas of knowledge and professionals, totaling approximately 4,000 participants, from more than 40 municipalities of the region of Maringá, state of Paraná. The research was approved by the ethics committee in June 2016, Opinion Number: 1.592.868.

The questionnaire was applied during the event, where the subjects were approached by chance. After clarifying the research objectives, highlighting the confidentiality in relation to the data and ensuring the participant's freedom to choose to respond or not, they signed the informed consent. It should be emphasized that the theme was not previously discussed with the participants. The average data collection time was approximately 10 minutes.

For data collection, a questionnaire containing 12 multiple choice closed questions was applied, where several alternatives were presented and the respondent indicated only one (single answer) or more than one (multiple answers) and were about the following aspects: 1) Sociodemographic characteristics of the interviewees: the municipality where they live, rural or urban area, gender, age and schooling level; 2) Specific questions about the African snail: knows the snail, knows the damage caused by the snail, if so, identify the damages, whether to human health, crops or the environment; if had contact with the snail, if yes, if some form of control was used, if yes, identify the form: manual, chemical, others and what was the final destination used: incineration, burial, discard. The elaboration and analysis of the answers considered the assumptions of Bardin (2006).

Pearson's "r" coefficient of correlation with previous angular transformation was used to determine possible correlation between the knowledge from damages and age class of the interviewees.

Results and discussion

Data on the sociodemographic characterization of interviewees (Table 1) showed that 47.33% live in the municipality of Maringá, most of them live in urban areas, although a large proportion of these residents work in rural areas. From this total, there was parity with regard to the gender of the participants. Most of the interviewees are young people and young adults, aged between 15 and 30 years (57.33%). Regarding the level of schooling, a great part of the interviewees had high school and graduation.

Data collected on the interviewees knowledge about the Giant African snail revealed that of the total number of interviewees, the majority (72.67%, N = 109) had knowlwdge about it. Of these, 61.47% (N = 67) reported having knowledge about the damage caused by this mollusk, and when questioned about the type of damage caused, human health was the most frequent and the environment was the least cited (Table 2).

Of the total number of individuals who knew the damage, 50 (74.64%) related the snail at least once to human health, 42 (62.68%) to the crop and 18

(26.87%) to the environment. The high frequency of individuals who have recognized and has the perception that this snail can cause harm to health is a very positive result and meets the scientific consensus.

Table 1. Frequency of the socio-demographic characteristics of the individuals interviewed (N=150).

Variable	Category of the answer	Frequency (%)
Municipality of residence	Maringá	47.33
	Other	52.00
	Not informed	0.67
Residence zone	Rural	12.67
	Urban	86.00
	Not informed	1.33
Gender	Male	50.00
	Female	49.33
	Not informed	0.67
Age class (years old)	15 - 20	26.00
	21 - 25	17.33
	26 - 30	14.00
	31 - 35	6.00
	36 - 40	3.33
	41 - 45	6.00
	46 - 50	10.00
	51 - 55	6.00
	56 - 60	5.33
	> 60	5.33
	Not informed	0.67
Schooling level	Elementary School	12.67
	High School	27.33
	Undergraduate student	40.00
	Graduate student	19.33
	Not informed	0.67

Table 2. Frequency of interviewees aware of the damage caused by African snail to human health, crops and the environment (N = 67).

Knowledge of the damages	Frequency (%)
Human health	29.85
Crops	19.40
Environment	2.98
Human Health and crops	23.88
Crops and environment	2.98
Human, health and environment	4.49
Human health, crops and environment	16.42

Achatina fulica is a public health problem for presenting high populations in urban areas and being a potential host of numerous disease-causing pathogens in humans and animals. Colley and Fischer (2009) claimed that the African snail is host of nematodes of the species *Angiostrongylus costaricensis* Morera & Cespedes, 1971, which causes diseases to human (zoonoses) such as angiostrongyliasis or abdominal angiostrongylosis. This disease can evolve to an intestinal perforation, peritonitis, abdominal bleeding and secondary to mesenteric ischemia, and pronounced eosinophilia (Prasad et al., 2004; Rodriguez et al., 2008), and may even lead to death. Although not registered in Brazil, eosinophilic meningoencephalitis (meningoencephalitis, angiostrongylosis or eosinophilic meningitis) was recorded for the first time in Cuba for the helminth *A. cantonensis* (Chen, 1935) in the host *Helix pomatia,* Linnaeus, 1758 (Teles & Fontes, 1998), but it has already been recorded in the Pacific islands, in Southeast Asia, Australia and the United States (Oliveira, Gentile, Maldonado Jr., Torres, & Thiengo, 2015). In Brazil, the fact that there are no records of diseases or deaths related to the African snail, does not indicate that they do not exist or that they are not occurring, this can be due to the absence of identification of this host as the cause of the problems.

The International Union for Conservation of Nature/IUCN (2010) emphasizes giant snail as a vector of human diseases. Morocoima et al. (2014) stated that *A. fulica* is a vector of helminths, protozoa and bacteria and represents an epidemiological risk to public and veterinary health. These pathogens can be transmitted to humans and animals by ingestion of vegetable and water contaminated by excreta (Faruque, 2012), consumption of raw or undercooked snail (Zanol et al., 2010; Vitta, Polseela, Nateeworanart, & Tattiyapong, 2011) or by improperhandling of live snails, resulting in contact of their excreta with the eyes, nose or mouth (USDA, 2008).

A study carried out in Tanzania (Mead, 1979) with shells from dead individuals of *A. fulica* showed that, in the period of intense rainfall, the shells were home to small populations of *Aedes aegypti* L., yellow fever vector mosquito in this country and dengue and dengue-hemorrhagic, in Brazil. This study, coupled with the fact that these animals die with the shells open facing upwards and that most States show heavy rainfall in the summer, lead to the supposition that the shells of these animals serve as pools of mosquito larvae. Studies demonstrate that the *A. aegypti* mosquito is a potential vector of urban yellow fever (Tauil, 2010). Despite the epidemic of wild yellow fever that has affected many Brazilian states since 2016, and this was last recorded in 1945, it is not ruled out that the sick man could become a source of infection for *A. aegypti* in urban areas. In this way, it is extremely important to know the population about this animal and the appropriate forms of control also the shells, thus avoiding the increase of cases of dengue fever, zyka and records of cases of urban yellow fever.

Shells left in the environment or destined for inappropriate disposal constitute a serious health problem, since in addition to the cases mentioned above, other species of insects, bacteria and rats, transmitters of zoonoses, can also use these reservoirs as deposits of eggs, refuge or food, as well as in the maintenance of their life cycles.

Among the respondents who knew the damage, 62.68% related these data to crops, whether isolated or in conjunction with health and the environment. In a research conducted in the State of Paraná, Colley and Fischer (2009) reported, based on data from the *Secretaria de Saúde do Estado do Paraná* (SESA/PR), *Empresa de Assistência Técnica e Extensão Rural* (EMATER/PR), *Secretaria de Estado da Agricultura e Abastecimento do Paraná* (SEAB/PR), *Instituto Agronômico do Paraná* (IAPAR) and the *Ministério da Agricultura, Pecuária e Abastecimento* (MAPA/PR), that *A. fulica* is not considered an agricultural pest at the damage is occasional and local. In turn, Fischer, et al. (2005) also observed the occurrence of this snail in several municipalities of the Paraná coast, such as Pontal do Paraná, Guaraqueçaba and Paranaguá, but in this study, *A. fulica* is considered an agricultural pest and can be found in gardens, dumps, wastelands and ornamental plants.

Currently, the fact of not being considered agricultural pest is controversial, since economic losses in crops occur on a small scale compared to other pests. However, in the case of family farming or organic production, the impact is more severe. It should be noted that there is a lack of sufficient information or analysis to identify these impacts.

This snail, besides Brazil, has already been recorded in Latin America in Argentina, Paraguay, Colombia, Ecuador, Peru and Venezuela. Its distribution is due not only to the dispersion of populations but also due to the transportation carried out by fishermen, who use this snail as bait, sold in petshops, or transported along with solid residues, plants and building material (Vogler et al., 2013).

Considering the isolated and associated answers, it was possible to verify that the large minority of the interviewees (26.87%) is unaware of the fact that this mollusk can affect the environment. This evidences the limited knowledge of these individuals in relation to the different forms of aggression that the environment can suffer, including the inherent damages to the snail, an exotic species, which due to the absence of natural enemies and its voracious appetite can generate environmental imbalances (IUCN, 2010). In this sense, it is evident that the environmental factor is clearly neglected, and among respondents, there is no identification of natural or degraded environment. Another important factor is the fact that the mucus produced by the snail can inhibit the presence of *Megalobulimus* sp., a snail native to the Brazilian fauna (Colley, 2010).

By relating the age classes of the participants, in the group that is aware of the damages that the snail promotes, the majority (62.39%) presented a high level of schooling (graduate or postgraduate student), and only 11.09% presented complete or incomplete elementary school.

This result leads to suppose that the dissemination of knowledge is occurring within higher education institutions, since the knowledge of interviewees with lower ages and education level, presented low percentages of information.

A comparative analysis of knowledge of damage per age group (Figure 1) showed almost 60% of the interviewees aged less than or equal to 30 years had knowledge of these damages. Despite this, no presented significant correlation between knowledge of these damages and age class ($r = -0.4667$, $p = 0.1738$).

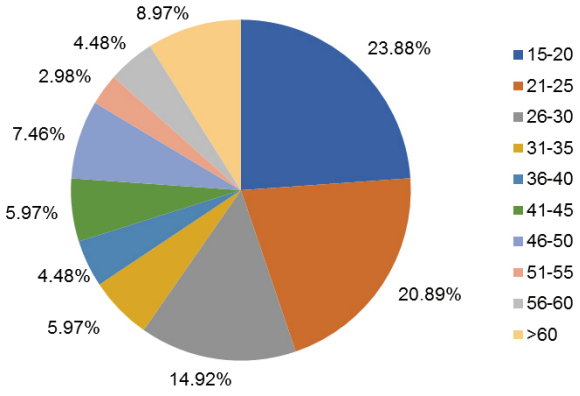

Figure 1. Frequency (%) of interviewees that know the damages produced by the African snail *Achatina fulica* per age class (N = 67).

Another important result observed is that only 43.11% (N = 47) of the respondents who informed knowing the snail answered that they had used some form of control, most notably the manual collection (Figure 2). Despite the low frequency, the form of chemical control identified in the research consisted in the use of salt or lime on the snails. These methods are also reported in studies conducted by Durço, Vargas, Silva, and Carraro (2012).

Manual collection, regular and safe, followed by incineration, has been shown to be a recommended and efficient method in several countries (Almeida, 2016). However, its efficiency depends on several combined actions and involvement of society. The success of manual control depends on a prior diagnosis of the population structure of *A. fulica* by professionals, who should monitor the collection to be performed in a standard management, in addition to inspect that native mollusks are not accidentally slaughtered in place of the invasive species (Colley, 2010). As the general society be unable to

distinguish correctly the invasive species from the native species, manual catch has resulted in threats to native species such as *Megalobulimus* sp. (Colley & Fischer, 2009), which is harmless and flagship species of the Atlantic Forest (Pecora & Miranda, 2014). Campaigns should be made with caution so as not to induce the population to inadvertently exterminate any mollusk species, since there are several native mollusks.

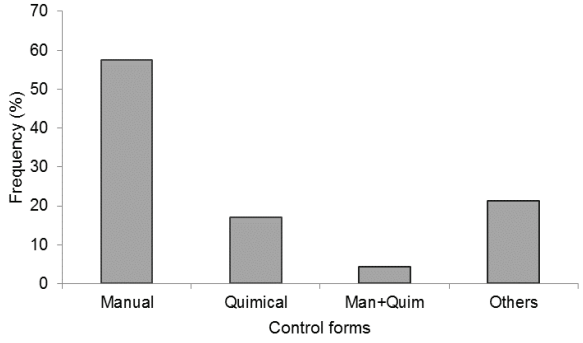

Figure 2. Frequency of respondents who had contact and who used forms of control against the African snail *Achatina fulica*.

The various forms of control, management and eradication of the snail are derived from chemical, biological and physical control. The use of chemicals is an alternative widely used in several countries, but it is not always successful. Molluscicides are composed of metaldehyde, carbamates and phosphate iron, but their use in urban, agricultural or natural environments requires legal authorization from the *Agência Nacional de Vigilância Sanitária* (ANVISA), *Ministério da Agricultura, Pecuária e Abastecimento* (MAPA) and *Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais e Renováveis* (IBAMA).

According to ANVISA (2017), currently, in Brazil, granulated baits, metaldehyde-based, are commercially marketed with a maximum concentration of 5.0% w / w, for the chemical control of the mollusk, and these products are only released as household sanitizers.

In an attempt to find synthetic muliscicidas for the control of *A. fulica*, a study was conducted by Mata and Mata (2012), which used granulated baits, but no efficacy was found for any of these substances. The use of pesticides can cause toxicity problems for humans, domestic animals and the environment (Souza et al., 2007).

Biological control is based on the use of natural enemies, such as pathogens, predators and parasites, aiming to control growth or exterminate the snail (Colley, 2010). Natural predators, also called malacophagous species, have been considered by several researchers but these predators are also exotic and can become pests, beyond the risk of not only preying upon *A. fulica*, but also negatively affecting other species (Souza et al., 2007). Thus, according to Prasad et al. (2004), the biological control performed by malacophagous species is inadvisable. Although there are several reports in the literature, the biological control of *A. fulica* is not very effective.

The most cited physical control consist of: directed planting, physical barriers, sanitation and manual collection. Targeted planting is an alternative that can be used to reduce the losses caused by the snail. This technique is based on intercropping, both in agriculture and in gardening, of plants not appreciated by the mollusk, reducing the probability of invasion (Colley, 2010). In this sense, Prasad et al. (2004) suggested the use of *Annona glabra* L. (Annonaceae), a plant resistant to snails and the Global Invasive Species Programmee (IUCN, 2010) suggests the use of the fruit of *Thevetia peruviana* (Pers.) Schum or yellow oleander, which also have action against the African snail, although it should be considered the toxicity of this plant for humans (Teixeira, Mazutti, Gontijo, Silva, & Ogawa, 2013).

Physical barriers can prevent or reduce the dispersal of snails. They may be extensive strips of bare soil or gutters that prevent the movement of mollusks or may provide direct protection to the plant with the use of screens or paper (Colley, 2010). Nevertheless, these barriers have limited efficiency and require constant maintenance.

The role of sanitation in the control of snail is a fundamental point to be considered, since it is known that poorly preserved areas, with accumulation of waste and debris favor the establishment of the African snail population (Colley, 2010).

The monitoring by trained professionals should be carried out so that control measures such as use of pesticides, mainly illegal ones, salt, lime and bleach are not used in other native mollusks, which, in the long term, can be extremely harmful to the environment. Unfortunately, even in small numbers, this research showed that some individuals interviewed who had contact with the snail used salt or lime to control the snails, reflecting the lack of information from these individuals regarding this subject.

In a similar study with students of a school in the state of Pernambuco, the authors also verified that the best known method used by the interviewees is the manual collection and destruction of the animals, in order to keep the populations of the molluskat acceptable levels (Souza et al., 2007).

After the application of the control measure, the final destination of the snail was very variable, however, incineration and disposal in the garbage were the main forms (Figure 3).

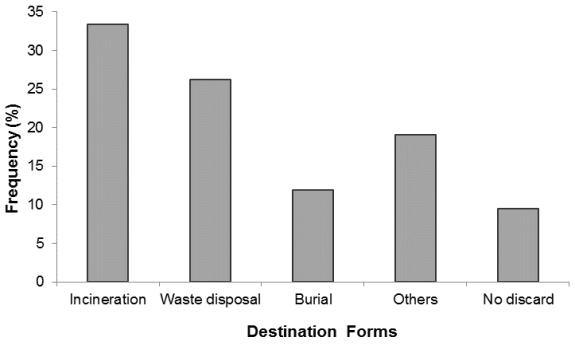

Figure 3. Frequency of final destination forms of the African snail *Achatina fulica*.

Boaventura (2011) stated that the mollusk can be incinerated, provided that under suitable conditions with the use of an incinerator, oven or brass, or crushed and buried in deep ditch, throwing limestone on the bottom and on the top, to avoid contamination of groundwater, mainly in cases of large quantities collected. According to Colley (2010), burial measures are not sufficient and the destination, in the case of live animals, to the system of garbage collection or release in lakes, rivers or the sea hardly leads the mollusks to death, being able to transfer and disseminate the snails to other locations. According to the author, the destination of slaughtered snails should be discussed with the authorities, since the same, since Normative Instruction 73, of August 18th, 2005, the competent federal, State and municipal bodies, as well as non-governmental organizations with proven experience in the area, were authorized to implement measures to control, collect and eliminate the snail *A. fulica*, as a way tocontain the current invasion of this mollusk in urban, rural and natural environments (IBAMA, 2005).

Worldwide, manual and regular collection, always with the use of personal protective equipment, mainly gloves, followed by incineration, has been shown to be a more efficient method to date (Almeida, 2016).

Conclusion

The results of the present study enabled to establish that most of the interviewees have knowledge about the African snail and in relation to the damage that it can cause, the majority showed concern about the transmission of diseases and the damage to crops, however, the attention to the fact that this pest can be considered the basis of environmental imbalances was recognized by a low number of respondents. This evidences that the environmental factor is clearly neglected, which is worrisome, especially nowadays, when the search for a balanced environment is fundamental.

In this way, it is suggested to implement actions to disseminate this knowledge and raise the population's awareness about health and the environment. Sucessful experiences point out the dissemination of knowledge, associated with ongoing and responsible actions involving the population and trained professionals in the areas of health, environment and agriculture strengthens control actions.

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