Revista Nacional de
Gerenciamento de Cidades
ISSN eletrônico 2318-8472, volume 08, número 67, 2020

Precariety of basic sanitation and the presence of the african snail (Achatina Fulica Bowdich, 1822) in the city of Manaus / AM-Brasil

Michael Guimarães de Souza
Master student, UFAM, Brasil
radgeo_michael@yahoo.com.br

Ana Mara Cruz Lachi
Master student, UFAM, Brasil
mara2lachi@gmail.com

Adoréa Rebello da Cunha Albuquerque
Doctor Professor, UFAM, Brasil
adorea27@yahoo.com.br

Revista Nacional de
Gerenciamento de Cidades
ISSN eletrônico 2318-8472, volume 08, número 67, 2020

SUMMARY

The African snail (Achatina fulica) represents a serious risk to public health as it is a vector of disease such as eosinophilic meningitis. This mollusk has become abundant in urban environments, where its habitat is the areas located around rivers and vacant lots. Due to this context, it was the main objective of the present research, the identification of the areas of occurrence of the African snail in face of the precarious situation of sanitation in Manaus. The methodology was worked through field surveys, georeferencing and use of the database of the Brazilian Institute of Geography and Statistics. The results show that in the 126 areas mapped with the presence of the African snail, 119 census tracts are marked by the existence of untreated sewage and inadequate destination. In these sectors, the highest population density of the species was noted. The precarious situation of sanitation in the capital of Amazonas, shows that only 12.3% of the population receives sewage collection service, and the scarcity of sewage services becomes the main factor in favoring the spread of African snails in Manaus.

Keywords: Basic sanitation. African snail. Manaus.

INTRODUCTION

About four decades ago, the mollusk known as african snail (achatina fulica) was introduced in Brazil, under the economic perspective to become a sophisticated delicacy on the escargot market. Contrary to the perspective proposed, this specie, as well as other exotics species, has been caused a serie of socio-environmental problems to the country, mainly the problems related to the inadequate sanitation conditions. For the authors as Thiengo *et al* (2005), the records of intimate human relationship with the mollusks are date in prehistory, whether in its use for food, whether in the tool or adornments manufacturing or whether in the anthropozoonosis transmission, which remain until today, and affect milions of people, especially in developing countries with the sanitation and health precarious indexes.

When referring about sanitation and health systems Rosen (2006), points out that archaeological remains of public hygiene structures was found in many countries as India, Egypt, Greece and Rome. Beyond these places, remmants of sanitation buildings was discovored in the ancient pre-columbian civilization ruins, where was registered in the past, the existence of an improved irrigation and waste collection system. This evidences, indicates that sanitation startegies were aimed to maintaining the health community.

Many of these archaological finds were geographically isolates, therefore we comprehend that care used in the water related diseases control, weren't incorporated by other civilizations, causing a disease increase, in civilizations considered "modern" (RESENDE; HELLER, 2008).

According to Guimarães (2001), in a first moment the urban sanitation was the only "remedy" to control the begining of the infectious diseases transmission process. In the scenery, the Pan American Health Organization/PAHO identifying the lack of the basic sanitation in many countries, was estimated, that for each monetary unit that is effectively invest on basic sanitation, four other units won't be spent by governments in health care (PAHO, 2019).

When the topic is basic sanitation, mainly the sewage access, it's worth to discard that Brazil ranks the 11th position in the ranking between 17 countries analyzed by PAHO, being behind Bolivia, Peru, Uruguay, Ecuador, Venezuela, Chile, Mexico, Argentina, Colombia and Costa Rica. With the new progress of basic sanitation investment in Brazil, estimated in order of

10 billions for year, the country would need at least 20 years to can universalize the service to the entire population (PAHO, 2019).

In this precarious political-administrative conjucture of access to sanitation, the african snail (*Achatina fulica*) arrives to the country in the final of 1980 decade, and since then its numerical and geographic expasion has been remained constant. Nowadays, examples of this mollusk are found in all federation states and, for being a specie which has a strong influence with abiotic factors, therefore, therefore adapted its self well to the amazonic environment.

In the case of Manaus city, the mollusk began to be found since the year of 2003 precisely on midwest of this city. Informations indicates that the snails from illegal tanks and breeding grounds, after the escargot price decreasing on nacional market and the banning of the commerce by competents bodies, were random and arbitrary discarded on environment.

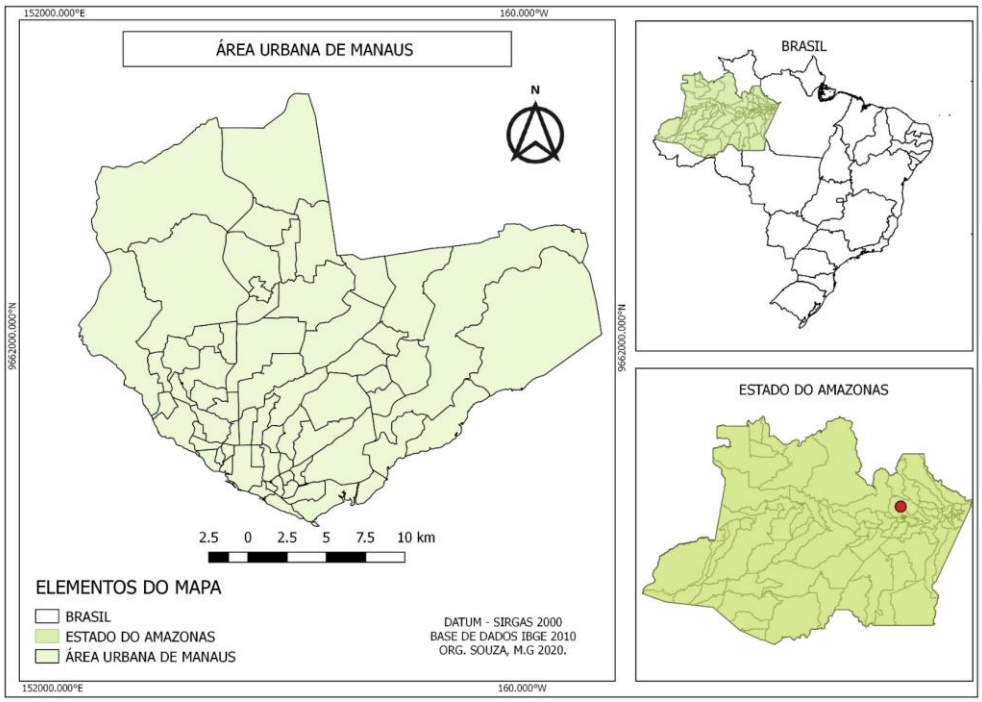
OBJECTIVE

This study aimed to identify the occurrence areas of african snail in Manaus city and concomitantly, relate them to the precariety of basic sanitation and the disease spread.

MATERIAL AND METHOD

The study was made on urban area of Manaus county. This area is delimited on a territorial surface of 592,194 km^2 (EMBRAPA, 2017), located between the following geographical coordinates: 02° 56’ 12,5 a 3° 09’ 45,6 - South Latitude and 59° 48’44,4 a 60° 06’54,7 Greenwich West Longitude (Figure 1).

Figure 01 – Study area location map



Source IBGE, 2010. Elaboration: SOUZA M, G. 2020.

The Manaus county is located in the river Negro and Solimões confluence range, occuppying an area of 11.401 km², that represents 0.7258 % of the Amazon state, 0.2959 % of North Region and 0.1342 % of entire brazilian territory IBGE (2010).

According to the IBGE Demographic Census (2010), there are 1.802.014 habitants in Manaus, that represents 10,89% of the North region population and 49,9% of Amazon state population. For estimation data, the IBGE points out that a populacional contingente of 2.182,763 people maintain the city as 7th the most populous city of country in 2019.

The methodological procedures included for collection and data obtaning, a detailed review of theoretical reference about the specie *Achatina fulica*, basic sanitation and diseases associated with the presence of the mollusk. In a continuous act, was performed a search of interdisciplinary character in the database of Brazilian Digital Library of Theses and Dissertations (BDLTD), portal of Coordination of the Improvement of Higher Education Personnel (CAPES) and in the database of Scientific Electronic Library Online (SCIELO) that brings together a vast collection of academic journals produced in Brazil and abroad about the most diverse knowledge areas including Geography, Biogeography and Medicine.

Beyond the bibliographic survey, of the search and of the field supervisions, accomplished at september 2018 to september 2019, was integrated a year of analysis and study where was accomplished 53 visits to 32 neighborhood of the city, allowing the georeferencing of 126 points, that correspond to occurence mollusk areas.

The records obtained in the field allowing the cartographic projection, which in its turn, generated as a product a thematic map about the spatial distribution of african snail in Manaus city. This map by overlay technique was overlaid to areas with deficient sanitation for census sectors, built by Brazilian Institute of Geography and Statistics (BIGS,2010). The geographic information sistem (GIS) used was the free Software QGIS, version 2.8 La palmas.

RESULTS AND DISCUSSION

The social contrasts, presents in many peripheries, force the population to ocuppy inadequates areas and to build neighborhoods with irregular forms and contours, where the building house on slopes it's commom. In this scenery of urban chaos, agravattes the basic sanitation problematic and garbage collection, that corresponds to the high risk of disease spread (CORREA, 2006).

With reference of sanitation theme, authors as Rezende *et al* (2008), Gil (2010) and Machado (2018), describe that the sanitation politic in Brazil can be divided into five phases. The first corresponds to the begining of the 16th century until the first half the 19th century, is characterized by the absence of the State in sanitary matters. The phases of Brazil Colony marks the concerns focused only for the exploration of the land, pointing out few and isolated interventions more for the individual, than for the collective.

In the later stage, that corresponds to the second part of the 19th century until the begining of 1910, the State takes on e creates health protection sanitary into the politic context wich the english companies start to perform infrastructure services in the country.

The third phase corresponds to the years 1910 to 1950, referring to the period of nationalization in the sector, in order to guarantee large and efficient actions in densely populated cities.

The fourth phase of 1950-1969 is marked by the assignments rupture of the health and sanitation policies by the Union. States and counties start to detain creation duties of statal sanitation or mixed economy company, ensuring a direct management, not more centralized.

The fifth phase was established between 1970-1990, marks the moment without major investments. After the Fernando Henrique Cardoso economy inauguration to foreigners capital, 1995-2003, occurs an intesive privatization in the sector putting the responsability by precary sanitation system maintenance on the nacional and foreign companies.

After successive debates between Union and the states in 2007, is proposed the elaboration of Nacional Basic Sanitation Plan – PLANSAB, which has through by updates, being voted and approved by Federal Senate with the creation of the LEI Project nº 4162 in 2019. In this process was established a new regulatory mark of basic sanitation in Brazil (COSTA, 2020).

From the point of sanitary view, the basic sanitation in Manaus is deficient. This frame becomes dramatic, if we consider geographic condititions of the local hidrographic — evidenced by the dense drainage system constituted by a true urban rivers plot totally polluted — owing to the extensive waste quantity.

According to Treat Brazil Institute informations, in the year of 2019, Manaus was ranked as the sixth city on country with the worst basic sanitation index. It's estimates that in Manaus only 12,3% of the population receive sewage collection services, and 47,6% of Amazon capital sewage are treat. Totally opposed to this situation, Goiania presents 92,5% of its population with sewage collection, and 68,8% of Goias capital sewage are treat.

In front of this frame of complete insecurity with the treatment of waters served, it's worth to emphase that, through the nonexistence of channeled structures, it's commom a large part of population, mainly the one that resides close to the hydrographic channels, discharging sanitary wastes directly on urban rivers. Also with this discharge alternative, another population parcel is added with those the connect water served canalization to the fluvial system, pouring human excrement into the river Negro, main river of the city.

This practice alters the natural conditions of ecosystems and the quality of water resources in urban rivers, this circumstance is responsible for flare a serie of environmental problems, among which can be enunciated: the spread of waterborne diseases, intensive emission of strong and fetid odor in this places, and the drainage system obstruction. Against this insalubrity urban and complet chaos, that indicates the poor quality of the water, the african snails spreads it self turning these places in its survival and reproduction habitat. Actually, these places to consist in high humidity zones, bring together conditions that favoring the animal existence.

Even though a land mollusk, the proximity of african snail with the water occurs by the temperature and the humidity need of maintenance where a vegetal cover serves as shelter and food. When referring to the theme, Fisher (2005) point that anywhere that offer adequate protection against light and desiccation, will be used by african snail (*Achatina fulica*) in urban areas (Figure 2).

Figure 2. Hydrographic channel of Educandos neighborhood in the Central South zone (a). African snail in humid areas close to the banks of the channel (b).

(a) (b)

Source: Souza M, G. 03/04/2020.

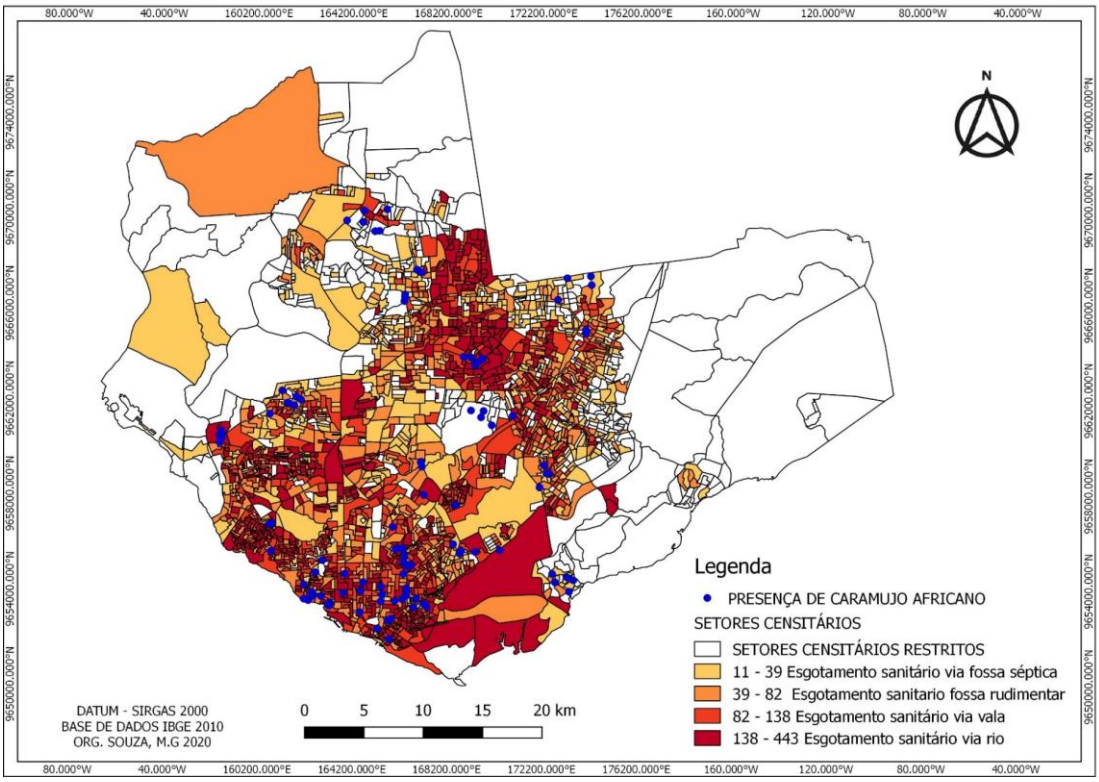
About the form of reproduction, this snail specie reaches the quantitative of 400 eggs by posture, that allows it to constitute expressive colonies of individuals in urban environment. Beyond this aspect, they are exotic animals without local predators, featured that favors their survival. The places where they are easily found, are areas with garbage accumulation, low grounds with vegetation or sewage areas and unhealthy sanitry conditions, the best examples are the river banks that cut across the city territorial surface.

For referring to a specie with easy adaptability, the expressive increase in the number of individuals occurs at the begining of the rainy season, where the mild temperatures and the abundant vegetation are shelter and food zones.

The Works that inclued the field survay to obtain data in this study, points out that the zones with most african snail occurrence, proven, are the most insalubrity, as the map below shows (Figure 3).

Revista Nacional de
Gerenciamento de Cidades
ISSN eletrônico 2318-8472, volume 08, número 67, 2020

Figure 3. African snail occurrence areas map and the basic sanitation conditions.



Source. IBGE, 2010. Elaboration: SOUZA M, G. 2020.

The census sectors identified with concentration of african snail population, are marked by the deficiency of basic sanitation services and, the conduct of this study refers to the interpretation that in these places, the animal survival is favored by humidity ground, especially in areas that receive the sewage discharge an open-air. The spatial projection of the georeferenced points in the map — that correspond to snail occurrence areas — it's an indicator of poor quality services sewage.

The results indicates that among 126 georeferenced points with the african snail presence in the Manaus city, 119 showed census sectors in which a parcel of private households permanents, inclued it self on household group with sewage discharge inadequate. The application of overlay technique allowed to check that the georeferenced points, when superimposed on cartographic basis, made evident that the african snail concentration was around 1.493 examples of this specie on South zone, South Center, East and West of Manaus City. These locations indicates the absence of adequate sewage canalization and reflect the scenery of insalubrity and deficient of the sanitation into the Amazon capital.

The analysis of the historical Evolution process of this scenery, refers to an involution context, which the fact of postponing the solution problem, truly assumes a regression reality. The involution of sanitation system, has been installed for over a decade, once that in the year of 2008 the IBGE, indicates that only 25% of the households in Manaus were connected to the sewage system. In this same period, the National Sanitation Information System – NSIS, registered that the Manaus performance, has ranked the 66th position in the ranking of the 100

largest brazilian cities, and, in 2010, was registered a heavy drop in this performance, then taking this city to occupy the 82th position, in the respective years until 2017, led it to be the 97th position among the 100 Brazil largest cities, which besides being na aggraviting to the public health, shows the inequality social. Analyzing the theme Rocha (2019) describes:

> These data confirm the nefarious capitalist contradiction, once that Manaus is the one of the most productive city of Brazil, (6th nacional PIB) at the same time, coexist with the worst basic sanitation public policies of the country. In this reality, the inequality and Injustice manifests themselves an open way, indicating that they are inscribed elaboration and implementaion public policies. Its about implementing inequalities to eternalize the perverse social hierarchy that shapes the society.

Unfourtunately, a sad finding is that only 50% of the city population are interconnected to the colletion system.

Nematode *Angiostrongylus cantonensis*

The medical importance of the african snail is by the fact of the specie being the *Angiostrongylus cantonensis* intermediate host, that can cause eosinophilic meningitis, inflammatory reaction of the meninges membrane that coating the central nervous system, caused in the most part of the time by parasites (OLIVEIRA *et al*.,2018).

According to Morassutti *et al* (2014, p.10) the eosinophilic meningitis, is a infectious disease that was restricted to Asian countries, having its first case registered in Brazil in 2007. Being identified on urban areas in at least 11 federation of north and south of country.

The *Angiostrongylus cantonensis* contagion in humans, often occurs accidentally by carelessness ingestion, of raw food or undercooked food, as snails, slugs, crutaceans (shrimp and crab), frogs and bush meat (lizards), spices, salads, herbs, fruits and natural juices (THIENGO *et al*., 2007).

The evolutionary cycle of the parasite, occurs in the arterial system of rodents, of canids and of felids, with the presence of adult worms in these animals, while, the larval stages develop into mollusk, as snails and slugs. The viral the bacterial meningitis receive attetion from public health bodies fo having the ability to become epidemic outbreaks .

The eosinophilic Meningitis (*cerebral angiostrongilíase*) is an inflammation that affects the meninges, membranes that involve the central nervous system. The disease is caused by a worm, called *Angiostrongylus cantonensis*, that was identified for the first time in Brazil in 2006. It's transmit for humans by crustaceans, for examples, crabs, shrimps, Garden tatoo and mollusks (soft-bodies animals protected, in general, by a shell). The african snail (*Achatina fulica*) is the most frequent vector of this worm, was introduced in Brazil by escargot breeders who were interested in spreading the product commercially (BRUNA, 2017).

The meningitis caused by the *Angiostrongylus cantonensis* is fatal in at least 3% of cases and, the period of disease manifestation can range fromone day to three months, after infection, with symptoms occurring within two weeks in the most cases (BRAZIL, 2014).

According to the Ministry Health (2019), 82% of the disease cases in the country were caused by virus ar bacteria, just some cases, can be associated to parasites, however on the

Notifiable Diseases Information System – NDIS website of Misnistry Health, there is no division of meningitis types in the country, framing all the cases only as meningitis.

The number of emergents diseases in Brazil has been grow in the last decade. Diseases as measles, yellow fever, H1N1, dengue, zika and Chikungunya manifests themselves in an evident way. The increase of these diseases has been redirected efforts and resources to the control and maintenance of acceptable indexes. For the Agudo-Padron (2011), currently, the diseases transmited by mollusks have been neglected by the competente authorities, who works only with diseases, in na epidemiological emergency.

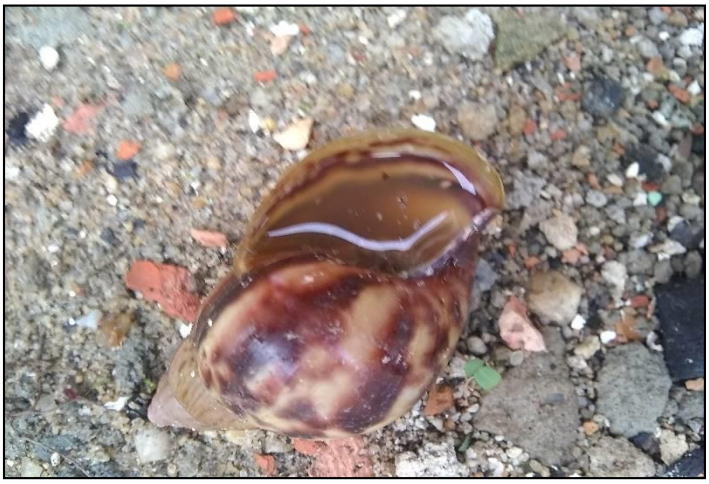
Breeding grounds to *Aedes aegypti mosquitoes*

The *Aedes* vector was describe in 1818 with the name as *Aedes aegypti. Egyptisan mosquisto that transmits diseases as dengue, yellow fever,* Chikungunya and Zika (FIOCRUZ, 2020).

The mosquito lifes cycle occurs by standing water stock on pots, water tank, gutter, bottles or any other open recipient that can accumulate wate.

In this context, when the african snail dies, its shell remain exposed on the terrestrial surface, for a long time. Constituted of calcium carbonate ($CaCO_3$) it's tough and becomes a perfect recipient for the water accumulation for long periods, favoring the life cycle and the mosquitoes reproduction (Figure 4). In this way, these environments bring together conditions to promote the indexes increase and spread of the diseases previously cited (ALMEIDA, 2016).

Figure 4. *Achatina fulica shell's water accumulation*, found in the neighborhood Nossa Senhora de Aparecida – Central South Zone of Manaus.



Source: SOUZA, M.G 2020.

About this topic, Almeida (2016, p.76) relate for us that:

> The shell in adults mollusks, in general, it's an elongated and conical spiral made by calcium carbonate. After the animal's death, the soft part is quickly decomposed by bacterias, fungi and insects. However, the shell takes a long time to be completely degraded and can remain on environment for decades. Usually, the shell stays with

> the opening facing upward, which can accumulate raining water and becomes a breeding ground to mosquito species.

The first report about an empty *Achatina fulica* shell's as a breeding ground for *Aedes aegypti* was made by Trpis (1973), in Tanzania, where the empty shell found in shaded places by vegetation, served as breeding niche for the various mosquitoes species reproduction. The Organic waste that they containd, are used as food resources for the deposition of larvae.

In Brazil, shell with larvae focus was found in Campinas, Sao Paulo, in 2001 (BRAZIL, 2014). In Manaus, was also found larvae of *Aedes aegypti* into *Achatina fulica* shell, according to the News published by the newspaper "A Crítica" at 1/16/2018 where the reporter Silane Souza points out:

> [...] residents of 12 neighborhood of Manaus searched for the Municipal Secretariat for Environment and Sustainability (MSES) looking for information about how to deal with african snail. The mollusk spreads on rainy seasons, causing apprehension, because it's a disease vector as hepatitis and meningitis, besides indirectly, has its shell serving as breeding ground to *Aedes aegypti*, transmitting mosquisto of Dengue, Zika virus, Chikungunya e Yellow Fever. Therefore, follows the guidance to crushing its shell, to prevent that it becomes a focus of larva [...]

Besides this information, there are residents relates, that prove the environment problematic experience in their own homes, like what is presented on Vila da Prata neighborhood, West Zone, where the spread of african snail is present. The housewife Rose Miranda, 37 years old, resident of Travessa Cunha Melo explain:

> [...] you can't take a rest on backyard, because the mollusk spread is large, especially, after rains and late afternoon. Rose mentions: "my husband throw salt at them, but they don't end, I don't know from where they comes. In the past, there is no african snails around here" [...]

According to the Municipal Health Secretariat (MSES) website information (2019),among 63 neighborhoods registered in Manaus City, 22 was ranked with high vunerability to dengue spreads, these are: Jorge Teixeira, Tancredo Neves and Coroado, in the east side; Colônia Terra Nova and Novo Aleixo, in the north zone; Parque 10, Chapada, Petrópolis, Japiim e São Lázaro in the South zone, which are established as priorities to intensify the mosquitoes combat.

With the exception of the Parque Dez and Chapada neighborhood, in all other neighborhoods ranked with high risk of mosquito spread, were found a large quantity of the mollusk, however, it's necessary a more detailed study to establish a possible relationship of the mollusk with focus of *Aedes aegypti.*

FINAL REMARKS

The occupation process and the differents forms of urban ground utilization, modify the natural landscapes through the waterproofing of rivers and deforestation, however, an invasive specie, as african snail, easily adapts it self to modified areas, having the unhealthy spaces maintenance as primary factor.

Over this study, was possible to accomplish the georeferencing of 126 points of african snail infestation in Manaus City. The absence of basic sanitation showed by the census sectors databases, contributed on map's production that identified the population vunerability to diseases considered emerging, which spread through the differents neighborhoods in the city.

Therefore, in front of this scenery, its necessary the improve of sanitation and urbanistic conditions of the city, as well as the campaign maintenance to the mollusk infestation combat, decreasing possible new cases of infestation that would compromise the quality lifes' population.

BIBLIOGRAPHICAL REFERENCES

ACRITICA, Recorre da tarifa de esgoto em Manaus, 06 outubro. 2017. Disponível em:< https://www.acritica.com/channels/manaus/news/quer-recorrer-da-cobranca-da-tarifa-de-esgoto-em-manaus-veja-como>. Acesso em 06 junho 2020.

ALMEIDA, M.N.; PEREIRA, T, M.; LIMA, L.H.C. – **Comportamento de *Achatina fulica* (Bowdick, 1822) (Mollusca, achatinidae) em ambiente urbano**. Revista Biociência. V.22, n.2, ISSN 1415-7411. Taubaté, SP: 2016.

AGUDO-PADRON, A. I. 2011. **Exotic molluscs in Santa Catarina's State, Southern Brazil region (Mollusca, Gastropoda et Bivalvia**): check list and regional spatial distribution knowledge. Biodiversity Journal, Palermo, 2 (2): 53-58.

BRASIL. Ministério da Saúde. **Dispõe sobre o Meningite: o que é, causas, sintomas, tratamento, diagnóstico e prevenção**. República Federativa do Brasil. Brasília, 2019. Disponível em:< http://www.saude.gov.br/saude-de-a-z/meningites> Acesso em 18 de junho 2020.

BRASIL. Ministério da Saúde. **Secretaria de Vigilância em Saúde. Departamento de Vigilância Epidemiológica. Manual de vigilância epidemiológica de eventos adversos pós-vacinação. Brasília**, 2014. 250 p. Disponível em :<http://bvsms.saude.gov.br/bvs/publicacoes/manual_vigilancia_epidemiologica_eventos_adversos_pos_vacinacao.pdf> Acesso em 18 de junho 2020.

BRUNA, M. H. V. - ***Meningite eosinofílica é causada por um verme chamado Angiostrongylus cantonensis, que foi identificado pela primeira vez no Brasil em 2006***. Disponível online no site: Dr. Drauzio Varela. Acesso em 20 junho 2020.

CORRÊA, Roberto Lobato. **Estudos sobre a rede urbana**. Rio de janeiro. Ed. Bertrand Brasil, 2006.

COSTA, Gilberto. Novo marco legal do saneamento básico divide entidades. Disponível em: <https://agenciabrasil.ebc.com.br/geral/noticia/2020-06/novo-marco-legal-do-saneamento-basico-divide-entidades>. Acesso em 27 junho de 2020.

EMBRAPA. **Identificação, mapeamento e quantificação das áreas urbanas do Brasil**. Campinas, SP maio 2017. Disponível em : <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/176016/1/20170522-COT-4.pdf >Acesso em 01 abril 2020.

FISCHER, M L; COLLEY, E, **Espécie Invasora em Reservas Naturais: caracterização da população de Achatina fulica Bowdich, 1822 (Mollusca - Achatinidae) na Ilha Rasa, Guaraqueçaba, Paraná, Brasi**l. Biota Neotropica, 2005, disponível em:< http://www.biotaneotropica.org.br > Acesso 23 junho 2020.

FIOCRUZ. Casos de dengue, zika e chikungunya aumentam no verão. 2020. Disponivel em:<**https://portal.fiocruz.br/noticia/casos-de-dengue-zika-e-chikungunya-aumentam-no-verao**>. Acesso em 06 julho 2020.

GIL , Gustavo Luz. **Saneamento ambiental: participação popular e transversalidade em matéria de políticas públicas.** dissertação apresentada ao programa de pós graduação em direito ambiental da universidade do estado do amazonas,2010. F 163. Disponível em: < http://www.pos.uea.edu.br/data/area/titulado/download/31-7.pdf>. Acesso em : 04 de junho 2020.

GUIMARÃES, Raul Borges. **Regiões de saúde e escalas geográficas**. Cadernos de Saúde Pública. V. 21, n. 4, jul/ago. 2001. p. 1017-1025.Disponível em< http://www.scielo.br/scielo > . Acesso em 12 junho 2020.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATISTICA. **Censo Demográfico – Características Gerais da População. Resultados da Amostra**, 2019. Disponível em: <http://www.ibge.gov.br> Acesso em: 02 maio 2020.

MACHADO, Adriana de Souza .**A estrutura tarifária e a universalização dos serviços de saneamento básico: tensões e possíveis conciliações** . 2018. 119 f. Dissertação (mestrado) - Escola de Direito do Rio de Janeiro da Fundação Getulio Vargas.

MORASSUTTI, A.L.; THIENGO, S.C.; FERNANDEZ, M.; SAWANYAWISUTH, K.; GRAEFF-TEIXEIRA, C. **Eosinophilic meningitis caused by Angiostrongylus cantonensis: an emergent disease in Brazil**. Mem. Inst. Oswaldo Cruz, v. 109, n. 4, p. 399-407. 2014.

OLIVEIRA, **Meningite associada à parasitose por angiostrongylus cantonensis**. III congresso brasileiro de ciências da saúde. V. 1, 2018, Disponível <http://www.editorarealize.com.br/revistas/conbracis/anais.php.> Acesso em: 15 junho 2020.

OPAS. Organizacion Panamericana de La Salud. **Quase 16 milhões de pessoas ainda defecam ao ar livre na América Latina e no Caribe.** 2019. Disponível em:<https://www.paho.org/bra/index.php?option=com_joomlabook&view=topic&id=522>. Acesso em 18 junho de 2020.

PREFEITURA MUNICIPAL DE MANAUS / SECRETARIA MUNICIPAL DE SAÚDE. **Moradores aprendem a combater o caramujo africano**. 2019 SEMSA disponível em: <http://www.manaus.am.gov.br/noticia/moradores-aprendem-a-combater-o-caramujo-africano/>. Acesso em 18 junho 2020.

PLANSAB. **Plano nacional de saneamento basico. Mais saúde com qualidade de vida e cidadania**. Ministério do Desenvolvimento Regional Secretaria Nacional de Saneamento. 238 páginas. Ano 2019. Disponível em < https://www.cidades.gov.br/images/stories/ArquivosSNSA/Arquivos_PDF/plansab/Versaoatualizada07mar2019_consultapublica.pdf>. Acesso em 04 de junho. 2020.

ROCHA, SANDOVAL. **O Saneamento Básico de Manaus continua entre os piores do Brasil**. 2019. Disponivel em:<https://amazonasatual.com.br/o-saneamento-basico-de-manaus-continua-entre-os-piores-do-brasil/>. Acesso em 03 julho 2020.

ROSEN, George. **Uma História da Saúde Pública**. Traduzido por Marcos Fernandes da Silva Moreira 3.edição Ed. Hucitec 2006 São Paulo.

REZENDE, Sonaly Cristina; HELLER, Léo. **O saneamento no Brasil:** políticas e interfaces. 2. Ed., Belo Horizonte: UFMG, 2008.

TRATABRASIL. **Novo Ranking do Saneamento Básico evidencia: melhores cidades em saneamento investem 4 vezes mais que as piores cidades no Brasil**. Disponível em: <http://www.tratabrasil.org.br/images/estudos/itb/ranking2019/PRESS_RELEASE___Ranking_do_Saneamento___NOVO.pdf>. Acesso: 04 de junho 2020.

THIENGO SC, Fernandez MA, Mattos AC, Barbosa AF, 2007. **Dispersão do molusco introduzido Melanoides tuberculatus (Muller, 1774) (Gastropoda; Thiaridae) no Brasil**. Tópicos em Malacologia, Sociedade Brasileira de Malacologia p. 1-365.

THIENGO, S.C.; BARBOSA, A.F.; COELHO, P.M.; **Moluscos exóticos com importância médica no Brasil**. Departamento de Malacologia, Instituto Oswaldo Cruz, Fundação Oswaldo Cruz. Av. Brasil, 4365, 21045-900, Rio de janeiro, RJ - Brasil. 2005 .