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## CURRENT DISTRIBUTION OF *Achatina fulica*, IN THE STATE OF SÃO PAULO INCLUDING RECORDS OF *Aelurostrongylus abstrusus* (NEMATODA) LARVAE INFESTATION

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### SUMMARY

The currently known distribution range of *Achatina fulica* Bowdich, 1822, in the state of São Paulo, Brazil, is presented. The record of *A. fulica* naturally infested with *Aelurostrongylus abstrusus* larvae (Railliet, 1898) (Nematoda: Metastrongylidae) can be found in the city of Guaratinguetá. It was found *A. fulica* with Metastrongylidae larvae without known medical and veterinary importance in the cities of Carapicuíba, Embu-Guaçu, Itapevi, São Caetano do Sul, São Paulo and Taboão da Serra.

**KEYWORDS:** *Achatina fulica*; Geographical distribution; São Paulo; *Aelurostrongylus abstrusus*

### INTRODUCTION

*Achatina fulica* Bowdich, 1822 is an African terrestrial mollusk, registered in Africa, Southeast Asia, Pacific Islands, Australia and Japan, and it was introduced in the American continent around 1939<sup>14,19</sup>. In Brazil, the species was introduced in the state of Paraná in the 80's, for commercial use, and later spread to other Brazilian states<sup>10</sup>. Currently the species can be found in all Brazilian states, except Acre, Roraima and Amapá<sup>11,15</sup>.

A while ago, *A. fulica* was restricted to antropic environments, but due to the saturation of these areas the species invaded regions of native forests<sup>6</sup>. Nowadays, *A. fulica* can be found in forests, scrubs, "caatinga", swamp, vegetable-gardens, agriculture, plantations, strips of land, yards and gardens<sup>4,17</sup>. It can be found in soil, arbor, in decomposing material and dumps<sup>6,13,19</sup>.

The deposition of common solid residue in the urban environment is a factor that favors the maintenance and proliferation of the species, therefore increases the availability of food and shelter for specimens<sup>5,12</sup>.

Because of their voracious feeding habits, with some recorded cases of cannibalism, the species contributes to the extermination of native fauna, diminishing the amount of available resources and competing for physical space. These factors, including the absence of natural pathogens, render *A. fulica* a high capacity for dispersion, causing serious disequilibrium and loss of biodiversity<sup>9,17</sup>.

The species present great epidemiological interest, for it acts as an intermediate host for the *Angiostrongylus cantonensis* (Chen, 1935) nematodes, which causes eosinophilic meningoencephalitis in Africa,

Asia and Oceania<sup>12,16</sup> and also for *Angiostrongylus costaricensis* Morera & Céspedes, 1971, which causes abdominal angiostrongyliasis, from southern USA to northern Argentina<sup>15</sup>.

In light of the great concern generated by *A. fulica*, the aim of this work was to determine the current geographical distribution of this species in the state of São Paulo, in addition to recording those infected by the larvae of *Aelurostrongylus abstrusus* (Railliet, 1898) (Nematoda: Metastrongylidae) in the city of Guaratinguetá.

### MATERIAL AND METHODS

The distribution record for *A. fulica*, in the state of São Paulo, was compiled from the available bibliography, data from the Malacology Laboratory of SUCEN and the scientific collection of the Zoology Museum of the University of São Paulo (MZSP).

The technique of artificial digestion with Pepsin was used in order to examine specimens of *A. fulica* from the city of Carapicuíba (collected by DPE team, in November and December of 2009; source: Paraná Street - S23°32'8.3" x O46°49'46.3"; 35 specimens and Coração de Jesus Street - S23°31'23.4" x O46°50'52.9"; six specimens), Embu-Guaçu (led by the Zoonoses Control Center of the county to the DPE malacology laboratory, in November and December of 2009; source: Francisco Munhoz Cegarra Street, Jardim Boa Vista District - S23°50'23.6" x O46°49'11.2"; 44 specimens and Firmino Alves Filho Street - S23°50'22.6" x O46°49'6.4"; 41 specimens), Guaratinguetá (103 specimens; collected by DPE team, in March and April of 2008; source: Olinda, Bairro Vista Alegre Street), Itapevi (three specimens; led by the Zoonoses Control Center of the county to the DPE lab, in

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February of 2010; source: Cajamangas Street, Jardim Vitápolis District), São Caetano do Sul (13 specimens; led by Zoonoses Control Center of the county to the DPE lab, in December of 2009; source: Aurélia Street, Olímpico District - S23°37'2.4" x O46°33'24.0") and Taboão da Serra (two specimens; led by the Zoonoses Control Center of the county to the DPE lab, in March of 2010; source: Agueda Gonçalves Street, Jardim Pedro Gonçalves District - S23°36'49.4" x O46°46'24.6"), SP.

Only the foot of the specimens was used in the artificial digestion process, the remainder of the body was discarded. The material was macerated and placed in Petri dishes together with the digestive fluid along with Pepsin Lot Sigma 123K0661 for two hours in a water bath under 37 °C for the digestion process. The amount of digestive fluid was enough to cover the material. Afterwards, the product of the digestion was transferred to the Baermann funnel, where it remained for two hours. The filtered material was then examined under LEICA MZ95 stereoscopic microscope and LEICA DFC 420 light microscope. Images were taken from the light microscope using LEICA QWIN Image Processing and Analysis Software, and from the Confocal Laser Scanning Microscope, LSM 510 Meta-Zeiss. The confocal microscope belongs to the Parasitology Laboratory of the Butantã Institute, São Paulo.

## RESULTS AND DISCUSSION

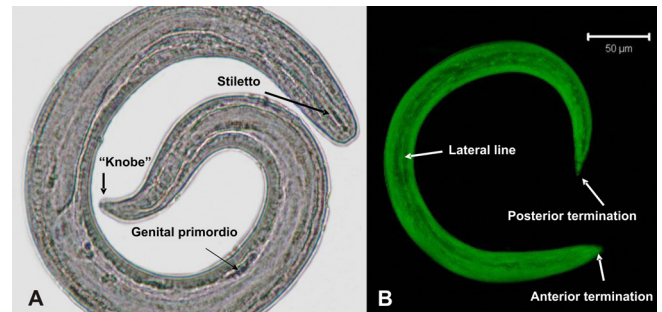
The Brazilian states mostly infested by *A. fulica* are Goiás, São Paulo, Paraná, Rio de Janeiro, Mato Grosso, Espírito Santo, and Minas Gerais<sup>17</sup>. In the state of São Paulo, the geographical distribution of *A. fulica* is widened from 69 counties<sup>17</sup> to 105. In São Paulo, the species was recorded in the cities of Aparecida, Arapeí, Areias, Atibaia, Americana, Bananal, Bom Jesus dos Perdões, Botucatu, Bragança Paulista, Caçapava, Cachoeira Paulista, Campinas, Caraguatatuba, Cruzeiro, Cunha, Guarujá, Ilhabela, Igaratá, Iporanga, Itanhaém, Itariri, Jacareí, Jacupiranga, Jambeiro, Jarinu, Jundiá, Lagoinha, Lavrinhas, Lençóis Paulista, Limeira, Lorena, Mairiporã, Mongaguá, Monteiro Lobato, Natividade da Serra, Nazaré Paulista, Panorama, Paraibuna, Paulínia, Paulicéia, Pedreiras, Peruíbe, Pindamonhangaba, Piracaia, Piracicaba, Potim, Praia Grande, Presidente Prudente, Queluz, Redenção da Serra, Registro, Rio Claro, Ribeirão Preto, Roseira, Santa Branca, Santos, Santo André, Santo Antonio do Pinhal, São Bento do Sapucaí, São José do Barreiro, São José dos Campos, São Luiz do Paraitinga, São Sebastião, São Paulo, São Vicente, Silveiras, Sorocaba, Sumaré, Tietê, Taubaté, Tremembé, Ubatuba and Votuporanga<sup>3,4,14</sup>.

Based on the data from the Malacology Laboratory of SUCEN and from MZUSP, the distribution of *A. fulica*, in the state of São Paulo is extended to Águas de Lindóia, Amparo, Avaré, Barra Bonita, Bertioga, Boqueirão, Cajamar, Carapicuíba, Cotia, Embu-Guaçu, Estiva Gerbi, Ferraz de Vasconcelos, Guaratinguetá, Guararema, Guarulhos, Iguape, Itapeva, Itapeví, Itapira, Mogi-Mirim, Pilar do Sul, Pirapora do Bom Jesus, Pirassununga, Ribeirão Pires, Santa Isabel, Santana do Parnaíba, São Caetano do Sul, São José do Rio Pardo, Taboão da Serra, Valinhos, Vargem Grande do Sul and Vargem Grande Paulista.

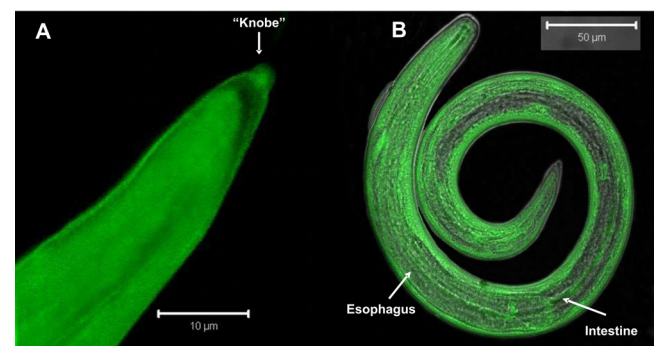
*A. fulica* has been found in Brazil (Espírito Santo and São Paulo), infested by larvae of Metastrongyloidea *A. cantonensis*<sup>1,2</sup>. In the state of Santa Catarina (City of Florianópolis), 244 specimens of *A. fulica* were collected, which were imposed to experimental infection by *A. costaricensis* larvae<sup>8</sup>. Among these specimens, one (prevalence of 0.4%) has demonstrated itself susceptible to the parasite. NEUHAUSS *et al.*<sup>8</sup>

believe in the possibility of *A. costaricensis* transmission by *A. fulica*, which nowadays is considered the potential host of the parasite in Brazil. FRANCO-ACUÑA *et al.*<sup>7</sup> record *A. fulica* infested by larvae of nematodes in the state of Rio de Janeiro (City of Mesquita).

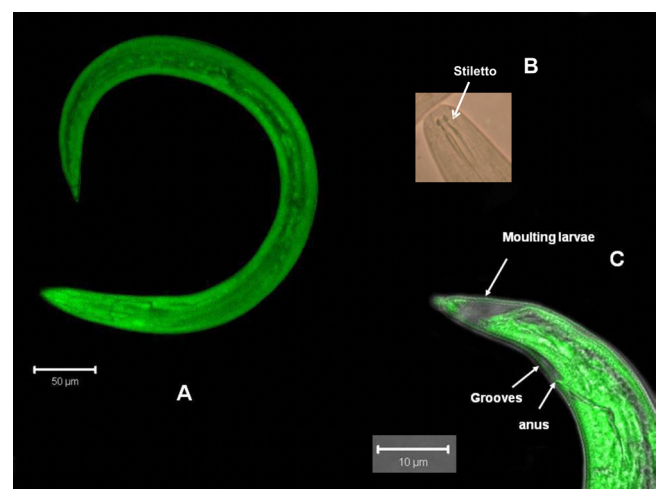
Recently, specimens of *A. fulica* from the city of Guaratinguetá, were found infested by larvae (in the period of larval transition L2 for L3; moulting larvae) of Metastrongyloidea *A. abstrusus* (Figs. 1-3). A.



**Fig. 1** - *Aelurostrongylus abstrusus* (Railliet, 1898). A-B: Larvae. A: Light microscope, 920 X. B: Confocal Laser Scanning Microscope.



**Fig. 2** - *Aelurostrongylus abstrusus* (Railliet, 1898). A: Detail of the posterior region of the larvae in the period of larval transition L2 for L3. B: larvae in the period of larval transition L2 for L3. Confocal Laser Scanning Microscope.



**Fig. 3** - *Aelurostrongylus abstrusus* (Railliet, 1898). A: Larvae in the period of larval transition L2 for L3. B: Detail of the anterior region of the larvae. C: Detail of the posterior region of the larvae. A,C: Confocal Laser Scanning Microscope. B: Light microscope.

**Table 1**  
Measurements ( $\mu\text{m}$ ) of *Aelurostrongylus abstrusus* (in the period of larval transition L2 for L3)

Measurements	Mean	Interval	Specimens
Length	424.5	355.18 - 516.30	6
Width at the base of esophagus	26.1	24.38 - 27.16	6
Stiletto (length)	20.59	18.5 - 23.44	6
Esophagus (length)	210	202.84 - 223.19	4
Distance from the genital primordium up to the posterior region	141	134.83 - 146.11	3
Distance from the excretory pore up to the anterior region	82.8	72.11 - 88.37	3
Distance from the anus up to the posterior region	31	25.28 - 37.85	5
Posterior termination	2.87	2.69 - 3.55	7

*abstrusus* is a Nematoda Metastrongyloidea, parasite of domestic dogs and cats, primates and badgers. The definite host becomes infected while ingesting mollusks infested with the parasite. In Brazil, the *A. abstrusus* has usually been found in the lungs of domestic cats<sup>18</sup>.

*A. abstrusus* infesting *A. fulica* had been mentioned by THIENGO *et al.*<sup>18</sup> in the states of Espírito Santo (two cities), Goiás (five cities), Mato Grosso (one city), Minas Gerais (one city), Rio de Janeiro (four cities), São Paulo (one county) and Sergipe (one city). In São Paulo, the authors recorded *A. fulica* infested with nematodes only in the city of Jundiá.

*A. fulica* from the cities of Carapicuíba, Embú-Guaçu, Itapevi, São Caetano do Sul and Taboão da Serra had been discovered infested by larvae of Metastrongyloidea, without medical and veterinary importance known until that moment.

The identification of the larvae was based on morphological characteristics, such as the presence of a lateral line throughout the body, grooves in the tegument, position of genital and excretory pores and the presence of stiletto in the anterior extremity and a structure similar to a rounded button (“knobed”) in the posterior extremity.

The measurements of *A. abstrusus* larvae (in the period of larval transition L2 for L3) are presented on Table 1.

The presence of *A. fulica* in our territory is considered extremely alarming not only due to the damages caused to agriculture and for their contribution to the extermination of our native malacofauna, but also due to the fact that it is a host mollusk for nematodes of medical and veterinary importance. This study shows that there is a need to establish an epidemiological monitoring system in order to prevent the possible installation of parasitological points where these mollusks are present.

## RESUMO

### Distribuição atual de *Achatina fulica* Bowdich, 1822 no Estado de São Paulo com registro de infestação por larvas de *Aelurostrongylus abstrusus* (Nematoda)

É apresentada a distribuição de *Achatina fulica* Bowdich, 1822 no Estado de São Paulo, Brasil. É fornecido o registro de *A. fulica*

naturalmente infestada por larvas de *Aelurostrongylus abstrusus* (Railliet, 1898) (Nematoda: Metastrongylidae) no município de Guaratinguetá. Foi encontrada *A. fulica* portando larvas de Metastrongylidae sem importância médica e veterinária conhecida nos municípios de Carapicuíba, Embu Guaçu, Itapevi, São Caetano do Sul, São Paulo e Taboão da Serra.

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