2014-07

First occurrence of the exotic Asian clam Corbicula fluminea (Muller, 1774) in the Jundiaí-Mirim River Basin, SP, Brazil

Revista Ambiente & Água, Taubaté, v.9, n.3, 2014
http://www.producao.usp.br/handle/BDPI/46108

Ambiente & Água - An Interdisciplinary Journal of Applied Science
ISSN 1980-993X – doi:10.4136/1980-993X
www.ambi-agua.net
E-mail: ambi-agua@agro.unitau.br

First occurrence of the exotic Asian clam *Corbicula fluminea* (Muller, 1774) in the Jundiaí-Mirim River Basin, SP, Brazil

doi: 10.4136/ambi-agua.1330

Received: 26 Feb. 2014; Accepted: 27 Jun 2014

Frederico Guilherme de Souza Beghelli[1*]; Marcelo Luiz Martins Pompêo[2]; Viviane Moschini Carlos[1]

[1]Universidade Estadual Paulista "Julio de Mesquita Filho" (UNESP), Sorocaba, SP, Brasil
[2]Universidade de São Paulo - IB (USP), Butantã, SP, Brasil
Departamento de Ecologia
[*]Corresponding author: e-mail: fred_sb@hotmail.com, mpompeo@ib.usp.br, viviane@sorocaba.unesp.br

ABSTRACT

Corbicula fluminea is a naturally occurring Asian bivalve that was spread around the world, and which has become a highly aggressive invasive species in many countries. *C. fluminea* has many ecological, economic and social impacts, such as the extinction of native species, ecosystems alterations, and damage to pipes and hydropower turbines. As an illustration of the potential damage that proliferation of *C. fluminea* can cause, it is noted that the United States government spends more than 1 billion dollars per year to control this species. This work recorded the first occurrence of the Asian clam *C. fluminea* in the Jundiaí-Mirim Basin, SP, Brazil, and included basic ecological information such as density, frequency distribution of size and species distribution along the basin. Seventy-eight individuals were sampled with a van Veen grab along the basin. The specimens were identified and measured. The exotic species was found only in two of four sampling points and its distribution was possibly influenced by sediment composition and water flow. Moderate densities were calculated, ranging from 12 to 235 ind.m^{-2}. Our data suggest that young populations are growing in the basin. The presence of *C. fluminea* is a concern for the maintenance of the ecosystem and for different water uses in the Jundiai region.

Keywords: invasive species, Corbiculidae, Bivalve.

Primeiro registro de ocorrência do bivalve exótico *Corbicula fluminea* (Muller, 1774) na microbacia do Rio Jundiaí-Mirim, SP, Brasil

RESUMO

Corbicula fluminea é um bivalve exótico natural da Ásia que espalhou-se rapidamente pelo mundo tornando-se uma espécie invasora altamente agressiva em muitos países. A espécie tem o potencial de provocar uma série de impactos ecológicos, econômicos e sociais como a extinção de espécies nativas, alterações em ecossistemas e danos em tubulações e turbinas de hidrelétricas. Como exemplo dos danos que a espécie pode gerar, basta mencionar que o governo dos Estados Unidos gasta anualmente mais de 1 bilhão de dólares com a espécie. Os objetivos deste trabalho foram registrar a primeira ocorrência do bivalve invasor

C. fluminea na bacia do rio Jundiaí-Mirim, SP, Brasil bem como contribuir com alguns dados ecológicos básicos como densidade, distribuição de frequências de tamanho bem como a distribuição da espécie ao longo da bacia hidrográfica. Um total de 78 indivíduos foi coletado com draga van Veen. Os organismos foram identificados e medidos. O molusco foi registrado em apenas duas das quatro estações amostrais e sua distribuição provavelmente relaciona-se com a composição do sedimento e fluxo da água. Valores intermediários de densidade foram registrados variando de 12 a 235 ind.m^{-2}. Os dados sugerem populações jovens que estão em crescimento na bacia. A presença de *C. fluminea* é uma questão preocupante no que concerne a manutenção do ecossistema e da água para diferentes usos na região de Jundiaí, SP.

Palavras-chave: espécie invasora, Corbiculidae, Bivalvia.

1. INTRODUCTION

The introduction of exotic species is one of the main factors responsible for the loss of species and for ecosystems alterations around the world, due mainly to loss of habitat and food web links (Espíndola et al., 2005). The aquatic exotic bivalve *Corbicula fluminea* (Müller, 1774) is native to the Asian southwest and has rapidly spread around the world, becoming one of the most concerning invasive species. The arrival of the Asian clam in North America is attributed to the immigration of Chinese people who brought the bivalve as food resource (Mansur et al., 2004). In South America, the clam's arrival is probably related to its transportation in ballast water or its adherence to boat hulls. It was introduced in Brazil in about 1970 (Veitenheimer-Mendes, 1981). It has been registered in many Brazilian States: Amazonia (Pimpão and Martins, 2008), Brasília (Rodrigues et al., 2007), Goiás (Thiengo et al., 2005), Minas Gerais (Maroneze et al., 2011), Paraná (Bagatini et al., 2005), Rio Grande do Sul (Martins et al., 2006) and São Paulo (Vianna and Avelar, 2010). In São Paulo State, species records are mainly concentrated in the Midwest region and near the borders with Minas Gerais (FAPESP, 2014).

Rapid growth, early sexual development, reduced life cycle, high fecundity and great dispersion capacity favor their success in new environments (Sousa et al., 2008). Moreover, *C. fluminea* can migrate in both directions in a waterway: up- or downstream (Lucy et al., 2012), and can thus spread throughout an entire basin from wherever it is introduced.

The species has a filtering habit and can consequently alter primary production due to intense plankton consumption which can improve sedimentation rates (Zhang et al., 2011). Economic and social damage can also result. It frequently obstructs pipes and power turbines (Rosa et al., 2011). The United States spends more than 1 billion per year in order to limit their dispersion and to repair damages caused by *C. fluminea* (Pimentel et al., 2005). Until now, the Asian clam has never been recorded in Jundiaí-Mirim basin. The nearest occurrence was recorded in the Campinas region. (FAPESP, 2014).

Thus, the registration of these organisms in a water body is important information for managers and water quality programs should include their monitoring. This work registered the first occurrence of the exotic species in the Jundiaí-Mirim Basin and also estimated the mollusk's probable arrival period, serving as an alert to probable damages that the region may suffer due to *C. fluminea* proliferation.

2. MATERIAL AND METHODS

The Jundiaí-Mirim Basin is in the Piracicaba-Capivari-Jundiaí River Basin in São Paulo State (Figure 1). The Jundiaí-Mirim Basin covers three cities: Jundiaí, Jarinú and Campo Limpo Paulista with a combined population of around 468 thousand people; 95% of this population lives in urban areas (IBGE, 2010).

According to Freitas et al. (2013), although 19.9% of the basin is a legally protected area, only 44.6% of the protected area is preserved in agreement with the law. Many impacts occur due to antropic activities along the basin, such as pollution by sewage discharges, agrotoxic loads in the water bodies and the suppression of riparian forest.

Samples were collected on September 2nd, 2013 using a van-Veen grab (405 cm^2, area) with two cumulative launchings per sampling point (only launchings with the grab completely closed were considered) along the Jundiaí-Mirim Basin (Figure 1), comprising four sampling points which were in the littoral region. From headwater to downstream, the points were: 23° 6' 14.47" S / 46° 46' 37.77" W; 23° 8' 52.59" S / 46° 49' 21.11" W; 23° 8' 52.43" S / 46° 49' 18.96" W and 23° 9' 19.95" S / 46 °54' 12.08" W, named, respectively, as A, B, C and D points. The least possible distance (a straight line) between the sampling points are 6.71 km from A to B; 0.06 from B to C and 8.56 from C to D, totaling 15.33 km of distance. The sampling points may be characterized as follows:

- Point A: a small reservoir (about 80 meters length) used for agriculture purposes; the land around it is mainly converted to farming with the exception of minor spots of natural vegetation, including the right margins of the reservoir.

- Points B and C: both points are in a rural property used for commercial purposes (a restaurant). Only exotic vegetation, mainly grass. Domestic ducks were observed in the field. Point B is a little lotic watercourse and C is a deviation of the main course that was dammed and is used mainly to power a watermill.

- Point D: a passage point just before the waters is transferred to the treatment plant that supplies Jundiaí city.

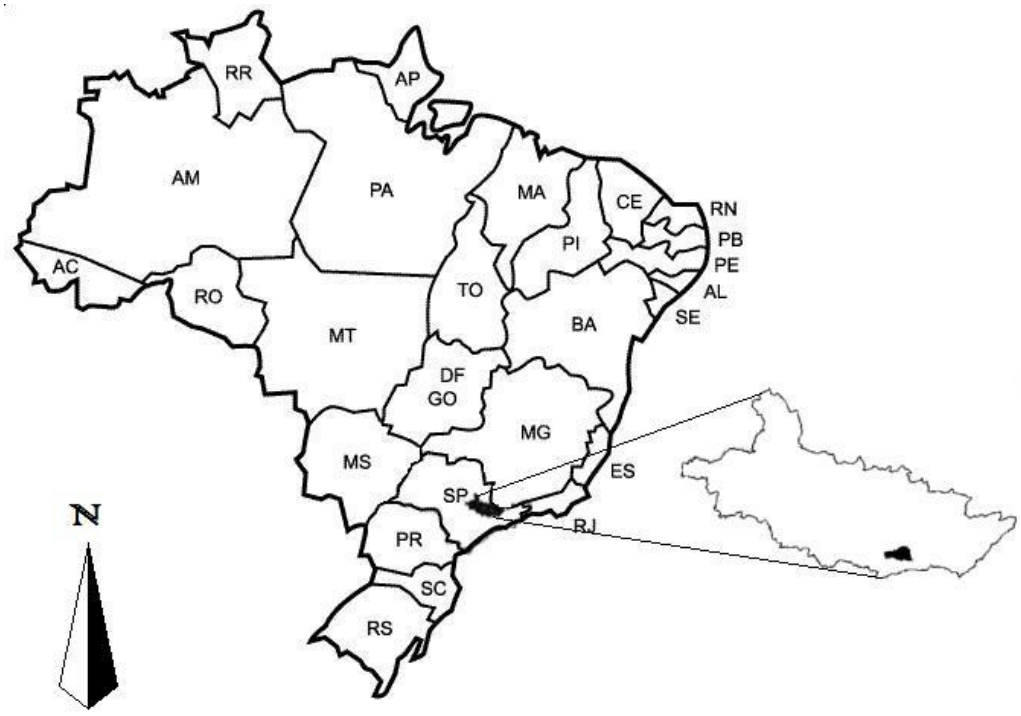

Figure 1. Location of Piracicaba Jundiaí Capivari (PCJ) and the Jundiaí-Mirim Basin in São Paulo State.

The sediment was sieved with a 0.2 mm mesh opening and organisms were separated using a plastic tray with small proportions of sediment over a case equipped with a lamp and covered with glass. Further, the specimens were identified (Mansur et al., 2004; Mansur and

Pereira, 2006) and their lengths and widths were measured using a caliper. The specimens were preserved in a 10% formaldehyde solution and were stored at Limnology Laboratory at UNESP, Sorocaba, SP, Brazil.

3. RESULTS AND DISCUSSION

The study recorded 78 individuals at just two points: one in point A, a headwater reservoir and 77 at B. No clams were recorded at the other points (C and D). The absence of *C. fluminea* in points C and D do not exclude the possibility of occurrence there, since the samplings in the present work were designed for a rapid diagnostic of the basin and not in an exhaustive way. Since *C. fluminea* is an aggressive invasive clam and lives and reproduces in a large range of conditions, and since no limiting conditions were observed, it is possible that the species inhabits the other points as well, but in lower densities. Densities observed varied from 12 to 235 ind.m^{-2}, considering the points with more than one clam in the sampling (A and B). These values can be considered moderate.

The density of *C. fluminea* can vary heavily in different environments. In this sense, Rodrigues et al. (2007) reported densities ranging from just three to 300 ind.m^{-2} in Paranoá Lake, Brasília, Brazil while França et al. (2007) recorded a density of 6154 ind.m^{-2} in the Promissão Reservoir, low Tietê, SP, during the wet season in sediments with high proportions of sand.

According to Lucy et al. (2012), the limiting factors for the bivalve growth are salinity, temperature, pH, calcium, oxygen, water flow, sediment type and food availability. Point B, where higher densities were recorded, has sandy sediments and is a lotic environment. Both characteristics are favorable for *C. fluminea* development. Points C and D have the finest sediments; C is lentic and D is lotic, but with lower oxygen concentrations (Medeiros, 2013). Thus, the differences in abundance observed are probably due to these variations.

The widths of shells ranged from 1.4 to 2.6 cm and the lengths from 1 to 2.3 cm. The most frequent class includes shells with widths around 2 cm and lengths around 1.8 cm (Figure 2).

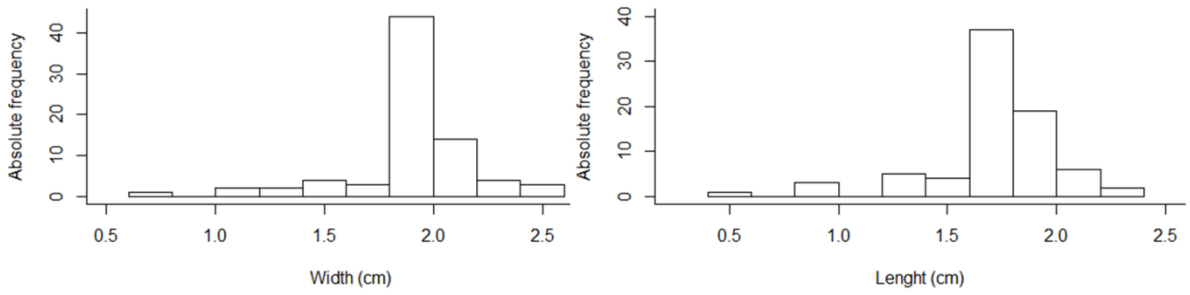

Figure 2. Histogram of width and length classes of the *C. fluminea* bivalves sampled at Jundiaí-Mirim basin (n=77).

According to Cataldo and Boltovskoy (1999), the age of *C. fluminea* can be estimated based on shell lengths, but the relation varies according environmental conditions, specially food resources, season and temperature. Moreover, for a correct estimation a systematic sampling must be performed in order to obtain growth curves that are not possible with the present data. The mentioned authors recorded shell lengths ranging from 0.6 to 33 mm in the Paraná River Delta, Argentina with marked differences between summer and winter, ages were estimated in length ranges corresponding to one year old (15.3-22.4 mm), two (23.5-27 mm) and three (27.5-29.3 mm).

In Brazil, Rodrigues et al. (2007) recorded that the most frequently found shell sizes ranged from 20 to 25 cm, corresponding to organisms around 2 years old. Performing a coarse comparison (considering that the relation of length to age may differ markedly between environments), the clams from Jundiaí-Mirim Basin could have ages varying from less than one to 2 years old, with the majority of them around one year old. Since the studied areas have mesotrophic conditions (Beghelli et al., 2013) and higher and more constant temperatures than those recorded by Cataldo and Boltovskoy (1999), and both are factors that improve the growth rates (Lucy et al., 2012), the organisms recorded in the present work are probably younger then the estimated age, indicating a recent invasion of the Asian clam in the basin.

It was estimated from the data that just 6% of the organisms are less than one year old; the majority (86%) is around one year old and 8% of them are about two years old, suggesting that the *C. fluminea* species must have been introduced in the environment around 2011 or later. From this data it can be estimated that there are around 57 ind.m^{-2} of less than one year old and so it can be concluded that the population is growing and reproducing in the Jundiaí-Mirim Basin. The data reflects a young population as compared with other studies (Rodrigues et al., 2007), and a rapid and worrisome introduction of the species to the region of Jundiaí, SP.

4. CONCLUSIONS

The recent first recording of the introduction of *C. fluminea* is a major concern to the maintenance of the ecosystem and for different water uses in the Jundiaí region. The densities recorded are high and the population is still young, which means that the species is rapidly establishing a foothold in the region. There are serious ecological, economic and social damages risks if the growth of the population continues unabated.

5. AKNOWLEDGEMENTS

To Fundação de Amparo à Pesquisa do Estado de São Paulo – FAPESP (processes numbers: 2013/03494-4; 2013/08272-0; 2012/11890-4) for financial support and to Dr. Eliana Pintor Arruda for orientations to confirm *C. fluminea* identification.

6. REFERENCES

BAGATINI, Y. M.; PANARARI, R. S.; HIGUTI, J.; BENEDITO-CECILIO, E.; PRIOLI, A. J.; PRIOLI, S. M. P. Morphological and molecular characterization of *Corbicula* (Mollusca, Bilvalvia) at Rosana Reservoir, Brazil. **Acta Scientarium. Biological Sciences,** Maringá, v. 27, n. 4, p. 397-404, 2005.

BEGHELLI, F. G. S.; MACHADO, F. H.; PECHE FILHO, A.; POMPÊO, M. L. M.; MOSCHINI-CARLOS, V.; RIBEIRO, A. I. et al. Análise de clorofila a e índice de estado trófico das águas da microbacia do rio Jundiaí-Mirim. In: WORKSHOP INTEGRAÇÃO DE SABERES AMBIENTAIS, 1., 03 dez. 2013, Sorocaba. **Livro de Memórias...** Sorocaba: UNESP, 2013. p. 10-14.

CATALDO, D.; BOLTOVSKOY D. Population dynamics of *Corbicula fluminea* (Bivalvia) in the Paraná River Delta (Argentina). **Hydrobiologia**, Belgium, v. 380, n. 1, p. 153-163, 1999. http://dx.doi.org/ 10.1023/A:1003428728693

ESPÍNDOLA, M. B.; BECHARA, F. C.; BAZZO, M. S.; REIS, A. Recuperação ambiental e contaminação biológica: aspectos ecológicos e legais. **Biotemas**, Santa Catarina, v. 18, n. 1, p. 27 - 38, 2005.

FRANÇA, R. S.; SURIANI, A. L.; ROCHA, O. Composição das espécies de moluscos bentônicos nos reservatórios do baixo rio Tietê (São Paulo, Brasil) com uma avaliação do impacto causado pelas espécies exóticas invasoras. **Revista brasileira de Zoologia**, Curitiba, v. 24, n. 1, p. 41-51, 2007.

FREITAS, E. P.; DE MORAES, J. F. L.; PECHE FILHO, A.; STORINO, M. Indicadores ambientais para áreas de preservação permanente. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v. 17, n. 4, p. 443-449, 2013. http://dx.doi.org/10.1590/S1415-43662013000400013

FUNDAÇÃO DE AMPARO À PESQUISA DO ESTADO DE SÃO PAULO – FAPESP. **Sinbiota 2.1.** Available in: <http://sinbiota.biota.org.br/> . Access in: 27 Jun. 2014.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA – IBGE. **Censo 2010**. Rio de Janeiro. Available in: <http://cidades.ibge.gov.br/xtras/home.php>. Access in Jun. 2014.

LUCY, F. E.; KARATAYEV, A. Y.; BURLAKOVA, L. E. Predictions for the spread, population density, and impacts of *Corbicula fluminea* in Ireland. **Aquatic Invasions**, Regional Euro-Asian Biological Invasions Centre, v. 7, n. 4, p. 465–474, 2012. http://hdl.handle.net/10759/317614

MANSUR, M. C. D.; PEREIRA, D. Bivalves límnicos da bacia do rio dos Sinos, Rio Grande do Sul, Brasil (Bivalvia, Unionoida, Veneroida e Mytiloida). **Revista Brasileira de Zoologia**, Curitiba, v. 23, n. 4, p. 1123–1147, 2006.

MANSUR, M. C. D.; CALLIL, C. T.; CARDOSO, F. R.; IBARRA, J. A. A. Uma retrospectiva e mapeamento da invasão de espécies de *Corbicula* (Mollusca, Bivalvia, Veneroida, Corbiculidae) oriundas do Sudeste asiático na América do Sul. In: SILVA, J. S. V.; SOUZA, R. C. C. L. (Orgs.). **Água de lastro e bioinvasão.** Rio de Janeiro: Interciência, 2004. p. 39-58.

MARONEZE, D. M.; COSCARELLI, D.; VIDIGAL, T. H. D. A.; CALLISTO, M. First record of *Corbicula fluminea* (Müller, 1774) in the drainage basin of the Araguari River, Minas Gerais, Brazil. **Brazilian Journal of Biology**, São Carlos, v. 71, n. 1, p. 221-222, 2011. http://dx.doi.org/10.1590/S1519-69842011000100033

MARTINS, D. S.; VEITENHEIMER-MENDES, I. L.; FACCIONI-HEUSER, M. C. Aspectos morfológicos e incubação em três espécies de Corbicula Mühlfeld, no lago Guaíba, Rio Grande do Sul, Brasil (Bivalvia, Corbiculidae). **Biota Neotropica**, Campinas, v. 6, n. 2, 2006. http://dx.doi.org/10.1590/S1676-06032006000200016

MEDEIROS, T. A. M. Indicadores físico-químicos de qualidade dos recursos hídricos da bacia do rio Jundiaí-Mirim. In: WORKSHOP INTEGRAÇÃO DE SABERES AMBIENTAIS, 1., 03 dez. 2013, Sorocaba. **Livro de Memórias...** Sorocaba: UNESP, 2013. p. 29-32.

PIMENTEL, D.; ZUNIGA, R.; MORRISON, D. Update on the environmental and economic costs associated with alien-invasive species in the United States. **Ecological Economics**, Ithaca, v. 52, p. 273-288, 2005. http://dx.doi.org/10.1016/j.ecolecon.2004.10.002

PIMPÃO, D. M.; MARTINS, D. S. Ocorrência do molusco asiático *Corbicula fluminea* (Müller, 1774) (Bivalvia, Corbiculidae) no baixo rio Negro, Amazônia central. **Acta Amazonica**, Manaus, v. 38, n. 3, p. 589-591, 2008. http://dx.doi.org/10.1590/S0044-59672008000300026

RODRIGUES, J. C. A.; PIRES-JUNIOR, O. R.; COUTINHO, M. F.; MARTINS-SILVA, M. J. First occurrence of the Asian Clam Corbicula fluminae (Bivalvia: Corbiculidae) in the Paranoá Lake, Brasília, Brazil. **Brazilian Journal of Biology,** v. 67, n. 4, p. 789-790, 2007. http://dx.doi.org/10.1590/S1519-69842007000400032

ROSA, I. C.; PEREIRA, J. L.; GOMES, J.; SARAIVA, P. M.; GONÇALVES, F.; COSTA, R. The Asian clam *Corbicula fluminea* in the European freshwater-dependent industry: A latent threat or a friendly enemy? **Ecological Economics**, Ithaca, v. 70, p. 1805–1813 2011.

SOUSA, R.; NOGUEIRA, A. J. A.; GASPAR, M. B.; ANTUNES, C.; GUILHERMINO, L. Growth and extremely high production of the non-indigenous invasive species *Corbicula fluminea* (Müller, 1774): Possible implications for ecosystem functioning. **Estuarine, Coastal and Shelf Science**, v. 80, n. 2, p. 289–295, 2008. http://dx.doi.org/10.1016/j.ecss.2008.08.006

THIENGO, S. C.; SANTOS, S. B.; FERNANDEZ, M. A. Freshwater molluscs of the lake of Serra da Mesa dam, Goias, Brazil. I. Qualitative study. **Revista Brasileira de Zoologia**, Curitiba, v. 22, n. 4, p. 867-874, 2005.

VEITENHEIMER-MENDES, I. L. *Corbicula manilenssis*, (Philippi, 1844) molusco asiático na bacia do Jacuí e do Guaíba, Rio Grande do Sul, Brasil (Bivalvia, Corbiculidae). **Iheringia Série Zoologia**, v. 60, p. 63-74, 1981.

VIANNA, M. P.; AVELAR, W. E. P. Ocorrência de espécie invasora *Corbicula fluminea* (Bivalvia, Corbiculidae) no rio Sapucaí, São Paulo, Brasil. **Biotemas**, Florianópolis, v. 23, n. 3, p. 59-66, 2010.

ZHANG, L.; SHEN, Q.; HU, H.; SHAO, S.; FAN, C. Impacts of *Corbicula fluminea* on oxygen uptake and nutrient fluxes across the sediment–water interface. **Water Air and Soil Pollution**, v. 220, n. 1/4, p. 399–411, 2011. http://dx.doi.org/10.1007/s11270-011-0763-3