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# First record of the golden mussel *Limnoperna fortunei* Dunker, 1857 (Bivalvia: Mytilidae) in a lentic system in Uruguay

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**Abstract:** *Limnoperna fortunei*, the invasive golden mussel, is extending its distribution in Uruguay. Here we present the first record of this species in Laguna del Sauce, one of the major reservoirs in the Rio de la Plata basin.

**Key words**: Biological invasions, macrofouling, bivalves.

**Resumen: Primer registro del mejillón dorado, *Limnoperna fortunei* Dunker, 1857 (Bivalvia: Mytilidae) en un sistema lentico de Uruguay.** *Limnoperna fortunei,* el mejillón dorado, está ampliando su distribución en Uruguay. Se presenta el primer registro de esta especie en la Laguna del Sauce, uno de los mayores reservorios de la cuenca del Rio de la Plata.

**Palabras clave:** Invasiones biológicas, macrofouling, *Limnoperna fortunei*, Uruguay.

Fresh water environments are exposed to several anthropogenic disturbances which can affect organisms at several biological scales (Verdonschot *et al.* 2012). Species that are sensitive to the disturbance can be killed or displaced, while the survival and proliferation of resistant taxa might be facilitated (Cheng & Hovel 2010). Biological invasions are considered to be an important hazard for biodiversity in the invaded ecosystem (Crooks 2002), however, invasions by exotic species simultaneously represent threats as well as opportunities to learn more about their biology and the ecosystem functioning (Savidge 1987).

Among the most spread biological invaders, benthic invertebrate species with planktonic larval phases are remarkable examples (Boltovskoy & Cataldo 1999, Mörtl & Rothhaupt 2003, Boltovskoy *et al.* 2006). Their larval phases are commonly carried passively to suitable settlement habitats in far away systems, even crossing entire oceans (Mörtl & Rothhaupt 2003), moreover, several anthropogenic vectors facilitating a much faster and wider distribution into new habitats have been suggested (Muniz *et al.* 2005).

The invasive Asiatic bivalve *Limnoperna fortunei* Dunker, 1857, native from rivers and streams of China and Southeast Asia (Morton 1977) invaded South America in 1990's, accidentally introduced through the ballast waters of ships arriving from Asia (Darrigran & Pastorino 1995). It was firstly recorded in Argentina (Pastorino *et al.* 1993), but later invaded the Río de la Plata, Paraná, Paraguay and Uruguay rivers (Darrigran 2002) at a rate of 240 Km/year. Later, *L. fortunei* was f ound

in southern Brazil in Lake Guaiba (Mansur *et al.* 1999) and Los Patos lagoon (Mansur *et al.*1999, 2003) and quite farher north at São Paulo State (Avelar *et al.* 2005).

In Uruguay *L. fortunei* first record occurred in 1999 at Palmar Reservoir, Río Negro, later, the species successfully colonized four of the six main hydrographic basins including Río de la Plata, Río Negro, Santa Lucia and Río Uruguay basins (Clemente & Brugnoli 2002, Brugnoli *et al.* 2005). In Laguna Merin basin their presence was recorded in 2005 (Langone 2005) while at the Atlantic Ocean basin has not yet been reported.


**Figure 1.** Geographical location of studied area. Laguna del Sauce system is located in the south eastern part of the Río de la Plata basin, one of the six main hydrographical basins in Uruguay. It comprises three concatenated lakes, del Sauce, de los Cisnes and del Potrero.

*Limnoperna fortunei* tended to occur preferentially in lentic systems in all the neotropical region (Darrigan & Ezcurra de Drago 2000, Darrigan 2002). Lotic systems including lakes and coastal lagoons appear as more resistant systems to this bivalve colonization. Despite that, it was already reported for Los Patos Lagoon (Mansur *et al.* 1999, 2003) and Lake Guaiba (Mansur *et al.* 1999) in Brazil.

Laguna del Sauce (34º 43´S, 55º 13´W) is a shallow system (maximum depth: 5 m) which includes 3 interconnected water bodies: del Sauce (4045 há), de los Cisnes (205há) y del Potrero (411há) (Rodríguez 2006; Fig. 1). Its main use is as drinking water source for one of the most important touristic areas in the eastern country. It has been classified as eutrophic and up to day the main management problems were associated to algal blooms, principally in summer time (Rodríguez 2006, Mazzeo *et al.* 2010).

*Corbicula fluminea* Müller, 1774 (**Bivalvia**: Cobiculidae), another invasive Asiatic bivalve had been previously recorded in this system (Marroni *et al.* 2014). Since the arrival of *L. fortunei* to the country it have been reported as a macrofouling bivalve causing filter obstructions, damage in the cooling systems and/or obstruction of pipes (Muniz *et al.* 2005). At Laguna del Sauce, the first macrofouling of *L. fortunei* was detected in the summer of 2007, in pipes and seines of the potable water plant (Fig. 2).

**Figure 2.** Macrofouling by *L. fortunei*. The photograph was taken in summer 2007; it shows a damaged part of the water pumping system at Laguna del Sauce after colonization by this invasive bivalve.

With this evidence we reanalyzed zooplankton samples taken periodically at four sampling points for zooplankton monitoring of Laguna del Sauce since 2002. These samples were periodically taken with a tube, integrating the whole water column at 2 points in south and north regions of del Sauce lake and at de los Cisnes and del Potrero lakes. They were inspected in order to determine the first sampling date where *L. fortunei* appeared. The first appearance of larval stages of *L. fortunei* occurred in summer 2006 (Fig 3) and were identified following descriptions in Cataldo *et al.* (2005) and Santos *et al.* (2005).

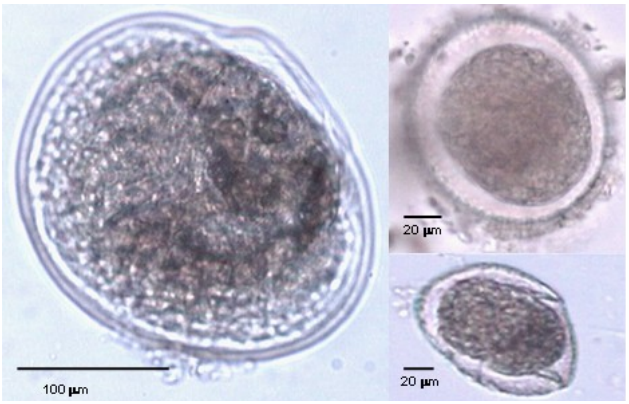


**Figure 3.**-Photographs of *L. fortunei* (unboned veliger, trocophore larvae and D shape larvae) larval stages recorded in summer 2006 samples from Laguna del Sauce which constitutes the first available sampling date where larval stages were detected.

In winter 2008, an extensive benthic sampling was conducted by apnea diving using a corer sampler of 12 cm diameter. *Limnoperna fortunei* was found in 4 out of 8 points in the middle of the main lake, although, in low densities (1-2 ind/m$^2$), ranging from 3 to 33% of total macrofaunal abundance in each point (Fig. 4). All this sites had soft bottoms (varying from sand to lime) and *L. fortunei* was found always attached to other bivalves' shelves (*Diplodon paralellopipedon* Lea, 1834 (**Bivalvia**: Hyriidae) or *C. fluminea* in the present case). In the other 2 interconnected systems (de los Cisnes and Potrero lakes) it was not found. The evidence presented here suggests that *L. fortunei* is able to colonize soft bottom areas by using other organisms as substrata.

From our results it is evident that the invasion by *L. fortunei* in Laguna del Sauce is very recent, and only 7 years after its first record in the country (Brugnoli *et al.* 2005). The first macrofouling incident at Laguna del Sauce water supply facilities, alerted of its presence as it had not been previously detected or reported, and triggered the search of their larval stages in water samples, which was set to only one year earlier. The rapid transition from its first detection to the fouling issue could be taken as an alarm signal of more serious incidents that may occur in the future.

The main concerns up to that day with the management of the water quality in this system were related to the occurrence of algal blooms, mainly cyanobacteria, principally during summer seasons (Mazzeo *et al.* 2010) which potentially affected the principal use of the water body as drinking source (Mendez *et al.* 2010). The infection by the golden mussel could raise a new issue for this use as probably will now become a serious problem mainly because of the fouling of important parts of the factory (Mendez, pers comm.) as it was earlier reported when this species invaded Hong Kong (Ricciardi 1998) and Japan (Magara *et al.* 2001). The costs of antimacrofouling can be high as occurred for example when Zebra mussels clog water pipes and reduce water flow which currently costsed U.S. industries an estimated US$100 million per year in control costs (Pimentel *et al.* 2001), with little if any resources spent on prevention.

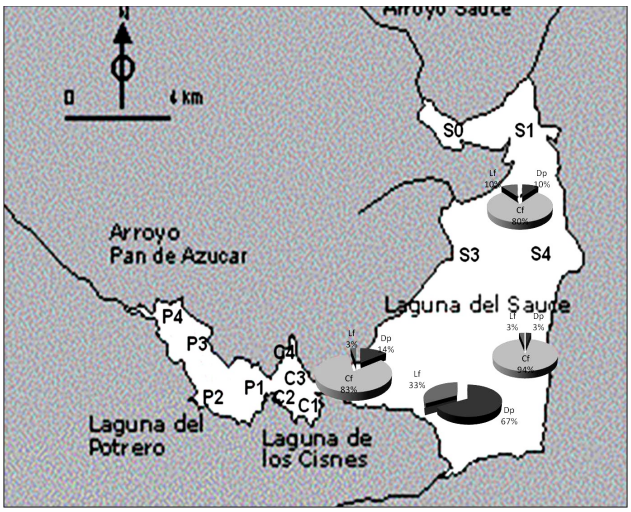


**Figure 4.-** Relative abundance of macrofiltrators in stations where *Limnoperna fortunei* (Lf) adults were found in the sampling conducted in august 2008, *Diplodon paralellopipedon* (Dp) and *Corbicula fluminea* (Cf). P1-4; C1-4 sampling stations at Potrero and de los Cisnes lakes, respectively. S0, 1, 3 and 4 sampling points in del Sauce lake where *L. fortunei* was not registered (redraw from Mazzeo *et al.* 2010).

*L. fortunei* seems also to affect the accompanying meiobenthic fauna in the colonyzed systems (Sardiña *et al.* 2011) while its veligers can become part of fish diet (Paolucci *et al.* 2010), altogether suggesting important ecosystemic alterations.

Moreover, phytoplankton species can be differently affected, with positive effects favoring species that are able to regulate their buoyancy. This might result on enhanced summer cyanobacterial blooms, as experimentally has been suggested by Cataldo *et al.* (2012). That might become an undesired indirect effect of the biological invasion compromising the use of this system as tap water source (Mazzeo *et al.* 2010).

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