



## Recent records of the exotic gastropod *Rapana venosa* (Valenciennes, 1846) along the Argentine coastline: is the invasion progressing southwards?

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**Abstract.** Recent range extensions of *R. venosa* along the Argentine coastline are presented (2010-2013), including the finding of an individual in Mar Chiquita lagoon (200 km southwards of the Río de la Plata). We discuss potential mechanisms for this expansion.

**Key words:** Invasive species, gastropods, estuaries, benthos, Argentina

**Resumen. Registros recientes del gasterópodo exótico *Rapana venosa* (Valenciennes, 1846) a lo largo de la línea costera Argentina: ¿Está progresando la invasión hacia el sur?** Se presentan los registros más recientes de *R. venosa* a lo largo de la línea costera de Argentina (2010-2013), incluyendo el hallazgo de un individuo en la albufera Mar Chiquita (200 km al sur del Río de la Plata). Se discuten los posibles mecanismos de expansión.

**Palabras clave:** Especies invasoras, gasterópodos, estuarios, bentos, Argentina

The Río de la Plata (Argentina-Uruguay) is one of the most important estuarine environments in the continent. The river has a funnel shape 320 km in length, with an open mouth of 230 km along the line Punta Rasa (Argentina)-Punta del Este (Uruguay) (Mianzan *et al.* 2001). A large number of exotic species were recorded in the region influenced by this large estuarine system, mainly along the Buenos Aires province in Argentina (Orensanz *et al.* 2002). One of those exotic species is the Asian Rapa whelk *Rapana venosa* (Neogastropoda, Muricidae), found during the late 1990s in the inner region of the Río de la Plata (Scarabino *et al.* 1999, Pastorino *et al.* 2000). This species invaded estuarine and marine waters worldwide (Mann & Harding 2000, Mann *et al.* 2004, Giberto *et al.* 2006, Kerckhof *et al.* 2006, Brugnoli *et al.* 2014). Its high fecundity (Chung *et al.* 1993, Giberto *et al.* 2006, Harding *et al.* 2007, Saglam & Duzgunes 2007, Harding *et al.* 2008) and dispersal assisted by a planktonic larvae capable of

remaining planktonic between 14 and 80 days (Mann & Harding 2003), make *R. venosa* a potentially successful invader worldwide (Savini & Occhipinti Ambrogi 2004).

Upon arrival to a new area some exotic species can quickly join in biological interactions such as predation and competition (Thomsen *et al.* 2011). If the species succeed and establish a source population, the invasion can progress to surrounding areas. This is particularly the case of *Rapana venosa* in the Río de la Plata, where this exotic species was successfully integrated into the benthic food webs (Giberto *et al.* 2006, Brugnoli *et al.* 2014). This generalist predator typically feeds on bivalves of economic interest like oysters, mussels and clams (Harding & Mann 1999, Seyhan *et al.* 2003, Savini & Occhipinti Ambrogi 2006, Giberto *et al.* 2011, Lanfranconi *et al.* 2013). It was first found in the muddy bottoms of the inner mixohaline regions of the Río de la Plata, but since then the distribution of *R. venosa* has changed. By 2006 this species

extended its range in a perceptible way, including almost the entire mixohaline waters of the Río de la Plata (Giberto *et al.* 2006), an area of *ca.* 35.000 km<sup>2</sup> according to Guerrero *et al.* (1997). The species distribution was typically associated to the presence of *Macra isabelleana* d'Orbigny, 1846, one of the most abundant bivalves of the region (Giberto *et al.* 2006). Many other potential preys inhabit the adjacent marine waters of the Argentine coast, including mussels, oysters and clam beds. Indeed, the Rapa whelks had proven capable of feeding upon many of these native species under laboratory conditions, leaving empty valves with broken shells and rasp marks on the edges after consumption (Giberto *et al.* 2011). Therefore, local bivalves could be a potential food source out of the Río de la Plata and might improve the chances of the establishment of new invasive populations of *R. venosa* along the shore.

Another factor involved in the success of the invasion is the reproductive cycle of *R. venosa*, which in the region is characterized by an intense reproduction during spring and summer, seasons at which the gastropods release a large amount of planktonic larvae to the water column (Giberto *et al.* 2006). The adjacent coast of Argentina presents salinity and temperature values within survival ranges for the recently hatched larvae, as suggested by laboratory experiments (Giberto *et al.* 2013). Indeed, the invasion to the adjacent marine coast of Argentina could be facilitated by the oceanographic regime of the Río de la Plata, which is characterized by a net southeasterly current traveling along the Argentinean coastline, influencing adjacent marine areas as far as ~200 km (Guerrero *et al.* 1997, Lucas *et al.* 2005, Piola *et al.* 2005, Guerrero *et al.* 2014, Matano *et al.* 2014). After a decade of invasion last records located *R. venosa* off Punta Rasa, at the exterior limit of the mixohaline waters but no yet in the expected adjacent marine region (Giberto *et al.* 2006). A similar situation occurred in the Uruguayan coast, where recent records in 2009 also placed *R. venosa* at the exterior limit of the mixohaline waters, in Punta del Este, where the species can be found in mussels beds close to the coast and in dock pilings (Brugnoli *et al.* 2014). So it is reasonable to assume an invasion to the adjacent Argentine coast in the medium to large term. In this context we update the current distribution of *R. venosa* between 2010 and 2013, summarizing data from grey literature and unpublished data of monitoring programs carried out to detect the presence of the species along the Argentine coastline.

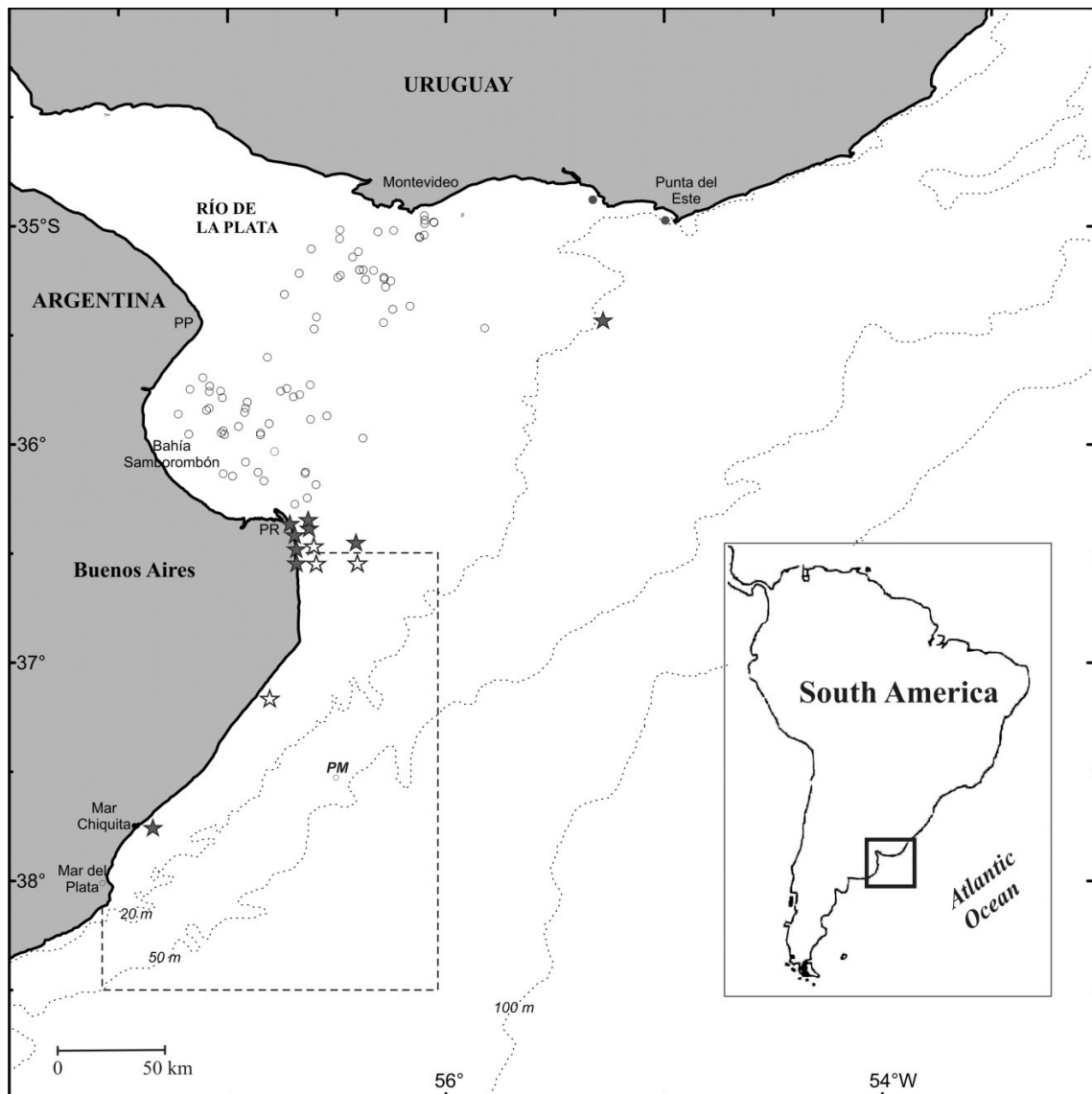
Rapa whelks came from different sources (see Table 1): 1) individuals and egg masses from sampling sites of research cruises carried out in spring and summer (between September 2010 and December 2013), by the R/V "Capitan Cánepa", the R/V "Eduardo Holmberg" (National Institute for Fisheries Research-INIDEP) and A.R.A Puerto Deseado (CONICET); 2) individuals and egg masses stranded on the beach along the Argentinean coast between San Clemente and Mar Chiquita between 2010-2013, throughout a Rapa whelk reporting system and the collaboration of the Science Club of the Partido de la Costa, Buenos Aires, Argentina; and 3) individuals found in 2010 during routine analysis of commercial samples of frozen mussels at the National Animal Health and Agri-food Quality Service (SENASA) from the coastal *Mytilus edulis platensis* d'Orbigny, 1842 beds (commercial captures of coastal mussels in a square with limits 36°30'S and 38°30'S, Alejandra Goya Pers. comm.<sup>1</sup>). The individuals and egg masses were collected at each case with 1) a bottom trawl designed to capture juvenile fishes (10 mm mesh size, duration of hauls= 15 min) and an epibenthic dredge (frame= 200 cm x 50 cm, mesh size= 1 cm, mean ship speed= 1.8 knots, duration of hauls= 5 min), 2) by hand on the beach during low tide, and 3) with bottom trawls at commercial vessels, respectively. Due to logistics constrains only a subsample of the collected specimens of *R. venosa* were frozen and examined later at the laboratory. Shell length (SL= maximum dimension from spire to siphonal canal) of those individuals was measured using a digital caliper (0.01 mm). Regarding the information of the Rapa whelk reporting system, since some of the information received were misidentifications of the native species *Adelomelon brasiliense* (Lamarck, 1811), we only considered records that provided at least one clear photograph to avoid confusions.

*Rapana venosa* individuals and egg masses were found all over the mixohaline waters of the Río de la Plata, with the typical subtidal records in front of Montevideo and Samborombón bay, but also found outside in marine waters and in some coastal sites stranded at the beach (Punta Rasa, San Clemente del Tuyú, Las Toninas, Santa Teresita, Carilo and Mar Chiquita, all in Buenos Aires province) (Figure 1). Subtidal collection sites in the

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Río de la Plata were characterized by muddy bottoms typical of the mixohaline region, while the records outside the Río de la Plata were characterized by sandy sediments. The individuals were found in spring and summer samplings, at an average bottom salinity of 18.4 (values ranging between 5.5 and 27.1) and depths up to 20 m (Table I). They were frequently collected together with the native bivalves *Macrta isabelleana* and *Mytilus*

*edulis platensis*. Also, during a short trawling in a mussel bed off Buenos Aires coast (Figure 1), many dead individuals of *Mytilus e. platensis* were found with predation marks very similar to those left by *R. venosa* (see Giberto *et al.* 2011). Finally, two juveniles were found in a commercial sample from the mussel beds off the Buenos Aires coast (see Figure 1).



**Figure 1.** The Río de la Plata and adjacent marine zones, with indication of recent records of *Rapana venosa* between 2010 and 2013. Filled circles (●) indicate records in the coast of Uruguay (from Lanfranconi *et al.* 2009), Empty circles (○) indicate subtidal records in the mixohaline zone of the Río de la Plata (6-20m), filled stars (★) indicate collections of individuals and egg masses outside the Río de la Plata, empty stars (☆) indicate records of egg masses only, while “PM” indicates the finding of possible predation marks of *R. venosa* in shells of dead *Mytilus edulis platensis*, at mussel beds close to the 50 m isobath. The area with dashed lines indicates the potential location of the juveniles of *R. venosa* collected by the commercial fleet at the mussel beds region (the exact location of the site is not known, see text for details). PP= Punta Piedras. PR= Punta Rasa.

**Table I.** Summary of main findings of *Rapana venosa* in the Río de la Plata and the adjacent coast of the Buenos Aires province, Argentina, for the period 2010-2013. SL= shell length.

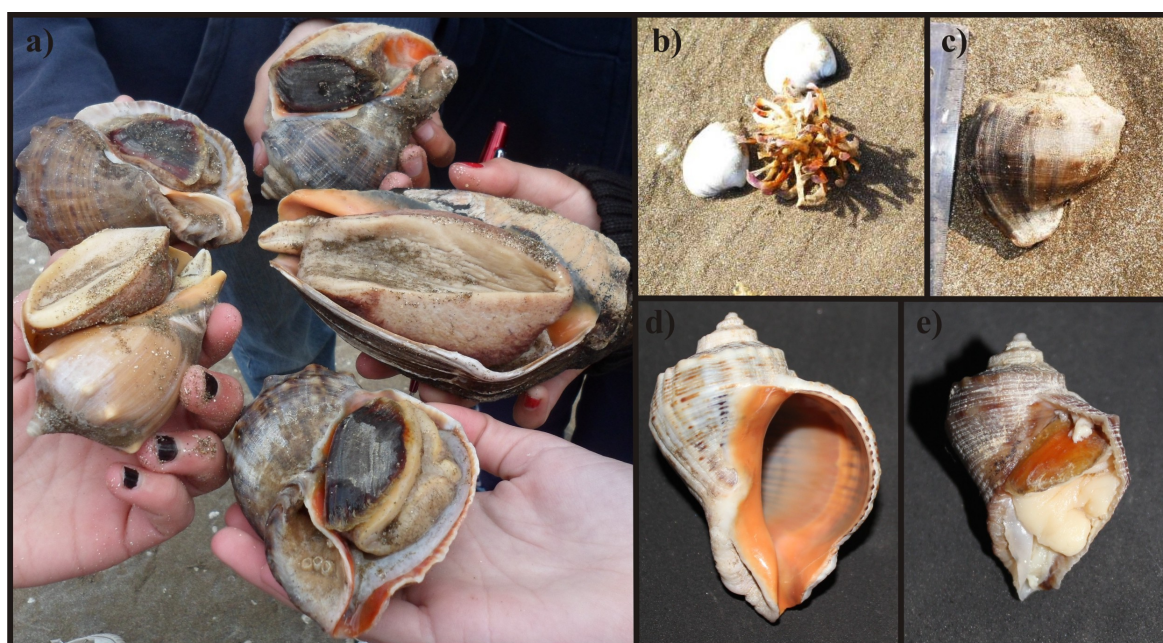
Sampling	Date	Depth (m)	Record	N	Average individual size and range (SL, mm)
Research cruises (Río de la Plata and adjacent subtidal coast)	2010-2013	6-20	Individuals	178	73.78 (21.6-126)
			Egg masses	50	
Rapa whelk reporting system (Between Punta Rasa and Cariló, Buenos Aires)	2010-2012	Beach	Individuals	97*	40.3 (20.5-60.5)**
			Egg masses	7*	
Mar Chiquita, Buenos Aires	2013	Beach	Individuals	1	60
			Egg masses	-	

\*This represents only a subsample of the individuals and egg masses found in that period. \*\* Only the small individuals were measured (some individuals of up to ~80 mm SL were reported in the Rapa whelk reporting system, but we only got standardized measures of some of the smaller ones).

The collected gastropods of the Río de la Plata included individuals of all sizes up to 130 mm SL, while those found stranded on the beach were of smaller size (Table I, Figure 2). The individuals and egg masses stranded on the beach were found up to 20 m from the sea line, usually after large tides or big storms. They were frequently collected together with other native gastropods, typically the volutid *Adelomelon brasiliense* (Figure 2) and gastropods of the genus *Buccinanops*, among others. One report in Las Toninas indicated the presence of *R. venosa* and many dead individuals of the yellow clam *Amarilladesma mactroides* (Reeve, 1854). Egg masses were found alone, attached to debris and to the shells of *Rapana venosa* or native gastropods. Finally, the extreme southern presence recorded corresponded to the finding of a stranded individual (60 mm SL) on the adjacent beach of the coastal lagoon of Mar Chiquita in the summer of 2013 (Figure 1). This gastropod looked recently dead and presented no signs of intense erosion by transportation of marine currents (e.g. with no loss of periostracum, natural shell abrasion and no shell fragmentation) (see Figure 2). It was found after a big storm and together with other native gastropods like *A. brasiliense*, at a sector of the beach where the finding of stranded individuals of local species is quite common.

As recently stated by Lanfranconi *et al.* (2009), the invasion of *R. venosa* was restricted, until now, to the mixohaline waters of the Río de la Plata, both in Argentina and Uruguay. Continued propagation of the invasion from source populations is usually dependent on sufficient propagule pressure

(Williamson 1996). Once the source population is established, the propagation may be the result of the larval dispersal from breeding areas via marine currents. As mentioned in previous paragraphs, the dynamics of the oceanographic summer regime of the Río de la Plata may explain why the invasion is slowly spreading southwards in the Argentinean coastline and not yet in the marine Uruguayan coast. In line with this, the inter-annual variations of the Río de la Plata discharge are also quite large, ranging between extremes of 11,000 and 80,000 m<sup>3</sup>/s, and is associated with El Niño/La Niña events (Piola *et al.* 2005, Matano *et al.* 2014 and references therein). The Río de la Plata response to these events is highly variable, and in the end determines years of low/high southern discharge to the Argentine coastline (Matano *et al.* 2014). This phenomenon may result in a highly variable summer larval pressure in the region, which in turn may slow down the species expansion to the south. Another factor to consider is the retention properties of the salinity wedge regime of the Río de la Plata (Mianzan *et al.* 2001, Acha *et al.* 2008), which at the end can also negatively affect the larvae exportation to the adjacent marine coasts. On the other hand, the competition with the native gastropod *Stramonita haemastoma* (Linnaeus 1767, Muricidae) was suggested by Lanfranconi *et al.* (2009) as a potential explanation for the absence of *R. venosa* in the adjacent marine waters of Uruguay. Finally, and considering the large size of the marine ecosystems under survey, it will also take time for the species to reach a density significantly enough to be detected by the monitoring surveys in the region.



**Figure 2.** Specimens collected along the Argentine coastline between 2010 and 2013. Individuals and egg masses stranded on the beach from San Clemente city (a-c): three *R. venosa* individuals (SL between 70 and ~80 mm) found together with two individuals of the local species *Adelomelon brasiliana* (a), Egg masses (b) and an individual of 70 mm SL found on the beach (c). Small individuals found stranded in Mar Chiquita lagoon beach (60 mm SL) (d) and in mussel beds off the coastal line of Argentina (50 mm SL) (e) are also indicated. Photographs a-c by Marina Soba and Susana Herrera, d-e by Diego Giberto.

Nevertheless, using data from research cruises and monitoring coastal programs we now can confirm that *R. venosa* is now widely extended along the mixohaline waters of the Río de la Plata but also outside of this region, at a distance of at least 100 km south to the Argentinean coastline; or even close to 200 km southwards if we consider the individual found in Mar Chiquita as a valid representative of the real range extension of the Río de la Plata population. The presence of and adult of *R. venosa*, proven not to be an fortuity arrival, also represents a potential threat to the marine ecosystem of this coastal lagoon, a UNESCO Man and the Biosphere Reserve supporting significant biological activities (UNESCO 1996). A future monitoring of the adjacent coast of the lagoon should be encouraged to confirm the possible establishment of an active population of this invasive gastropod, including the mussel beds located further than 20 m isobath, where certainly the species has enough available preys. In summary, data collected in the last years suggest that now the species is

progressing along the coast, where it has potential available preys and proper environmental conditions for survival and reproduction. The finding of many individuals and egg masses stranded on the beach was also reported in other regions invaded by *R. venosa* (e.g. Savini *et al.* 2004), and can be used to monitor the progress of the invasion southwards. Future studies in the adjacent marine ecosystems should analyze the effects of potential predators and competitors to properly predict if the species presence is a serious threat to the regional marine biodiversity and economical resources.

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