

First report of predation by a small shark on the invasive rapa whelk *Rapana venosa* (Valenciennes, 1846) in Argentinean waters

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Abstract

The rapa whelk *Rapana venosa* (Valenciennes, 1846) has few predators in areas outside of its native range. Here we report the first incidence of predation by a small shark *Mustelus schmitti* Springer, 1939 on the rapa whelk in coastal waters of Argentina. This finding could give information about possible trophic control over *R. venosa* as it potentially disperses into coastal waters of Atlantic South America.

Key words: Argentina, sharks, diet, gastropods, exotic species

Introduction

Mustelus schmitti Springer, 1939 is a small-bodied shark endemic to the southwestern Atlantic Ocean from Florianópolis (27°S, Brazil) to Bahía Grande (52°S, Argentina) (Van der Molen et al. 1998; Chiaromonte and Pettovello 2000; Cousseau and Perrotta 2004). *Mustelus schmitti* is one of the most abundant species of elasmobranchs in the northern Argentine coastal ecosystem (Jaureguizar et al. 2004), and an important fishing resource. This small shark is a demersal-pelagic predator with a diet comprised mainly of large decapods (Brachyura and Anomura), polychaetes, and, of particular importance for this study, whelks (Gastropoda: Buccinidae) (Bergonzi 1997; Belleggia 2012; Belleggia et al. 2012).

The rapa whelk *Rapana venosa* (Valenciennes, 1846) is a large predatory gastropod native to the Sea of Japan, east China Sea, and Taiwan. It was first recorded in South America in 1998 from the Río de la Plata (RdIP) near Montevideo (Figure 1),

and then it spread throughout the central estuary (Scarabino et al. 1999; Pastorino et al. 2000). Afterwards, it was found in Samborombón Bay (south coast of RdIP, Giberto et al. 2006), throughout the entire RdIP estuary (Scarabino et al. 1999; Rodríguez-Capítulo et al. 2002), and more recently in nearby marine coastal waters of both Uruguay (Lanfranconi et al. 2009) and Argentina (Giberto and Bruno 2014). Due to its high fertility and the fact that the temperatures of the estuarine system are within the tolerance range for breeding, rapa whelk continues to spread, and is extending its distribution to the coastal area of Argentina such that it is now common as a by-catch of several fisheries (Giberto and Bruno 2014).

The effects of the rapa whelk on the functioning of the RdIP ecosystem is not understood but preliminary work indicates it affects multiple ecosystem components both directly and indirectly (Lercari and Bergamino 2011). For example, the rapa whelk often preys upon economically important bivalves. Within the RdIP and adjacent marine waters, the spatial

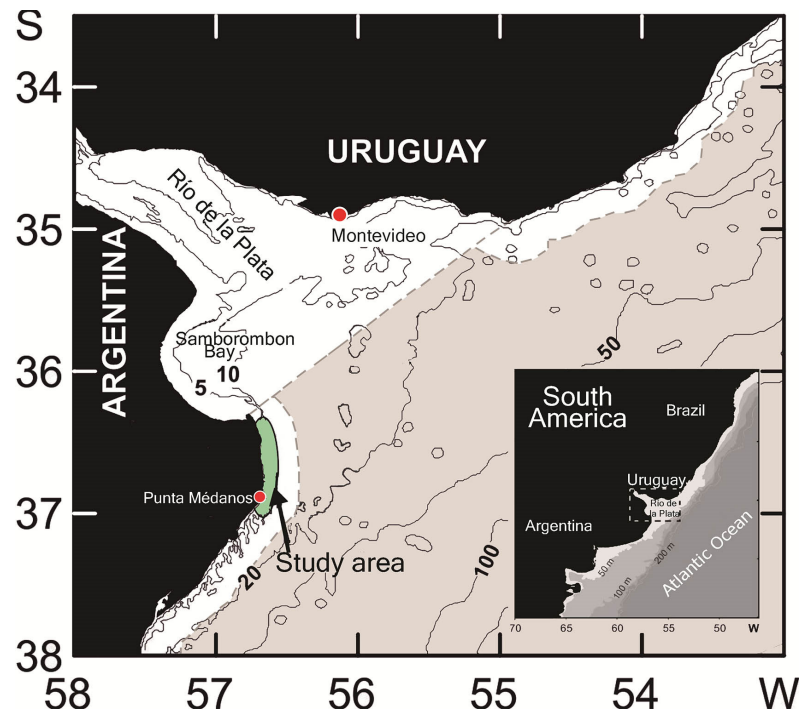


Figure 1. Study area, showing (in colour), and site of the catch of *Mustelus schmitti* by small-scale fishery of Partido de la Costa. Depth contours are in m.

distribution of *R. venosa* matches with the distribution of commercially important native bivalves, i.e., *Macra isabelleana* d'Orbigny, 1846 and *Ostrea puelchana* d'Orbigny, 1842, and it likely preys upon these species (Giberto et al. 2006). Such predation could have negative socio-economic consequences (Lercari and Bergamino 2011). In addition, *R. venosa* shows high diet overlap with the Whitemouth croaker *Micropogonias furnieri* (Desmarest, 1823), an important finfish coastal resource, and that raises the possibility of competition for food.

The rapa whelk has relatively few predators in invaded locations. The blue crab *Callinectes sapidus* Rathbun, 1896 is capable of preying upon small Rapa whelks, at least in the laboratory (Harding 2003). Under natural conditions in the RdIP estuary, adult loggerhead turtles *Caretta caretta* (Linnaeus, 1758) can consume large numbers of rapa whelks (Carranza et al. 2010) in addition to their normal diet of benthic invertebrates (crustaceans and mollusks) and fishes discarded from coastal fisheries (Estrades et al. 2007; Martinez-Souza 2009). In the RdIP estuarine waters, *R. venosa* has higher densities than in the outer marine coastal waters; however, its abundance is increasing (Giberto and Bruno 2014), which could make it an attractive prey to marine benthic feeders. However, until now, there was no evidence of predation on rapa whelks in the neighboring marine coastal waters of RdIP, and

there are no reports of predation by fish in invaded habitats worldwide (Harding 2003; Carranza et al. 2010). This paper is the first report of predation by a shark on *R. venosa* in the outer marine coastal water of RdIP and discusses the results in the context of the ecological features of both species.

Methods

The small-scale fishery located in Punta Médanos (36°53'S, 56°39'W; Figure 1) is mainly conducted in fully marine waters, but there are low salinity extensions of the RdIP plume during summer months (Jaureguizar et al. 2015). This small-scale fishery uses small fiberglass boats and employs nylon gillnets (stretched mesh ranging from 90 to 120 mm and 2 m in height). During spring, the average (\pm SD) soak time is 17.8 ± 6.5 h, average length of net is 511.6 ± 251.4 m, and the average distance to the coast is 3.4 ± 2.05 km (Jaureguizar et al. 2015).

A small number ($n = 28$) of *Mustelus schmitti* were collected during October 2012. The shark specimens were between 565 and 774 mm total length (TL) and captured in waters < 10 m deep. Whole sharks were transported to the laboratory, stomachs were dissected, and then total stomach-content weight was recorded. The prey items were identified to the lowest possible taxonomical level, counted, and weighed.

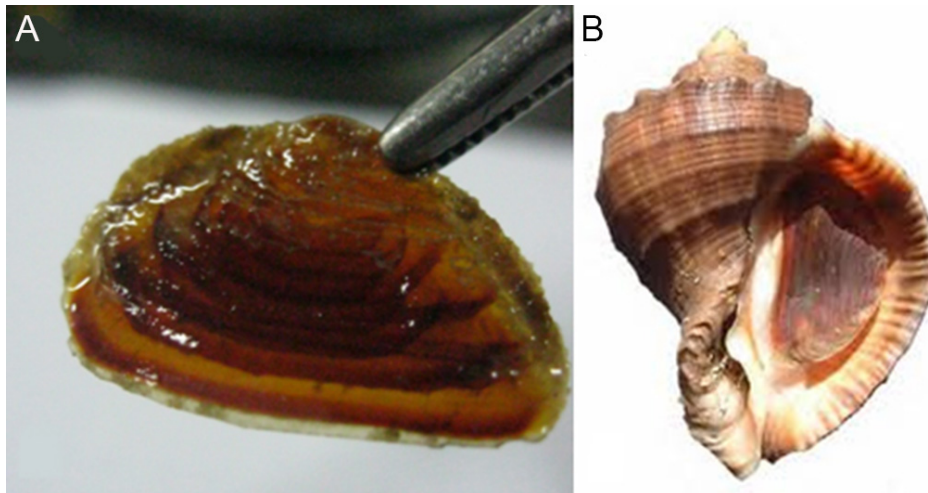


Figure 2. (A) *Rapana venosa* operculum (total length: 23 mm) found in stomach content of *Mustelus schmitti*. (B) Exotic gastropod, *Rapana venosa*. Photographs by A. G. Bonelli (A) and www.diytrade.com (B).

Results

All 28 stomachs analyzed contained food, 21 prey taxa in total. In terms of percent by number, the principal prey were polychaetes (Family Glyceridae) at 34%; hermit crabs *Pagurus* sp. at 18.3%, and unidentified polychaetes at 12.4%. When expressed as % wet weight, the main prey were unidentified crabs (50.2%), the squid *Doryteuthis sanpaulensis* (Brako-niecki, 1984) (18.4%), and hermit crabs (17.9%). One shark 651 mm TL contained a rapa whelk operculum (23 mm longest axis; Figure 2A) along with some of the body tissue. Based on a published regression equation (Carranza et al. 2010), this corresponded to a rapa whelk of 58 mm shell length.

Discussion

The shark *M. schmitti* feeds opportunistically upon benthic prey, typically crustaceans, polychaetes, and fishes (Belleggia et al. 2012). Gastropods are a secondary prey and, like other sharks, hard and soft parts are reported in stomach contents (Vögler et al. 2003). Considering the feeding strategy and dentition of *M. schmitti* (Belleggia 2012), the finding of remains, including an operculum, of *R. venosa* did not seem to be an accident.

Rapana venosa occurs mostly in estuarine waters of RdIP, and its abundance abruptly decreases along the adjacent marine coastal waters as one moves away from the RdIP mouth (Giberto and Bruno 2014). The differences in predation upon *R. venosa*

between loggerhead turtles and the small shark in the RdIP area reflects differences in distribution of the two predators. Loggerhead turtles occur more in the estuarine area while *M. schmitti* mainly inhabits the outer coastal waters in salinities 28–30 (Cortés 2012). These salinities represent the outer salinity front of RdIP (Lucas et al. 2005) and correspond to the boundary for marine species intrusions into the estuary (Jaureguizar et al. 2003, 2004, 2006). Given that only a few shark stomachs were collected, clearly there is need for additional sampling to assess the potential role of *M. schmitti* as a predator of rapa whelks. Moreover, we currently cannot rule out the possibility that the shark in this study scavenged a whelk discarded by a commercial fishery. The two hypotheses, of course, are not mutually exclusive.

Other potential predators of this exotic mollusc include demersal fishes as *Micropogonias furnieri*, which also feeds on benthic prey, such as polychaetes, gastropods and bivalves (Puig 1986; Giberto 2001; Giberto et al. 2006; D'Anatro et al. 2013). The similarity in diet between the fish and whelk also raises the possibility of a competitive interaction should the whelk become abundant enough for food to be limiting. However, to date *R. venosa* had not been found in stomach contents of any other predator in the outer marine coastal water of RdIP. As the rapa whelk population continues increasing and spreading, it would be useful to assess whether potential predators begin consuming this invasive gastropod and to examine the changing role of this invasive whelk in the coastal ecosystems, including studies conducted during different seasons of the year.

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References

- Belleggia M, Figueroa DE, Sánchez F, Bremec C (2012) The feeding ecology of *Mustelus schmitti* in the southwestern Atlantic: geographic variations and dietary shifts. *Environmental Biology of Fishes* 95: 99–114, <http://dx.doi.org/10.1007/s10641-011-9874-3>
- Belleggia M (2012) Ecología trófica del gatuzo, *Mustelus schmitti* (Springer 1939), en el Mar Argentino. PhD Thesis, Universidad Nacional de Mar del Plata, Mar del Plata, Argentina
- Bergonzi C (1997) Interrelaciones tróficas de algunas especies de peces del área costera de la Provincia de Buenos Aires. Br. Thesis, Universidad Nacional de Mar del Plata, Mar del Plata, Argentina
- Carranza A, Estrades A, Scarabino F, Segura A (2010) Loggerhead turtles *Caretta caretta* (Linnaeus) preying on the invading gastropod *Rapana venosa* (Valenciennes) in the Río de la Plata Estuary. *Marine Ecology* 32: 142–147, <http://dx.doi.org/10.1111/j.1439-0485.2010.00424.x>
- Chiaramonte GE, Pettovello AD (2000) The biology of *Mustelus schmitti* in southern Patagonia, Argentina. *Journal of Fish Biology* 57: 930–942, <http://dx.doi.org/10.1111/j.1095-8649.2000.tb02202.x>
- Cortés F (2012) Hábitats esenciales de condrictios (Chondrichthyes) costeros, y su relación con los procesos oceanográficos. PhD Thesis, Universidad Nacional de Mar del Plata, Mar del Plata, Argentina
- Cousseau MB, Perrotta RG (2004) Peces marinos de la Argentina: Biología y Distribución. INIDEP, Mar del Plata, Argentina, 167 pp
- Estrades A, Souza G, Scarabino F, Laporta M, Miller P, Rinderknecht A, Sanchez P (2007) Ecología alimenticia de la tortuga Cabezona (*Caretta caretta*) en la plataforma uruguaya: resultados preliminares. In: Libro de Resúmenes de las III Jornadas de Conservación e Investigación de Tortugas Marinas en el Atlántico Sur Occidental, 26 al 28 de octubre de 2007, Piriápolis, Uruguay
- D'Anatro A, Naya DE, Lessa EP, Defeo O (2013) Contrasting patterns of morphological variation with dietary preferences in *Micropogonias furnieri*: insights from stable-isotope and digestive-trait analyses. *Journal of Fish Biology* 82: 1641–1658, <http://dx.doi.org/10.1111/jfb.12103>
- Giberto D (2001) Fondos de alimentación de la corvina rubia (*Micropogonias furnieri*) en el estuario del Río de la Plata. Br. Thesis, Universidad Nacional de Mar del Plata, Mar del Plata, Argentina
- Giberto D, Bremec C, Schejter L, Schiariti A, Mianzan H, Acha E (2006) The invasive rapa whelk *Rapana venosa* (Valenciennes 1846): Status and potencial ecological impacts in Río de la Plata Estuary, Argentina-Uruguay. *Journal of Shellfish Research* 25: 919–924, [http://dx.doi.org/10.2983/0730-8000\(2006\)25\[919:TIRWRV\]2.0.CO;2](http://dx.doi.org/10.2983/0730-8000(2006)25[919:TIRWRV]2.0.CO;2)
- Giberto D, Bruno LI (2014) Recent records of the exotic gastropod *Rapana venosa* (Valenciennes, 1846) along the Argentine coastline: is the invasion progressing southwards? *Pan-American Journal of Aquatic Sciences* 9: 324–330
- Harding JM (2003) Predation by blue crabs, *Callinectes sapidus*, on rapa whelks, *Rapana venosa*: possible natural controls for an invasive species? *Journal of Experimental Marine Biology and Ecology* 297: 161–177, <http://dx.doi.org/10.1016/j.jembe.2003.07.005>
- Jaureguizar AJ, Menni R, Bremec C, Mianzan H, Lasta C (2003) Fish assemblage and environmental patterns in the Río de la Plata estuary. *Estuarine, Coastal and Shelf Science* 56: 921–933, [http://dx.doi.org/10.1016/S0272-7714\(02\)00288-3](http://dx.doi.org/10.1016/S0272-7714(02)00288-3)
- Jaureguizar AJ, Menni R, Guerrero R, Lasta C (2004) Environmental factors structuring fish communities of the Río de la Plata estuary. *Fisheries Research* 66: 195–211, [http://dx.doi.org/10.1016/S0165-7836\(03\)00200-5](http://dx.doi.org/10.1016/S0165-7836(03)00200-5)
- Jaureguizar AJ, Menni R, Lasta C, Guerrero R (2006) Fish assemblages of the Northern Argentine Coastal System: spatial patterns and their temporal variations. *Fisheries Oceanography* 15: 326–344, <http://dx.doi.org/10.1111/j.1365-2419.2006.00405.x>
- Jaureguizar AJ, Cortés F, Milessi AC, Cozzolino E, Allegra L (2015) A trans-ecosystem fishery: environmental effects on the small-scale gillnet fishery along the Río de la Plata boundary. *Estuarine, Coastal and Shelf Science* 166 (Part A): 92–104, <http://dx.doi.org/10.1016/j.ecss.2014.11.003>
- Lanfranconi A, Hutton M, Brugnoli E, Muniz P (2009) New record of the alien mollusk *Rapana venosa* (Valenciennes 1846) in the Uruguayan coastal zone of Río de la Plata. *Pan-American Journal of Aquatic Sciences* 4: 216–222
- Lercari D, Bergamino L (2011) Impacts of two invasive mollusks, *Rapana venosa* (Gastropoda) and *Corbicula fluminea* (Bivalvia), on the food web structure of the Río de la Plata estuary and nearshore oceanic ecosystem. *Biological Invasions* 13: 2053–2061, <http://dx.doi.org/10.1007/s10530-011-0023-x>
- Lucas AJ, Guerrero RA, Mianzan HW, Acha EM, Lasta CA (2005) Coastal oceanographic regimes of the Northern Argentine Continental Shelf (34–43 °S). *Estuarine, Coastal and Shelf Science* 65: 405–420, <http://dx.doi.org/10.1016/j.ecss.2005.06.015>
- Martinez-Souza G (2009) Ecología Alimentar da tartaruga marinha cabecuda (*Caretta caretta*) no Oceano Atlantico sul Occidental, Uruguai. MSc.Thesis, Universidade Federal do Rio Grande – FURG Pos-Graduacao em Oceanografia Biologica, Rio Grande do Sul, Brazil, 119 pp
- Pastorino G, Penchaszadeh PE, Schejter L, Bremec C (2000) *Rapana venosa* (Valenciennes, 1846) (Mollusca: Muricidae): a new gastropod in south Atlantic waters. *Journal of Shellfish Research* 19: 897–899
- Puig P (1986) Análisis de contenidos estomacales de corvina blanca (*Micropogon opercularis*) (Sciaenidae, Perciformes): Verano 1984. *Publicación de la Comisión Técnica Mixta del Frente Marítimo* 1: 333–340
- Rodriguez-Capitulo A, Cortelezzi A, Paggi AC, Tangorra M (2002) Phytoplankton and Benthos of the environmental survey of the Río de la Plata. N° 2. Benthos. Technical report United Nations Development Programme-Global Environmental Facilities. PNUD Project/Gef RLA/99/G31, 48 pp (in Spanish)
- Scarabino F, Menafra R, Etchegaray P (1999) Presence of *Rapana venosa* (Valenciennes, 1846) (Gastropoda: Muricidae) in the Río de La Plata. *Boletín de la Sociedad Zoológica de Uruguay* 11: 40
- Van der Molen S, Caille G, González R (1998) Bycatch of sharks in Patagonian coastal trawl fisheries. *Marine and Freshwater Research* 49: 641–644, <http://dx.doi.org/10.1071/MF98005>
- Vögler R, Milessi AC, Qui-ones R (2003) Trophic ecology of *Squatina guggenheim* on the continental shelf off Uruguay and northern Argentina. *Journal of Fish Biology* 62: 1254–1267, <http://dx.doi.org/10.1046/j.1095-8649.2003.00105.x>