



Short communication

Invasive bivalve assessment in the diet of pejerrey, *Odontesthes bonariensis* (Valenciennes, 1835), at the Upper Río de la Plata, Argentina

By F. Brancolini, M. E. Maroñas, E. D. Sendra and D. C. Colautti

Instituto de Limnología 'Dr. Raúl A. Ringuelet' (CONICET-UNLP), La Plata, Buenos Aires, Argentina

Introduction

Three species of exotic molluscs have shown a noticeable capacity to become part of the Río de la Plata fauna. Two of these species are the Asian clams, *Corbicula fluminea* (Müller, 1774) and *C. largillierii* (Philippi, 1844), both native to Southeast Asia, and first recorded on the coast of the Río de la Plata by Ituarte (1981). The third is the golden mussel, *Limnoperna fortunei* (Dunker, 1857), native to China and Southeast Asia, which was first detected here in the early 1990s (Pastorino et al., 1993). *L. fortunei* and *C. fluminea* have behaved as invasive species (Darrigran, 2002). Since the introduction of *C. fluminea*, both the density and distribution range increased, reaching densities of between 300 and 1000 individuals m^{-2} in the Lower Delta of the Paraná River (Boltovskoy and Cataldo, 1999). Similarly, the golden mussel *L. fortunei* has rapidly expanded its distribution range (Darrigran, 2002), with densities of nearly 380 000 individuals m^{-2} recorded in the middle zone of the Río de la Plata estuary (Spaccesi and Rodrigues Capítulo, 2012); its presence thus adds new species to the food web for fishes.

In the Río de la Plata, it has been discovered that invasive bivalves accumulate contaminants (Colombo et al., 1997; Bilos et al., 1998; Villar et al., 1999; Cataldo et al., 2001) and also affecting some commercial fish (Colombo et al., 2000; Villar et al., 2001). Furthermore, when considering these observations, García and Protogino (2005), warned about the human health risks linked to the consumption of fish that prey on these invasive bivalves.

The pejerrey, *Odontesthes bonariensis* (Valenciennes, 1835), is important to several Argentinean fisheries (Somoza et al., 2008). In the Río de la Plata, pejerrey is present during the cold months due to its migratory movements (Avigliano and Volpedo, 2013). The species has a wide trophic niche and can show relevant differences in its feeding habits, depending on its ontogenetic status, as well as the season and food availability (Ringuelet et al., 1980; Escalante, 1985; Grosman, 1995; Freyre et al., 2009). Before the bivalve invasion, the pejerrey diet in the Río de la Plata was characterised as zooplanktivorous, with a trend toward consuming other animal prey, including native molluscs (Ringuelet, 1942; Cabrera, 1962; Cabrera et al., 1973). The aim of this study is to determine the mollusc occurrence in the pejerrey diet, in its

juvenile and adult stages, at the Upper Río de la Plata, and analyze the relative importance attained by these exotic bivalves in the food chain of the pejerrey.

Materials and methods

Pejerrey samples were obtained in the Upper Río de la Plata, near Juncal Island, one of the most important sporting and commercial pejerrey fishing areas in Río de la Plata (Fig. 1).

The *O. bonariensis* were captured while sport fishing during the winter fishing season (May–August) of 2006, 2007 and 2008, with 56, 27, and 39 individuals, respectively. Total length (mm) was measured with a digital calliper. The entire digestive tract was removed and preserved in 10% formaldehyde. Gut content of the first third of the digestive tract was analyzed under a stereomicroscope. The items were grouped by their taxonomic affinity; according to the degree of identification, they were regrouped into major taxonomic categories (TC). The occurrence frequency (OF) of each TC was determined by fish size ranges of 50 mm, considering the number of individuals with a given TC in their stomach, and relative to the total number of fish with stomach contents.

The total number of molluscs contained in each fish was counted by genus or species. The number of beaks divided by two was used in order to count the *Limnoperna* and *Corbicula* specimens consumed. All molluscs were measured under a stereomicroscope with a digital calliper, recording the shell maximum length (SML). The respective mollusc volumes were estimated by measuring the displaced volume (Hyslop, 1980). Both number and volume were determined for each 50 mm fish length interval (given in percentages for comparison).

Pearson's product-moment correlation coefficient (r) was estimated to assess relationships between the fish size and the mollusc shell size.

Results

Based on analysis of the 83 specimens where food contents were found, the diet was characterized by five TC (Fig. 2). Insects were the most frequent category for pejerrey specimens of small and medium size (100–350 mm). In larger fish,

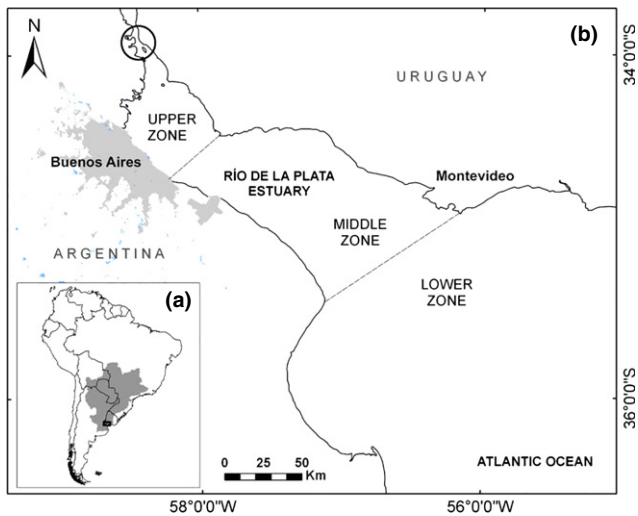


Fig. 1. Geographical location of study area and sampling site, Upper Río de la Plata, Argentina

plant remains and molluscs were the most frequent diet components, whereas fish items were a highly frequent in the diet of pejerrey between 350 and 450 mm. Arachnida were present in almost all class intervals, with a frequency of occurrence of < 25%.

Analysis of the mollusc fraction indicated that the pejerrey consumed six taxa. Four corresponded to native species *Heleobia* sp. (Stimpson, 1865); *Potamolithus* sp. (Pilsbry, 1896); *Chilina* sp. (Gray, 1828), and an unidentified species of the order Unionoidea (Stoliczka, 1871). The remaining taxa were the invasive bivalves *C. fluminea* and *L. fortunei*. Native mollusc valves were found both whole and broken, while the Asian clams were practically whole and united. Those belonging to golden mussels were found mostly with their valves separated and slightly crushed. The ranges of SML recorded for native molluscs were: *Heleobia* sp. 2.0–8.8 mm; *Potamolithus* sp. 3.7–5 mm and *Chilina* sp. 4.1–8.1 mm. There was only one specimen of Unionoidea with a size of

1.9 mm. The range for *L. fortunei* was between 4 and 14 mm and for *C. fluminea* between 1.8 and 19 mm. There was no correlation between pejerrey size and the size of the consumed native molluscs or with the *L. fortunei* size ($P < 0.05$). However, there was a positive relationship between the fish size and the *C. fluminea* shell size ($r = 0.82$, $P < 0.05$).

The percentages of molluscs consumed (number and volume) by each pejerrey size class are presented in Fig. 3. *Heleobia* sp. was common to all fish length ranges but its relative volume decreased according to fish size increments. The relative importance of *Potamolithus* sp. was lower than *Heleobia* sp. and did not have a relationship with the pejerrey size. *Chilina* sp. showed a moderate importance in small and medium fish size classes. *C. fluminea* was important, both in number and volume, to pejerrey larger than 350 mm, being represented in percentage volumes above 70% among the mollusc fraction. *L. fortunei* was present in middle-sized pejerrey; their percentage values in number and volume were below 30%.

Discussion

In this study, the main identified food items were terrestrial insects, fish, plant remains, molluscs and arachnida. This information differs when compared with the diet of pejerrey in the pampean shallow lakes where zooplankton (Cladocera and Copepoda) are the main source of food and generate a strong influence on pejerrey growth (Colautti et al., 2010; Garcia de Souza et al., 2013) and other population parameters (Freyre et al., 2009). The trophic plasticity appears to be a key factor for pejerrey feeding in the Upper Río de la Plata, because zooplankton was a negligible alimentary item. As was pointed out by Ringuélet et al. (1980), when the zooplankton community is scarce, the pejerrey shift to other food sources, incorporating vegetal, gastropods (*Heleobia* sp.), shrimp (Palaemonidae), ostracods, and fish. The few references on pejerrey feeding in the Río de la Plata estuary are for small and medium size specimens from the middle zone (Ringuélet, 1942; Cabrera, 1962; Cabrera et al., 1973). In

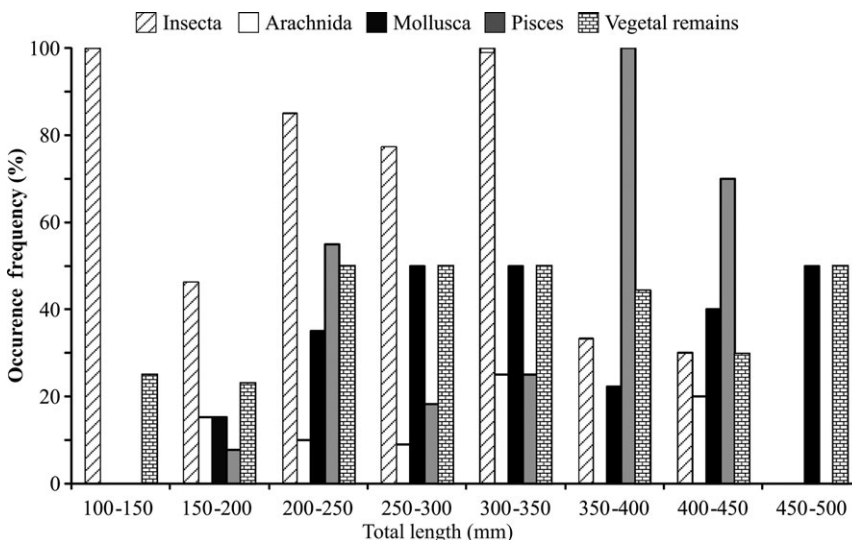


Fig. 2. Percent frequency of occurrence (OF%) of macroittems in different size classes of pejerrey, *Odontesthes bonariensis*

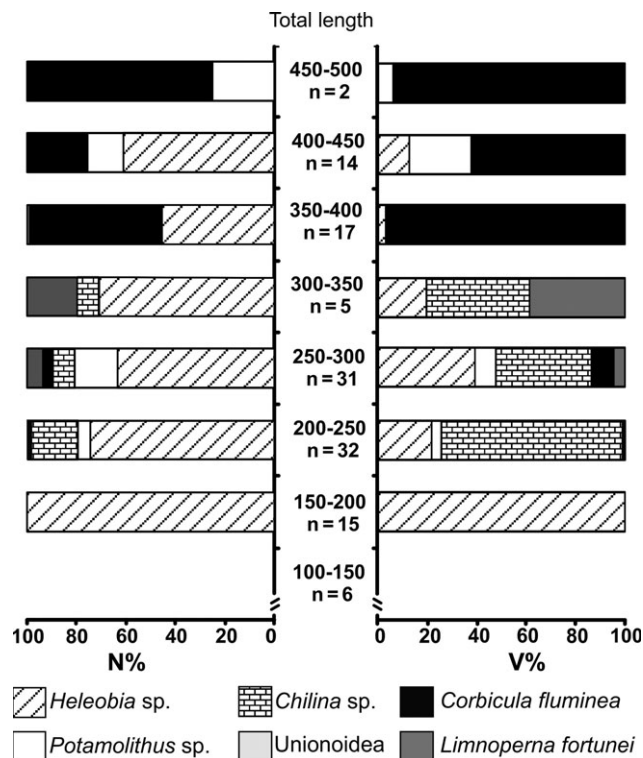


Fig. 3. Percentage by number (N%) and volume (V%), of molluscs consumed by different size classes of pejerrey, *Odontesthes bonariensis*

agreement with the findings of Ringuelet et al. (1980), in other environments, the item fish showed a trend to increase its importance, at least in occurrence terms, following the growth of pejerrey in size.

Molluscs were a frequent item found in the pejerrey diet in the surroundings of Juncal Island. This is in contrast with the results obtained by Cabrera et al. (1973) in the middle zone of the Río de la Plata estuary, where *Heleobia* sp. and undetermined native bivalves were recorded. In the present study, the consumption of molluscs also had a higher richness, for the first time adding *Chilina* sp., *Potamolithus* sp. and a species of Unionioidea.

The Mollusca category was not found in pejerrey with a size between 100 and 150 mm. Similar observations were made by Ringuelet (1942) and Cabrera et al. (1973). In the Juncal Island area, the size ranges of consumed *Heleobia* sp., *Potamolithus* sp. and *Chilina* sp. were similar for all sizes of pejerrey. The maximum size observed in gut content was in agreement with the maximum values recorded in the environment for the first two molluscs (de Gaillard and de Castellanos, 1976; López Armengol, 1996). Regarding *Chilina* sp., only small individuals were vulnerable to pejerrey predation because this genus grows to sizes above 30 mm (de Castellanos and de Gaillard, 1981).

Among the two invasive species, *C. fluminea* is the most depredated by pejerrey in the assessed area, a result that could be linked to availability issues. As native bivalves, the Asian clam prefers sandy substrates (Schmidlin and Baur, 2007), such as the river bottom around Juncal Island (Pittau et al.,

2003). Conversely, *L. fortunei* preferably colonizes hard substrates, to which it adheres by a resistant byssus (Darrigran and Damborenea, 2006), which are almost entirely absent in the study area.

As a conclusion, it can be stated that in the Upper Río de la Plata, molluscs are an important component in the diet of the pejerrey, *O. bonariensis*, although there appears to be a selective predation of exotic molluscs in accordance with the size of the fish. This is a relevant observation, because pejerrey larger than 300 mm are the target for sport and commercial fisheries, and mollusc invasions could be facilitating a new pathway through which contaminants could enter the food web. The observation of this risky situation is supported by the studies of Bilos et al. (1998), who found high levels of heavy metals in *C. fluminea* in the Río de la Plata. Further studies are necessary to assess the contaminant load in the pejerrey muscles and the potential threat to human health.

Acknowledgements

The authors are grateful to the Brancolini family for logistic and economic support and to Matías H. Parimbelli for helping with the sampling.

References

- Avigliano, E.; Volpedo, A. V., 2013: Use of otolith strontium: calcium ratio as an indicators of seasonal displacements of the silverside (*Odontesthes bonariensis*) in a freshwater-marine environment. *Mar. Freshw. Res.* **64**, 746–751.
- Bilos, C.; Colombo, J. C.; Rodríguez Presa, M. J., 1998: Trace metal in suspended particles, sediments and Asiatic clams (*Corbicula fluminea*) of the Río de la Plata Estuary, Argentina. *Environ. Pollut.* **99**, 1–11.
- Boltovskoy, D.; Cataldo, D. H., 1999: Population dynamics of *Limnoperna fortunei*, an invasive fouling mollusc, in the Lower Paraná River (Argentina). *Biofouling* **14**, 255–263.
- Cabrera, S. E., 1962: La alimentación natural del pejerrey del Río de la Plata. *Dir. Gral. Pesca, Secret. Agric. Ganad.*, Buenos Aires. 53 pp.
- Cabrera, S. E.; De Lourdes Baiz, M.; Christiansen, H. E.; Candia, C. R., 1973: Algunos aspectos biológicos de las especies de ictiofauna de la zona de Punta Lara (Río de la Plata). I. Parte alimentación natural del pejerrey (*Basilichthys bonariensis*). *Serv. Hidrogr. Nav.*, Buenos Aires, 29 pp.
- de Castellanos, Z. J. A.; de Gaillard, M. C., 1981: Mollusca Gasteropoda Chiliniidae. Fauna de agua dulce de la República Argentina **15**, 21–51.
- Cataldo, D. H.; Colombo, J. C.; Boltovskoy, D. C.; Bilos, C.; Landoni, P., 2001: Environmental toxicity assessment in the Paraná River delta (Argentina): simultaneous evaluation of selected pollutants and mortality rates of *Corbicula fluminea* (Bivalvia) early juveniles. *Environ. Pollut.* **112**, 379–389.
- Colautti, D. C.; Garcia de Souza, J. R.; Balboni, L.; Baigún, C. R. M., 2010: Extensive cage culture of pejerrey (*Odontesthes bonariensis*) in a shallow pampean lake in Argentina. *Aquac. Res.* **41**, 376–384.
- Colombo, J. C.; Brochu, C.; Bilos, C.; Landoni, P.; Moore, S., 1997: Long-term accumulation of individual PCBs, dioxins, furans, and trace metals in Asiatic clams from the Río de la Plata Estuary, Argentina. *Environ. Sci. Technol.* **31**, 3551–3557.
- Colombo, J. C.; Bilos, C.; Remes Lenicov, M.; Colautti, D.; Landoni, P.; Brochu, C., 2000: Detritivorous fish contamination in the Río de la Plata estuary: a critical accumulation pathway in the cycle of anthropogenic compounds. *Can. J. Fish Aquat. Sci.* **57**, 1139–1150.

- Darrigran, G., 2002: Potential impact of filter feeding invaders on temperate inland freshwater environments. *Biol. Invasions* **4**, 145–156.
- Darrigran, G.; Damborenea, C., 2006: Características de la especie. In: Bio-invasión del mejillón dorado en el continente americano. G. Darrigran, C. Damborenea (Eds). Edulp, La Plata, pp. 55–69.
- Escalante, A., 1985: Alimentación del pejerrey *Basilichthys bonariensis bonariensis* (Osteichthyes, Atherinidae) del embalse Río Tercero, provincia de Córdoba. *Neotrópica* **31**, 22–26.
- Freyre, L. R.; Colautti, D. C.; Maroñas, M. E.; Sendra, E. D.; Remes Lenicov, M., 2009: Seasonal changes in the somatic indices of the freshwater silverside, *Odontesthes bonariensis* (Teleostei, Atheriniformes) from a Neotropical shallow lake (Argentina). *Braz. J. Biol.* **69**, 389–395.
- de Gaillard, M. C.; de Castellanos, Z. A., 1976: Mollusca Gasteropoda Hydrobiidae. Fauna de agua dulce de la República Argentina **15**, 7–40.
- García de Souza, J. R.; Solimano, P. J.; Maiztegui, T.; Baigún, C. R. M.; Colautti, D. C., 2013: Effects of stocking density and natural food availability on the extensive cage culture of pejerrey (*Odontesthes bonariensis*) in a shallow Pampean lake in Argentina. *Aquac. Res.* **45**, 1–13.
- García, M. L.; Protogino, L. C., 2005: Invasive freshwater molluscs are consumed by native fishes in South America. *J. Appl. Ichthyol.* **21**, 34–38.
- Grosman, F., 1995: Variación estacional en la dieta del pejerrey (*Odontesthes bonariensis*). *Rev. Asoc. Cienc. Nat. Litoral* **26**, 9–18.
- Hyslop, E. J., 1980: Stomach content análisis a review of methods and their application. *J. Fish Biol.* **17**, 411–429.
- Ituarte, C., 1981: Primera noticia acerca de la introducción de pelecípodos asiáticos en el área rioplatense (Mollusca, Corbiculidae). *Neotrópica* **27**, 79–83.
- López Armengol, M. F., 1996: Taxonomic revision of *Potamolithus agapetus* Pilsbry, 1911, and *Potamolithus buschii* (Frauenfeld, 1865) (Gastropoda: Hydrobiidae). *Malacologia* **38**, 1–17.
- Pastorino, G.; Darrigran, G.; Martin, S.; Lunaschi, L., 1993: *Limnoperna fortunei* (Dunker 1857) nuevo bivalvo invasor en aguas del Río de La Plata. *Neotrópica* **39**, 101–102.
- Pittau, M.; Sarubbi, A.; Menéndez, A., 2003: Análisis del avance del Frente y del incremento areal del Delta del Río Paraná. Informe del Instituto Nacional del Agua (INA), Buenos Aires, Argentina. Available at: http://laboratorios.fi.uba.ar/lmm/congresos/cc_delta_frentes_conagua_may05.pdf (accessed on 1 April 2014).
- Ringuelet, R. A., 1942: El pejerrey (*Odontesthes bonariensis*) del Embalse Anzulón (La Rioja). *Notas del Museo de La Plata* **7**, 177–200.
- Ringuelet, R. A.; Iriart, R.; Escalante, A. H., 1980: Alimentación del pejerrey (*Basilichthys bonariensis*, Atherinidae) en la Laguna Chascomús (Buenos Aires, Argentina). *Relaciones Ecológicas de Complementación y Eficiencia Trófica del Plancton*. *Limnobiología* **1**, 448–460.
- Schmidlin, S.; Baur, B., 2007: Distribution and substrate preference of the invasive clam *Corbicula fluminea* in the river Rhine in the region of Basel (Switzerland, Germany, France). *Aquat. Sci.* **69**, 153–161.
- Somoza, G. M.; Miranda, L. A.; Berasain, G. E.; Colautti, D. C.; Remes Lenicov, M.; Strüssmann, C., 2008: Historical aspects, current status and prospects of pejerrey aquaculture in South America. *Aquac. Res.* **39**, 784–793.
- Spaceesi, F. G.; Rodrigues Capítulo, A., 2012: Benthic communities on hard substrates covered by *Limnoperna fortunei* Dunker (Bivalvia, Mytilidae) at an estuarine beach (Río de la Plata, Argentina). *J. Limnol.* **71**, 144–153.
- Villar, C.; Stripeikis, J.; D’Huicque, L.; Tudino, M.; Troccoli, O.; Bonetto, C., 1999: Cd, Cu and Zn concentrations in sediments and the invasive bivalves *Limnoperna fortunei* and *Corbicula fluminea* at the Río de la Plata basin, Argentina. *Hydrobiologia* **416**, 41–49.
- Villar, C.; Stripeikis, J.; Colautti, D.; D’Huicque, L.; Tudino, M.; Bonetto, C., 2001: Metals contents in two fishes of different feeding behaviour in the Lower Paraná River and Río de la Plata Estuary. *Hydrobiologia* **457**, 225–233.
- Author’s address:** Florencia Brancolini, Instituto de Limnología ‘Dr. Raúl A. Ringuelet’ (CONICET-UNLP), CC 712 (1900) La Plata, Buenos Aires, Argentina.
E-mail: fbrancolini@ilpla.edu.ar