

PREDATION OF THE INVASIVE FRESHWATER MUSSEL *LIMNOPERNA FORTUNEI* (DUNKER, 1857) (MYTILIDAE) BY THE FISH *LEPORINUS OBTUSIDENS* VALENCIENNES, 1846 (ANOSTOMIDAE) IN THE RIO DE LA PLATA, ARGENTINA

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ABSTRACT A study of the presence of the freshwater mussel *Limnoperna fortunei* in the diet of the native fish *Leporinus obtusidens* was performed in Costanera Norte, Buenos Aires. Fish were collected monthly for a 1-year period to analyze their digestive tracts. From a total of 157 fish collected (20–55 cm total length), 21 had empty digestive tracts. Of the remaining 136 individuals, 98 (72.1%) contained fragments of *Limnoperna* shells. The mussel represented 14.5% of the stomach content dry weight and 44.4% of the intestinal content dry weight. *Limnoperna* was present in almost all fish over 30 cm (total length). The largest number of mussels ingested by a *Leporinus* individual was 77, estimated by mussel beak count. Mussels 15–20 mm in shell length to be the most abundant in *Leporinus* digestive tract.

KEY WORDS: Invasive mussel, *Limnoperna* control, fish predation

INTRODUCTION

Limnoperna fortunei (Dunker 1857) arrived in Río de la Plata, Argentina, in the early 1990s (Pastorino et al. 1993). The mussel attaches to any available hard substrate using byssal threads and can form dense aggregations. The rapid expansion and the high densities achieved in the Río de la Plata and the Paraná basin (80,000 individuals per square meter recorded in 1993, Darrigran and Pastorino 1995; and more than 100,000 in 1995, Darrigran et al. 1998) give the impression that *L. fortunei* has not encountered local competitors, predators, or parasites.

A counter example is the Zebra mussel, *Dreissena polymorpha* (Pallas 1754), which invaded North America in the mid- 1980s. In laboratory conditions small Zebra mussels (< 8 mm in shell length) are preyed upon by Crayfish (Love and Savino 1993, MacIsaac 1994), and by the blue crab in estuarine conditions (Molloy et al. 1994). Several fish have been reported as significant predators of the Zebra mussel (French and Bur 1993, Marsden 1997, Tucker et al. 1996).

In Argentina, Darrigran and Colauti (1994) reported the importance of the native fish *Pterodoras granulosus* (Valenciennes 1833) as a predator on *Corbicula fluminea* (Müller 1774), another invasive freshwater species.

To identify possible predators of *Limnoperna fortunei* in the Río de la Plata, an analysis of fish gut contents caught in Costanera Norte, Buenos Aires was performed. Preliminary results showed that native *Leporinus obtusidens*, as well as being the dominant catch was a relevant predator of *Limnoperna fortunei* (Penchaszadeh et al. 1998). This paper is a specific study of the presence of the *L. fortunei* in the diet of *L. obtusidens*.

Leporinus obtusidens ("boga" is the common local name) has a small conic head, rounded snout, well-developed lips, and small frontal teeth in the mouth. Each maxillary has a single row of chisel-shaped teeth pointing forward, the two anterior being longer than the others: the name of the genus refers to this characteristic, this kind of dentition is reminiscent of leporinid rodents.

MATERIAL AND METHODS

Fish were collected from sports fishermen from March 1998 to February 1999 in Costanera Norte, Río de la Plata, 34°34'S, 58°23'W; a location heavily colonized by *Limnoperna*. The tidal regime is mixed, although predominantly semidiurnal with a tidal range of 0.63 to 1.07 m. Water levels and currents are strongly influenced by meteorological conditions, mainly wind direction and intensity, the most important of which is the "Sudestada." This is characterized by a gradual and persistent increase in wind speed blowing from the SE to the SSE, during which time, winds can pick up to around 25 m/sec (Guerrero et al. 1997). Heavy rain in the Parana basin can also strongly influence water levels. Mean surface water temperature values for Costanera Norte are: summer (January to March) 24.07 ± 2.01 °C; fall (April to June) 13.83 ± 4.68; winter (July to September) 14.63 ± 2.00 and spring (October to December) 21.04 ± 0.11.

Fish length was measured to the nearest 1 cm and then dissected *in situ*. The entire digestive tract was removed and preserved in a 10% formalin solution. In the laboratory, stomach and intestine contents of each *Leporinus* were analyzed under a dissecting microscope and separated into *Limnoperna* shells and other material. Then, the dry weight (80 °C until constant weight was achieved) of the two groups was taken.

Limnoperna beaks (anterior portion of the valve containing the umbral region) were counted, the total number then divided by two was the estimated number of *Limnoperna* contained in each fish. To estimate the length of the mussels consumed, *Limnoperna* individuals were collected from the same fishing site in January, 1999. These mussels were then measured and separated into four size ranges. Ten mussels from each category were weighed, and a proportion of shell length to shell weight was obtained for each category. The total shell weight in the digestive tract of each fish was then divided by the number of *Limnoperna* eaten, estimated by the beak count.

RESULTS

Of the 157 *Leporinus* analyzed, the digestive tracts of 21 were empty. Of the remaining 136 individuals, 98 (72.1%) had fragments of *Limnoperna* shells in the stomach, the intestine, or both (Table 1). *Limnoperna* shells represented 14.5% of the stomach content dry weight and 44.4% of the intestinal content dry weight. Considering the entire digestive tract, 33.4% of the content dry weight was *Limnoperna* shells. The digestive tracts did not show damage or bleeding, although they were sometimes fully packed with shell fragments.

Limnoperna was present in the diet of *Leporinus* during almost the entire year of sampling. Lowest values occurred during winter (June–August) when mussel shells were found in only 40, 14, and 0% of analyzed fish, respectively (Table 1). Winter was also the season of lowest *Leporinus* catch in the study area.

Except for six individuals, *Limnoperna* was present in all fish (47) over 30 cm (total length) with material in their digestive tract. The presence of *Limnoperna* in the *Leporinus* digestive tract was maximum during the period from October to February (83 to 100%).

The largest number of mussels ingested by a *Leporinus* individual was 77 (beak count method). According to the shell length–weight proportion found (Table 2), the 10 fish with the largest number of ingested mussels contained various sizes of prey. The mean shell weight ranged between 0.012–0.020g (<10 mm of shell length, 20%), 0.03–0.068g (10–15 mm of shell length; 70%) and 0.175 g (15–20 mm of shell length; 10%). These results indicate that *Limnoperna* of between 10–15 mm in shell length were the most abundant in *Leporinus* digestive tract.

In 36 cases, entire *Limnoperna* individuals with unbroken shells and intact soft tissue were found in the digestive tract of *Leporinus*. Mussels measured between 1.5 and 5.7 mm in shell length and fish ranged 26.0 to 33.0 cm (total length).

Aquarium observations (M. Brögger, pers. comm.) show that *Leporinus* do not always remove the entire mussel from its substrate; on several occasions fragmented mussels with the beak area still attached to the substrate were observed. Other mussels >30 mm had bite marks on the periostracum.

DISCUSSION

Before the *Limnoperna* invasion there were few published reports on *Leporinus obtusidens* diet, and almost all of these are confined to the middle Parana river region (Mastrarrigo 1950, De Occhi and Oliveros 1974).

Mastrarrigo (1950) defined the alimentary regime of *Leporinus* as mainly omnivorous, with a high proportion of aquatic vegetation (in the case of at least 72% of the fish analyzed in Rosario, middle Paraná), but also mentioned the presence of a small proportion of fragmented river snails in the gut. Snails were referred to as the main food for *Leporinus* in the Uruguay river (Gualedguaychú, Entre Ríos), where their digestive tracts are often full of shell fragments. Mastrarrigo (1950), commented that local fishermen called them "bogas caracolas" ("snail-eating bogas").

According to De Occhi and Oliveros (1974), mollusks were present in 32% of the examined *Leporinus* (5% bivalves and 27% gastropods, basically *Helobia* sp.; however, seeds and fruits were always dominant (37%). They believe that in *Leporinus obtusidens* because of the disposition of the pharyngeal teeth, these are used only to crumble soft material, because they lack crushing surfaces; whereas, fragmentation is achieved by action of the oral teeth.

Aquarium observations show that *Leporinus* did not always ingest the entire prey; instead, they bit off only a portion of the mussel (the bivalve was not completely removed from the substrate on many occasions). These observations suggest that there could be a underestimation in the amount of ingested mussels calculated by the beak counting method. This also could lead to an overestimation in the calculated size of ingested mussels.

The weight of *Limnoperna* in the fish digestive tracts could also be underestimated, because the soft material was weighed as a whole (with certain contribution of mussel tissue).

Differences observed in the amount of *Limnoperna* shell found in the stomach content (14.5%) and intestine content (44.0%) could indicate that *Leporinus* is preferentially an early-morning feeder, because all of the studied material was captured between 12:00 m. and 5:00 p.m.

The most abundant *Limnoperna* sizes in *Leporinus* digestive tracts were 10–15 mm in length. According to Boltovskoy and Cataldo (in press), who estimated *Limnoperna* growth in experi-

TABLE 1.

Presence of the freshwater mussel *Limnoperna fortunei* in the digestive tract of the fish *Leporinus obtusidens* in Costanera Norte, Buenos Aires (1998–1999).

Month	n	Fish Length (cm)			Digestive Tract with Contents (%)	Presence of <i>L. fortunei</i> in the Contents (%)
		Mean	SD	Range		
March	14	26.8	3.6	20–33	92.86	69.23
April	13	28.9	8.6	20–55	76.9	60
May	41	26.5	5.1	10.5–43	75.6	70.96
June	6	27.1	3.2	21–30	83.4	40
July	8	26.5	1.7	24–29	87.5	14.28
August	2	27.5	4.9	24–31	50	0.0
September	16	28.6	4.0	22–37	86.7	53.85
October	8	31.6	2.7	28–35	87.5	100
November	7	27.1	5.4	17–33.5	85.7	83.3
December	18	30.8	4.2	22.5–37	100	94.4
January	17	31.8	4.4	24–39	100	88.2
February	7	27.9	4.1	20–33	100	85.7
Total	157	28.4	5.1	10.5–55	86.6	72.1

TABLE 2.

Proportion of shell length to shell weight for four size-range groups of *Limnoperna fortunei*.

Shell length (mm) (anterior to posterior)	5-10	10-15	15-20	20-25
Shell weight (g)	0.022	0.067	0.172	0.317

mental conditions, these sizes correspond to mussels 3 to 6 months old.

The presence of *Limnoperna*, with its extraordinary abundance, occupying a seemingly empty niche in the Plata basin, has introduced a new element in the diet of some fish and constitutes the

main food item for *Leporinus obtusidens*. Although other predators have yet to be identified, the "boga" has proved to be an important natural enemy of the invading mussel, *Limnoperna fortunei*.

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