

The Recent Introduction of a Freshwater Asiatic Bivalve, *Limnoperna fortunei* (Mytilidae) into South America

by

GUSTAVO DARRIGRAN

Departamento Científico Zoología Invertebrados, Museo de Ciencias Naturales,
Paseo del Bosque s/n, 1900 La Plata—Buenos Aires, Argentina

AND

GUIDO PASTORINO

División Paleozoología Invertebrados, Museo de Ciencias Naturales,
Paseo del Bosque s/n, 1900 La Plata—Buenos Aires, Argentina

Abstract. The temporal and spatial distribution of *Limnoperna fortunei* in the Argentine littoral of the Río de la Plata is reported. Its distribution is limited by the most contaminated area and by an increment in the saline concentration. A decrease in density was recorded between August 1992 and January 1993. Subsequently there was an increase in density up to a maximum of 82,000 ind·m⁻² in May 1993. It is concluded that because of its functional and morphological characteristics, *L. fortunei* will spread quickly. With *Corbicula fluminea* and *C. largillierii*, *Limnoperna fortunei* is the third invading species to be introduced into South America from Southeast Asia. Its possible entry into Argentina, by trading ships from Korea and Hong Kong, is suggested. Import peaks correspond with the estimated arrival of these three invaders.

INTRODUCTION

Limnoperna fortunei (Dunker, 1857) (Mytilidae) is a freshwater species, which is found in rivers and streams of China and Southeast Asia (Morton, 1977). It was first discovered in South America in 1991, at Bagliardi (34°55'S–57°49'W) (Darrigran et al., 1993; Pastorino et al., 1993).

A great diversity of mollusks occurs along the littoral of the Río de la Plata, Argentina, and 27 species of gastropods and 23 species of bivalves have been recorded (Darrigran, 1991). There are six species of freshwater, infaunal bivalves, i.e., *Corbicula fluminea* (Müller, 1774), *C. largillierii* (Philippi, 1811), *Anodontites tenebricosus* (Lea, 1834), *Diplodon paranensis* (Lea, 1834), *Musculium argentinum* (d'Orbigny, 1835), and *Pisidium sterkianum* Pilsbry, 1897.

The only species of Mytilidae recorded from the Río de la Plata is *Mytella charruana* (d'Orbigny, 1842) (= *M. falcata* (d'Orbigny, 1842)), which occurs in Punta Piedras, Buenos Aires, Argentina (35°26'S–57°8'W) and in Montevideo, Uruguay (Darrigran, 1991).

The aim of the present work is to report upon the temporal and spatial distribution of *Limnoperna fortunei* (Dunker) in the littoral of the Río de la Plata, Argentina, and identify its way of arrival.

MATERIALS AND METHODS

Limnoperna fortunei populations occur on all available hard substrates such as trunks, roots, and stones, even on those placed artificially for coastal stabilization. In this case, they are found in the interstices formed by the piles of stones.

During summer 1993, samples were obtained from 10 littoral localities (Figure 1, Table 1). The discontinuous settlement of *L. fortunei* made the taking of samples difficult by uniform sampling protocol. Consequently, the area of the sampling quadrats varied according to the heterogeneity of the habitat. Taking into account such temporal variability, sampling was undertaken at approximately 60 day intervals in the locality where *L. fortunei* was first recorded from (Bagliardi).

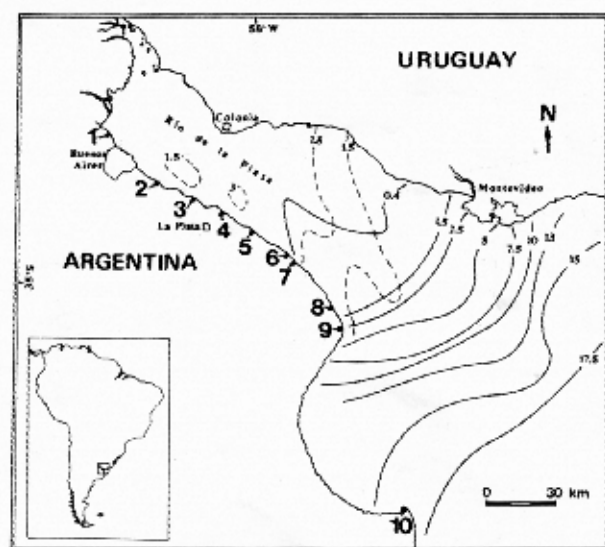


Figure 1

Map showing the sampling localities and isohalines along the Río de la Plata. Continuous lines correspond to average salinities during the 1982–1987 period; Broken lines correspond to an abnormal saline intrusion on 10 March 1984 (taken from Comisión Administradora del Río de la Plata, 1989). 1—Anchorena, 2—Quilmes, 3—Punta Lara, 4—Bagliardi, 5—Punta Blanca, 6—Atalaya, 7—Magdalena, 8—Punta Indio, 9—Punta Piedras, 10—Punta Rasa.

Values of average density were obtained using the following formula:

$$D = [\Sigma(n/a)/M]$$

where:

D: the average number of individuals $\cdot m^{-2}$

M: total number of samples

n: number of individuals sampled $\cdot m^{-1}$

a: sampled area

To determine the possible introduction route, trade statistics between Argentina and the countries where this species is found, were analyzed. These values indirectly

express the number of ships that may have introduced it (Morton, 1987). Data were taken from the National Institute of Statistics and Census of the Argentine Republic (Instituto Nacional de Estadísticas y Censos—I.N.D.E.C., 1987–1991).

RESULTS

Description of the Environment

A marked temporal and spatial variability in salinity characterizes the Río de la Plata. Studies carried out on the littoral macrobenthos, showed that the Río de la Plata is freshwater from its origin up to an imaginary line linking Colonia (Uruguay) with La Plata (Argentina) (Darrigran, 1991). The remaining part is a large zone of poikilohaline waters whose temporal and spatial variation in salinity oscillates between 0.05‰ at the head to >25‰ at the river mouth.

The distribution of the littoral sedimentary facies shows a stepped arrangement of texture, being sandy at the river head and caliche at the mouth. Only in sampling localities 1 and 9 (Figure 1) was it possible to find caliche (natural hard substrata) or vegetation (sampling locality 5). Elsewhere, the scarce available hard substrata is anthropogenic (walls and piers).

The distribution pattern of *Limnoperna fortunei* is limited by a highly contaminated zone (localities 1 and 2) and by high salinities (localities 9 and 10). Table 2 shows several parameters of water quality. Sample localities 1 and 2 coincide with areas more polluted than the others, probably because of the proximity of factories and sewage of Buenos Aires City. Southward the pollution decreases and the salinity increases (see Table 2 and Figure 1). Low density at site 5 results from a lack of available hard substrata, since only roots and stems of *Scirpus californicus* (C. A. Mey) Steud. occur here (Figure 2).

Figure 3 shows the temporal variation in *Limnoperna fortunei* densities at Bagliardi. It was first found here, in September 1991, as isolated groups of five or six individuals. In May 1992, the average density was 31,222 individuals $\cdot m^{-2}$; a decrease was then observed from August

Table 1

Sample localities on the coast of the Río de la Plata (n = number of samples).

Sample localities		Date	n	Substrata
1. Anchorena	34°29'S–58°28'W	03/93	–	caliche
2. Quilmes	34°45'S–58°13'W	02/93	–	stones
3. Punta Lara	34°48'S–57°59'W	01/93	3	stones
4. Bagliardi	34°55'S–57°49'W	02/93	3	stones
5. Punta Blanca	34°56'S–57°40'W	05/93	2	sand/roots
6. Atalaya	35°00'S–57°33'W	01/93	2	stones
7. Magdalena	35°01'S–57°31'W	01/93	2	stones
8. Punta Indio	35°15'S–57°14'W	03/93	2	stones
9. Punta Piedras	35°26'S–57°08'W	03/93	3	caliche
10. Punta Rasa	35°46'S–56°50'W	03/93	–	caliche/stones

Table 2

Parameters of water quality (taken from A.G.O.S.B.A., O.S.N., S.I.H.N., 1992). DO = dissolved oxygen, mg $O_2 \cdot L^{-1}$; BDO = biological oxygen demand, mg $O_2 \cdot L^{-1}$; COD = chemical oxygen demand, mg $O_2 \cdot L^{-1}$; C = chlorides, mg L^{-1} ; S = sulfates, mg L^{-1} ; SM = suspension material, mg L^{-1} ; T = turbidity, NTU; Na, Pb, K, mg L^{-1} ; As, $\mu g \cdot L^{-1}$

Localities	Parameters										
	DO	BDO	COD	C	S	SM	T	Na	Pb	As	K
San Isidro 34°28'S-58°28'W	3.4	1.3	14.2	16	18	145	28	15.8	6	6.4	2.6
Palermo 34°34'S-58°25'W	3.2	3.5	4.2	19	15	87.9	50	19.8	18	6.4	3.7
Riachuelo 34°38'S-58°21'W	0.0	3.9	16.9	46	—	27.6	49	46.7	10	10.4	4.2
Santo Domingo 34°39'S-58°18'W	2.5	3.3	22.0	29	22	70.8	24	32.5	13	7.5	32.5
Bernal 34°43'S-58°19'W	4.5	10.4	17.0	48	—	43.4	—	52.3	15	10.4	4.2
Berazategui 34°45'S-58°11'W	3.1	11.1	30.0	40	27	2.4	28	41.9	8	9.6	3.8
Punta Colorada 34°46'S-58°08'W	0.2	11.6	30.0	36	20	35.8	35	37.8	13	8.6	4.2
Punta Lara 34°48'S-57°59'W	1.7	0.5	30.0	32	22	37.0	28	33.7	16	7.5	3.7
Water pumping 34°49'S-57°55'W	4.7	5.3	11.7	31	20	35.4	39	31.6	3	6.8	3.7
Sewage, Spill-Out 34°52'S-57°49'W	4.7	4.1	21.7	27	20	80.4	37	27.7	15	6.4	3.3

1992 to January 1993. Average density increased from February 1993 onward. The decrease in density recorded in March 1993 could be explained by a flooding of the Paraná River, the most important tributary of the Río de la Plata. In May 1993, it was 82,151 individuals m^{-2} , more than twice the numbers reported upon a year before.

DISCUSSION

Limnoperna fortunei is the third freshwater bivalve invading species which has used the Río de la Plata to enter South America. Ituarte (1981) reported the first occurrence in the Río de la Plata of two bivalve species from Southeast Asia: *Corbicula fluminea* (Müller, 1774) and *C. largillierii* (Philippi, 1844). Adaptive and reproductive characteristics allowed *C. fluminea* to expand rapidly in the Río de la

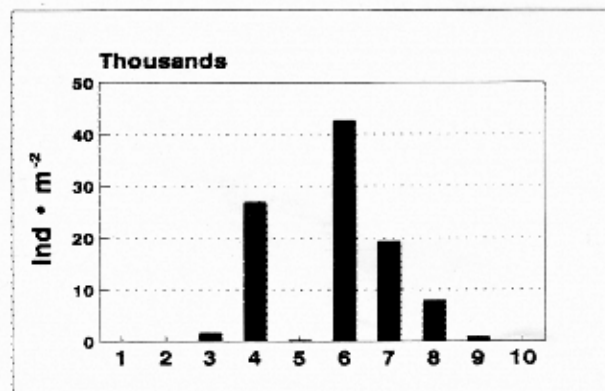


Figure 2

Average density of *Limnoperna fortunei* at each sampling locality (see Table 1). 1—Anchorena, 2—Quilmes, 3—Punta Lara, 4—Bagliardi, 5—Punta Blanca, 6—Atalaya, 7—Magdalena, 8—Punta Indio, 9—Punta Piedras, 10—Punta Rasa. Ind = individuals.

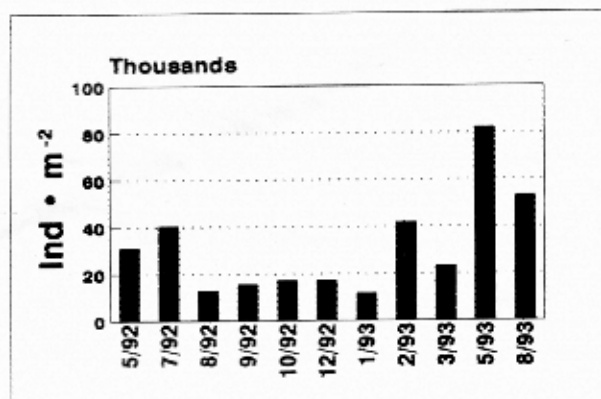


Figure 3

Average density of *Limnoperna fortunei* at the sampling locality at Bagliardi from May 1992 to September 1993. Ind = individuals.

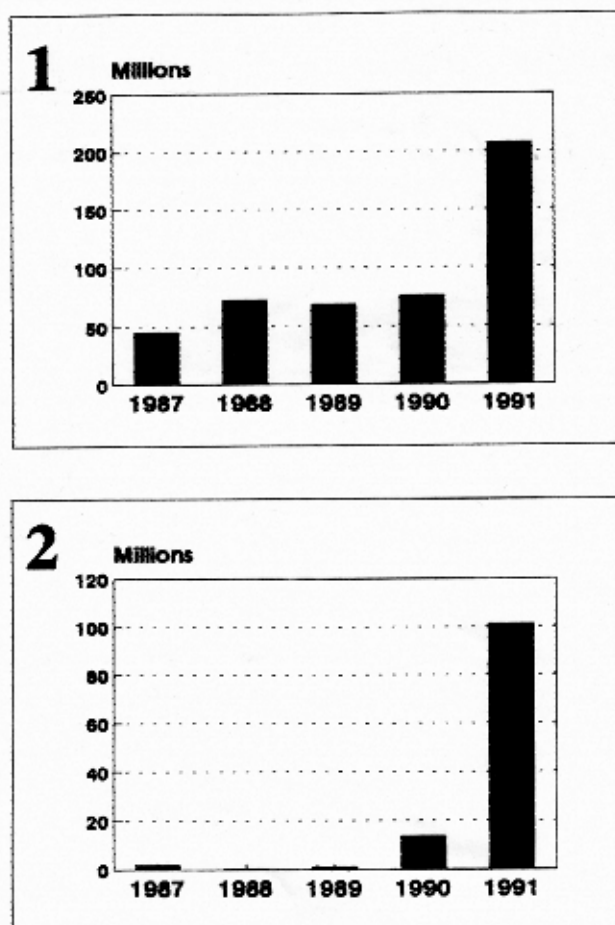


Figure 4

Argentine imports from Korea (1) and Hong Kong (2) from 1987 to 1991 in United States dollars (taken from I.N.D.E.C., 1987-91).

Plata estuary (Darrigran 1992), but also in the rivers Paraná and Uruguay. Corigliano & Malpassi (1993) have reported upon the presence of the genus *Corbicula* in the central part of Argentina (32°30'S-62°30'W), illustrating its potential for continuous expansion.

Trade by those countries where these invading species live, is carried out by ship. Allen (1953), Carlton (1992), and recently Carlton & Geller (1993) have argued for stricter controls of vessels departing such countries with a view to limiting the chances of introductions.

Ituarte (1981) suggests that *Corbicula* was introduced to Argentina between 1965 and 1975. Argentinian imports from Southeast Asian countries during that period were increased. In addition, this species is used as food in Asia; it may have been introduced alive for crew consumption.

A similar analysis may be done regarding *Limnoperna fortunei*. Continuous sampling in the Río de la Plata supports the suggestion that this species was introduced in

1991. Figure 4 shows the increase in Argentinian imports from Hong Kong and Korea. As the country with the steepest increment in imports is Hong Kong (more than fivefold times) and the presence of *Limnoperna fortunei* is confirmed (Morton, 1987), it seems to be the source of the Argentinian population of this species. Although it is not used as food, it may have been transported in tanks containing untreated fresh water.

Morton (1973) reported that *Limnoperna fortunei* has morpho-functional characteristics which would allow its rapid introduction elsewhere, as with *Corbicula fluminea* (Müller) in the United States and *Dreissena polymorpha* (Pallas, 1771) in Europe and North America (Hunter & Bailey, 1992).

Limnoperna fortunei has become ecologically and economically important because of the following factors: (1) Its epibyssate habit has no competition in the Río de la Plata littoral. (2) This species has a high biotic potential. Its invasion involves biofouling processes, affecting potable water supply systems for either human consumption or industrial use.

A stricter biological control of overseas ships is argued for.

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