INTERNATIONAL MARITIME ORGANIZATION

IMO

MEPC 40/10/1
10 June 1997
Original: SPANISH

MARINE ENVIRONMENT PROTECTION COMMITTEE
40th session
Agenda item 10

HARMFUL AQUATIC ORGANISMS IN BALLAST WATER

Appearance of non-indigenous bivalves in the River Plate and its tributaries

Submitted by Argentina

SUMMARY	
Executive summary:	This document contains the findings of a scientific study carried out by the University of La Plata (Argentina), on the appearance of non-indigenous bivalves in the River Plate estuary, and the causes.
Action to be taken:	Note the information.
Related documents:	MEPC 38/INF.26; MEPC 39/7.

1 The Marine Environment Protection Committee, at its thirty-ninth session, submitted document MEPC 39/7 containing the report of the Working Group on Ballast Water, convened during the previous period, in which various documents were mentioned that had been drawn up by the Secretariat and some Member States in order to identify different aspects of the problem and possible solutions to them.

2 Two of the reports were of particular interest to Argentina from the point of view of ecological risk and potential damage: document MEPC 38/INF.26, submitted by Germany, on the introduction of non-indigenous organisms into the North and Baltic Seas by ship traffic, and Australia's contribution to the review of intersessional activities, on a ballast water management strategy.

3 In this respect, it is noteworthy that while there are numerous documents containing proposals for the treatment, exchange (renewal) and/or discharge of ships' ballast water, relatively little mention is made of harmful or unwanted organisms, apart from in the documents mentioned above.

4 Argentina would like to bring to the attention of the Committee and the *ad hoc* working group, the fact that for a number of years, fresh water bivalves, originating mainly in eastern Asia, have been found in the River Plate, and more recently, in growing numbers, in the other rivers of the estuary.

5 The beds of the River Plate and its tributaries are formed of sediment, for the most part without a solid substrate (rock). The absence of natural predators in the local environment has enabled these non-indigenous organisms to reproduce at an alarming and uncontrolled rate. In order to survive, they have established themselves on wharves, fixed structures, drain outlets and industrial and drinking water inlet pipes where they cause blockages. This has damaging repercussions as regards both water purity and maintenance costs.

6 The problems mentioned, for which no solution has yet been found, are now being investigated and monitored by centres of higher education, such as the Faculty of Natural Sciences and the Museum of the National University of La Plata. The findings contained in this document, which was sponsored by the Faculty's Secretariat for Investigation and Transfer, provide an in-depth study of the problem, as well as identifying its possible causes.

7 The research shows that the molluscs had originally arrived in the form of "colonizing" organisms in the ballast water of cargo ships from South East Asian ports. A direct relationship was thus established between the appearance of the molluscs and an increase in bilateral trade relations - and consequently in maritime traffic - between the two regions, information which merited publication in the Argentine scientific journal, "Ciencia Hoy" ("Science Today") (Vol. 7 - No. 38-1997), and in the distinguished journal of malacology, "The Veliger", of the California Malacological Society (Vol. 38-No. 2-1995).

8 Argentina is bringing this information to the Committee's attention in order to highlight the need for urgent measures to solve the problem, in the light of principle 15 of the Rio Declaration endorsed by UNCED, and resolution MEPC.67(37).

INTRODUCTION OF HARMFUL AQUATIC ORGANISMS

BIVALVES, RIVER PLATE

Dr Gustavo A. DARRIGRAN*

* **Depto. Científico Zoología Invertebrados. Museo de La Plata.**
Universidad Nacional de La Plata (UNLP).
Paseo del Bosque s/nº (1900) La Plata. ARGENTINA.
Researcher for the Consejo Nacional de Investigaciones Científicas y Estudios Tecnológicos (CONICET).
E-mail: darrigra *arroba* isis.unlp.edu.ar

Introduction

The major ports of Buenos Aires and La Plata are situated on the River Plate (fig.1). In general, the local environment is characterized by marked seasonal variations in salinity. Research carried out on the macrobenthos associated with the river bank shows that the River Plate comprises an area inhabited by fresh water organisms, which extends from its source to an imaginary line between Colonia in Uruguay and La Plata in Argentina, and a large area of water inhabited by estuarine organisms, which has a seasonal variation of salinity of between 0.5 at the upper limit of the area and over 25 at the river mouth.

Sediment near the river bank varies in texture from sand near the source to clayey mud near the river mouth. Only in sampling stations 1 and 9 (fig.1), was there any sign of "caliche" (saltpetre). The scanty remains of a solid substrate on the Argentine side is man-made (embankment walls, jetties, etc.).

Many different species of mollusc are to be found near the Argentine bank of the River Plate: 27 species of gastropod and 23 species of bivalve (Darrigran, 1991). The only species from the Mytilidae family identified in the River Plate before 1991 was *Mytella charruana* (d'Orbigny, 1842) in Punta Piedras, Buenos Aires, Argentina (35°26'S-57°08'W) and Montevideo, Uruguay (Darrigran, 1991).

The accidental introduction of aquatic molluscs has become relatively commonplace with the increase in transoceanic traffic (Watters, 1997). The introduction of molluscs occurs in three ways:

1 **In ships' ballast water,** for example: the invasion of North America by:

A. The bivalve, "zebra mussel" *Dreissena polimorpha* (Pallas, 1771) and *D.bugensis* (Andrusov, 1897) from Spain.

B. The marine gastropod, *Philine auriformis* (Suter, 1909), from New Zealand.

The invasion from North America by:

C. The estuarial bivalve, *Mytilopsis leucophaeta* (Conrad, 1831), of Holland, France and Belgium.

D. The bivalve, *Mytilopsis sallei*, of India.

2 **As a food item or for aquaria,** for example:

A. The fresh-water bivalve, *Corbicula fluminea*, was introduced into the USA as a food item, (Watters, 1997).

B. Gastropoda ampullaridae, *Pomacea canaliculata*, was introduced into the Philippines from South America as a food item.

C. Gastropoda thiaridae, for display in aquaria, was repeatedly introduced into North America.

3 **The introduction of fish bearing the parasitic larvae of fresh-water bivalves.**

A. The bivalve, *Pseudodon vondembuschianus,* was introduced into Singapore from Indonesia through glochidia (the parasitic larvae of that species of fresh-water bivalve, present on non-indigenous fish).

B. The bivalve, *Anodonta woodiana* was introduced into North and Central America from Europe along with "carp", among other species.

The aims of this report are:

1 To show that harmful aquatic organisms (molluscs and bivalves) are being introduced near the Argentine bank of the River Plate;

2 To consider the implications of ships' ballast water acting as a reservoir and potential means of access for those organisms;

3 To demonstrate that the River Plate is a major means of access into South America for those organisms.

Development

Limnoperna fortunei (Dunker, 1857) (Mytilidae), is a species of fresh-water bivalve, indigenous to the rivers and streams of China and South East Asia (Morton, 1973). It was first recorded in South America in September 1991, at Balneario Bagliardi near the Argentine bank of the River Plate (34°55'S-57°49'W) (Pastorino et al., 1993).

Up until the end of 1993, there were no specimens of *L. fortunei* near the banks of the River Plate further north than Punta Lara (34°48'S; 57°59'W); nor was it to be found in any other country or river discharging into the River Plate estuary (fig.1).

By the end of 1994 and the beginning of 1995, it had been discovered in water inlets at Bernal (34°40'S; 58°14'W) and the port of Buenos Aires (34°35'S; 58°22'W). The species was also found for the first time near Colonia del Sacramento, Uruguay (34°28'S; 57°50'W) (Scarabino, 1995(1994)). These locations are all on the River Plate.

Towards the end of 1995, the first specimens of *L. fortunei* were taken from the River Paraná (fig.1,B) at Vuelta del Este, Zárate, on the River Paraná de Las Palmas (fig.1,B,I) and Paso Burghi, Rosario, on the River Paraná Inferior (fig.1,B,II). In 1996, many more specimens were found along the Paraná and connected bodies of water, on rubblework (River Salado del Norte) and marsh vegetation such as solanaceae (Rio Correntoso) and *Paspalum* sp. At the beginning of 1997, specimens of *L. fortunei* were discovered in the vegetable oil distillery, La Plata Cereal S.A., in Rosario, where it was causing "biofouling" of the company's water inlets on the River Paraná.

All this is evidence of the species' continued spread and adaptation to different conditions in the River Plate estuary and the more highly industrialized areas where it is causing "biofouling".

Limnoperna fortunei is the third species to invade South America via the River Plate. The presence of two species of bivalve from South East Asia, *Corbicula fluminea* (Müller, 1774) and *C. largillierti* (Philippi, 1844), was noted for the first time in South America, in the River Plate, by Ituarte (1981). Through its capacity to adapt and reproduce, *C. fluminea* spread rapidly, not only in the River Plate(Darrigran 1992), but also in the Paraná and Uruguay rivers. Corigliano and Malpassi (1993) note the presence of the genus *Corbicula* in central Argentina (32°30'S-62°30'W), providing confirmation of its continued spread. When *Corbicula fluminea* first arrived in North America during the 1930s it caused such havoc that it was commonly called "pest species".

Potential means of access

Invasions of this type can be caused by lax control systems for ballast water on ships coming from South East Asia.

For the purposes of investigating potential means of access, data on commercial activities carried out by the Republic of Argentina with countries from which the species may originally have been introduced, have been used. The data was collected by the National Institute of Statistics and Censuses (INDEC) of the Republic of Argentina. It indirectly reflects shipping flows between those countries and Argentina.

Ituarte (1981) identified the period between the end of 1960 and the beginning of 1970, as the time when the genus *Corbicula* first appeared in the River Plate. Figure 2 shows an increase in Argentine imports from south east countries during that period. The species is a food resource for the indigenous people of Asia, from which it might be deduced that specimens had been introduced by the crews of ships from the region.

A similar description could also be applied to *L. fortunei*. Through continuous sampling in the area, it can be demonstrated with certainty that the species first appeared in the River Plate in 1991. Figure 3 shows an increase in Argentine imports from countries where the species is a native. Though not used for food, it could have been transported entirely involuntarily in ships' ballast water.

Morton (1973) suggests that *L. fortunei* possesses a functional morphology which would enable it to spread rapidly, like *C. fluminea* in the United States, or *Dreissena polymorpha* (Pallas, 1771) in Europe and North America.

Two factors associated with *L. fortunei* give cause for concern in the region:

1 Because of its epibyssate habit, the species is not in competition with other bivalves living in the River Plate estuary;

2 It has a high potential for causing fouling and is currently responsible for biofouling of conduits carrying running water for human and industrial consumption.

Bibliography

CORIGLIANO, M. and MALPASI, R. 1993. Macroinvertebrados en la confluencia de dos ríos de llanura. **XVI Reunión Argentina Ecología, Resúmenes**:272.

DARRIGRAN, G.A. 1991. Aspectos ecológicos de la malacofauna litoral del Río de la Plata. Facultad de Ciencias Naturales y Museo - UNLP Thesis No. 568 (unpublished).

DARRIGRAN, G.A. 1992. Variación temporal y espacial de la distribución de las especies de *Corbicula* Megerle, 1811 (Bivalvia, Corbiculidae), en el estuario del Río de la Plata, República Argentina. **Neotropica**, 38(99):59-63.

ITUARTE, C.F. 1981. Primera noticia acerca de la introducción de pelecípodos asiáticos en el área rioplatense (Mollusca, Corbiculidae). **Neotropica**, 27(77):79-83.

MORTON, B. 1973. Some aspects of the biology and functional morphology of the organs of feeding and digestion of *Limnoperna fortunei* (Dunker) (Bivalvia: Mytilacea). **Malacología**, 12(2):265-281.

PASTORINO, G., DARRIGRAN, G., MARTIN, S. and LUNASCHI, L. 1993. *Limnoperna fortunei* (Dunker, 1857) (Mytilidae), nuevo bivalvo invasor en aguas del Río de la Plata. **Neotropica**, 39(101-102):34.

SCARABINO, F. and M. VERDE. 1994(1995). *Limnoperna fortunei* (Dunker, 1857) en la costa uruguaya del Río de la Plata (Bivalvia; Mytilidae). **Communicaciones Malacológicas del Uruguay**, 7(66-67):374-376.

References to figures

Figure 1. Rivers of the River Plate Estuary (A-H); A. - River Paraná; I. - River Paraná de las Palmas (Vuelta del Este, Zárate); II. - River Paraná Inferior (Paso Burghi, Rosario). B. - River Paraguay. C. - River Uruguay. D. - River Pilcomayo. E. - River Bermejo. F. - River Salado-Juramento. G. - River Salado del Sur. H. - River Plate.

Sampling stations and theoretical lines joining areas with the same salinity in the River Plate. Unbroken lines show salinity between 1982 and 1987. Broken lines show saline intrusion since 10 March 1984. 1. - Anchorena. 2. - Quilmes. 3. - Punta Lara. 4. - Balneario Bagliardi. 5. -Punta Blanca. 6. - Atalaya. 7. - Magdalena. 8. - Punta Indio. 9. - Punta Piedras. 10. - Punta Rasa. a. - Port of Buenos Aires. b. - Port of La Plata.

Figure 2. Argentine imports, in US dollars, from countries of South East Asia from 1965 to 1979. A. Thailand; B. Philippines; C. Japan; D. British overseas territories in Asia (principally Hong Kong).

Figure 3. Argentine imports, in US dollars, from countries of South East Asia from 1987 to 1991. A. Hong Kong; B. Thailand; C. Vietnam; D. Korea.

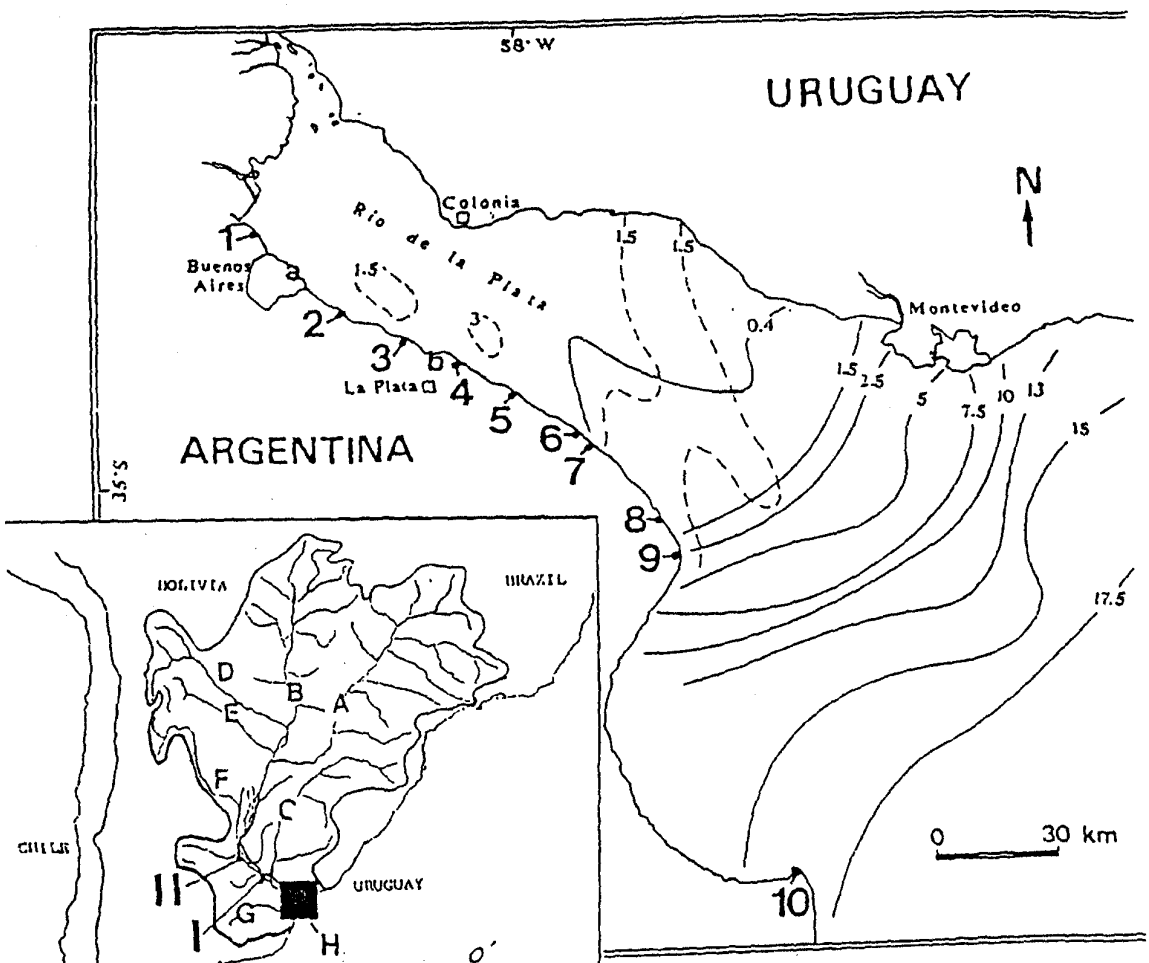

58° W
URUGUAY
N
Colonia
Río de la Plata
Buenos Aires
La Plata
Montevideo
ARGENTINA
35° S
1.5
0.4
2.5
5
7.5
10
13
15
17.5
0
30 km
1
2
3
4
5
6
7
8
9
10
BOLIVIA
BRAZIL
CHILE
URUGUAY
ARGENTINA
ATLANTIC O.
A
B
C
D
E
F
G
H
I
II
0
600 km

Fig. 1,A

Fig. 1,B

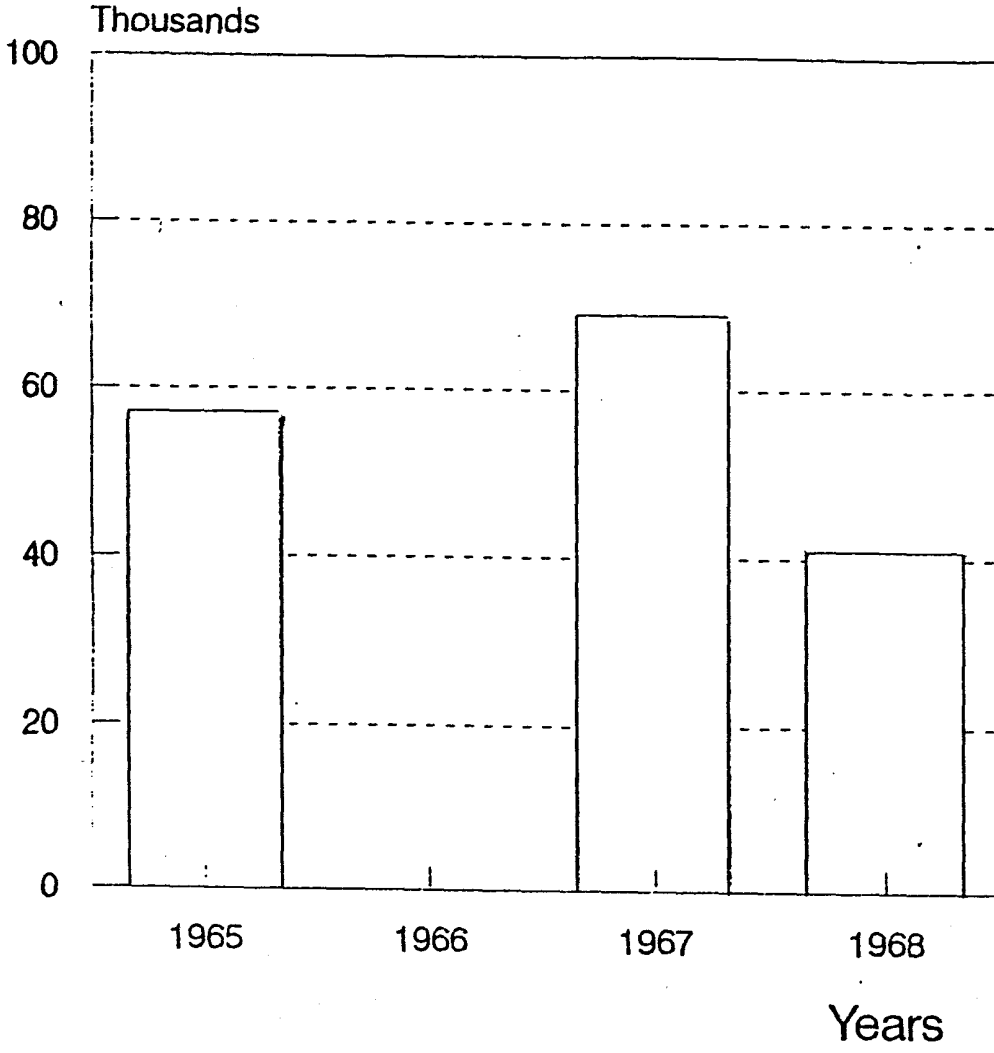
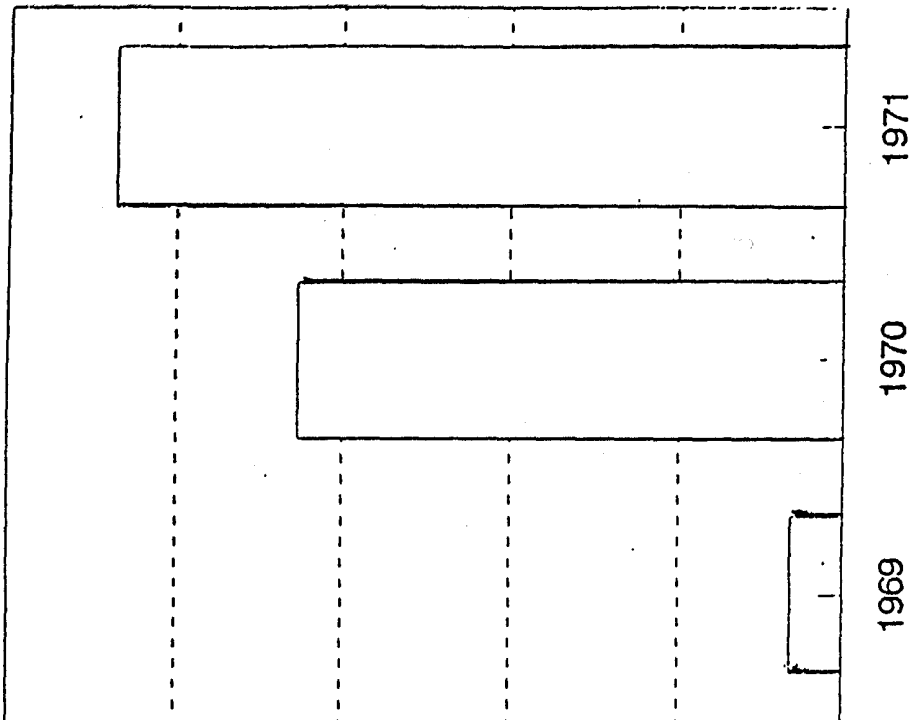


Fig. 2.A


1971
1970
1969

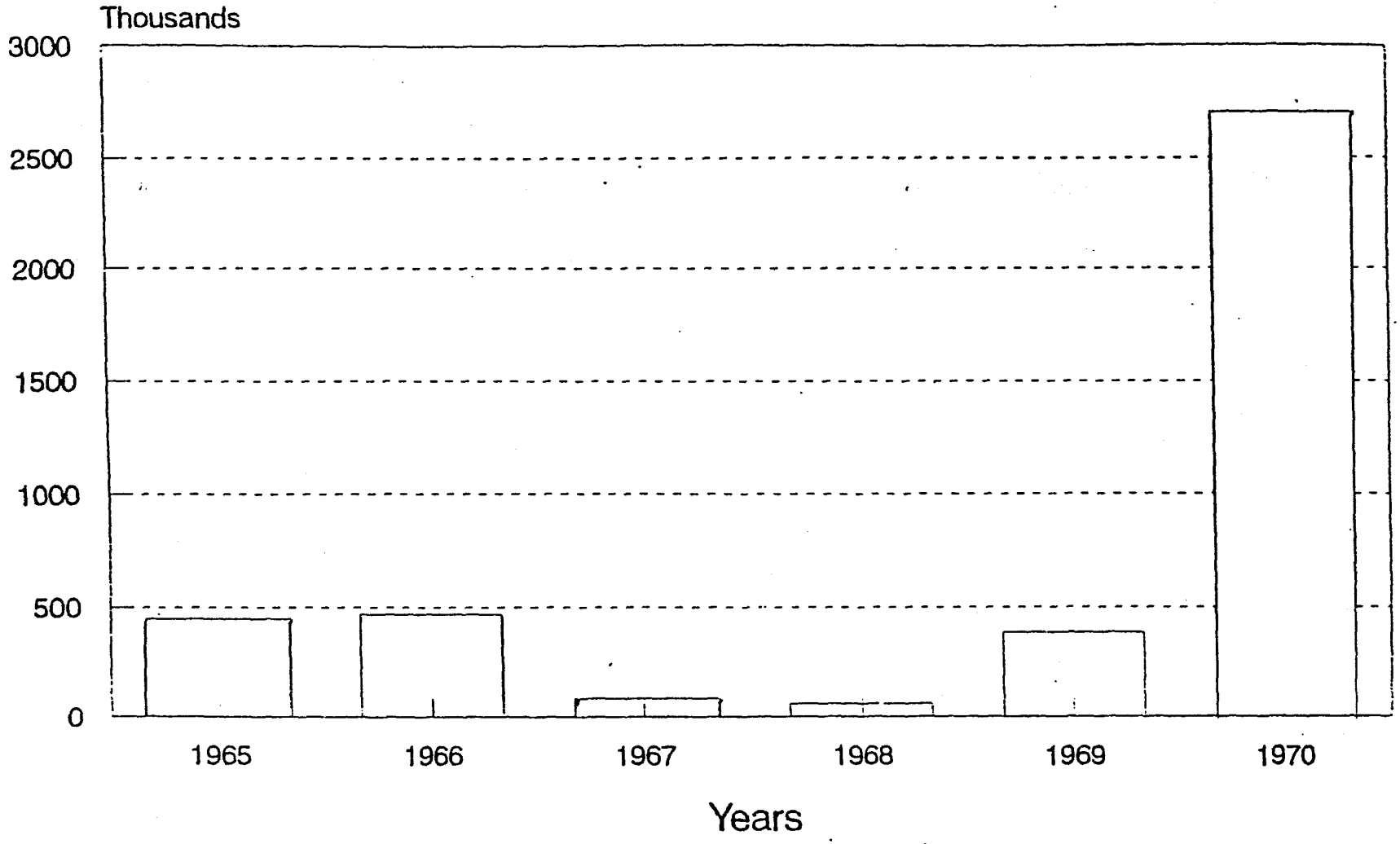

Thousands
3000
2500
2000
1500
1000
500
0
1965
1966
1967
1968
1969
1970
Years

Fig. 2.B

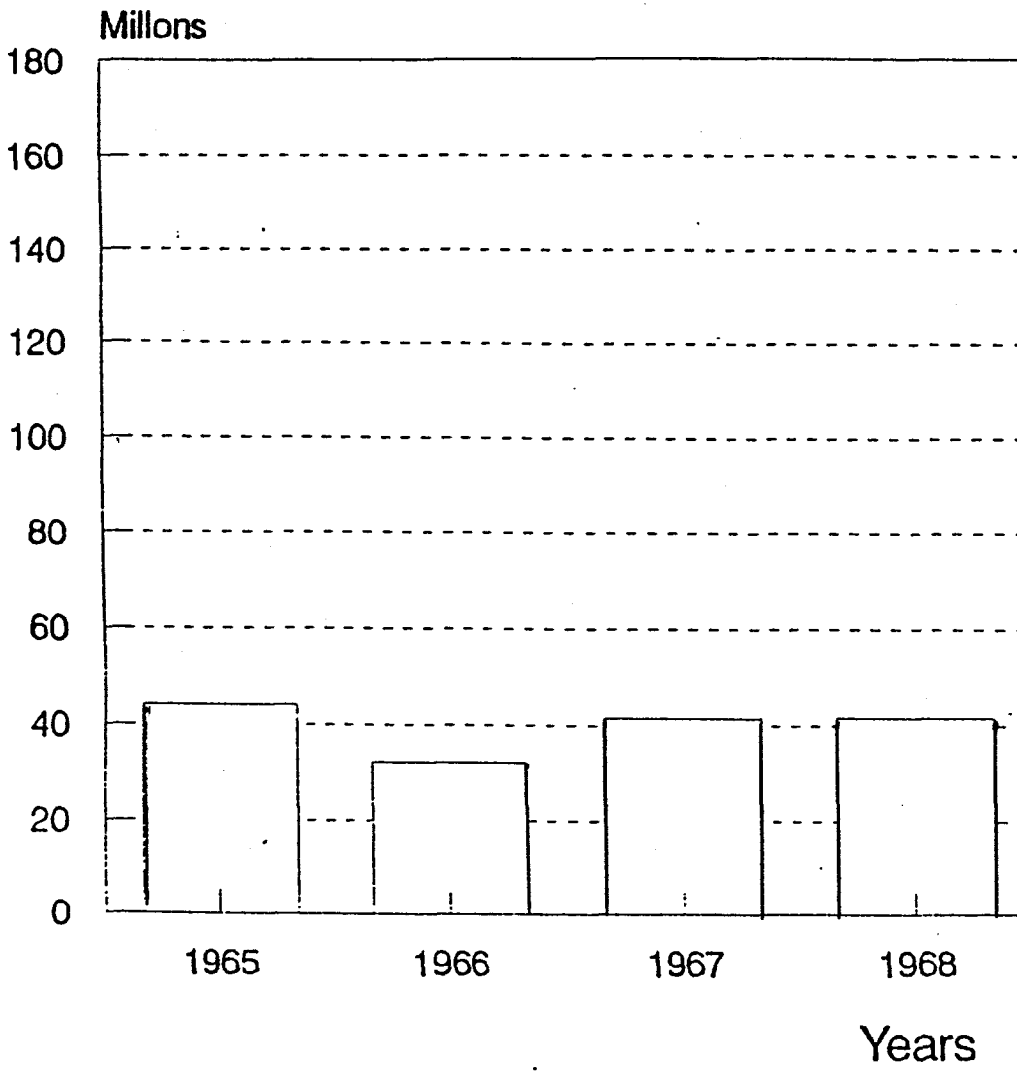
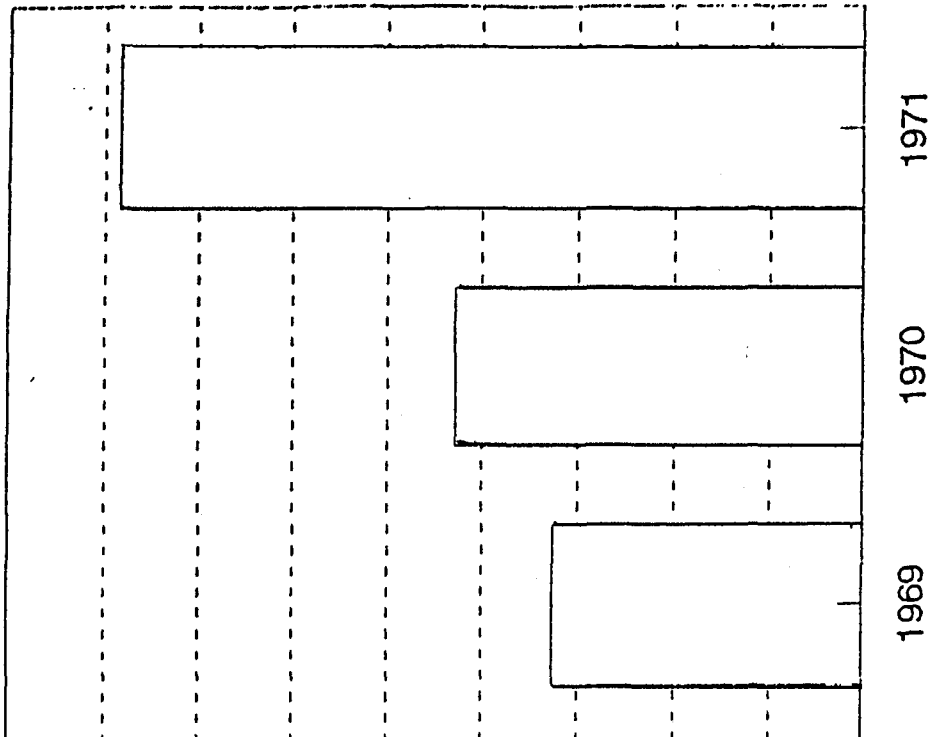

Millons
180
160
140
120
100
80
60
40
20
0
1965
1966
1967
1968
Years

Fig. 2.C


1971
1970
1969

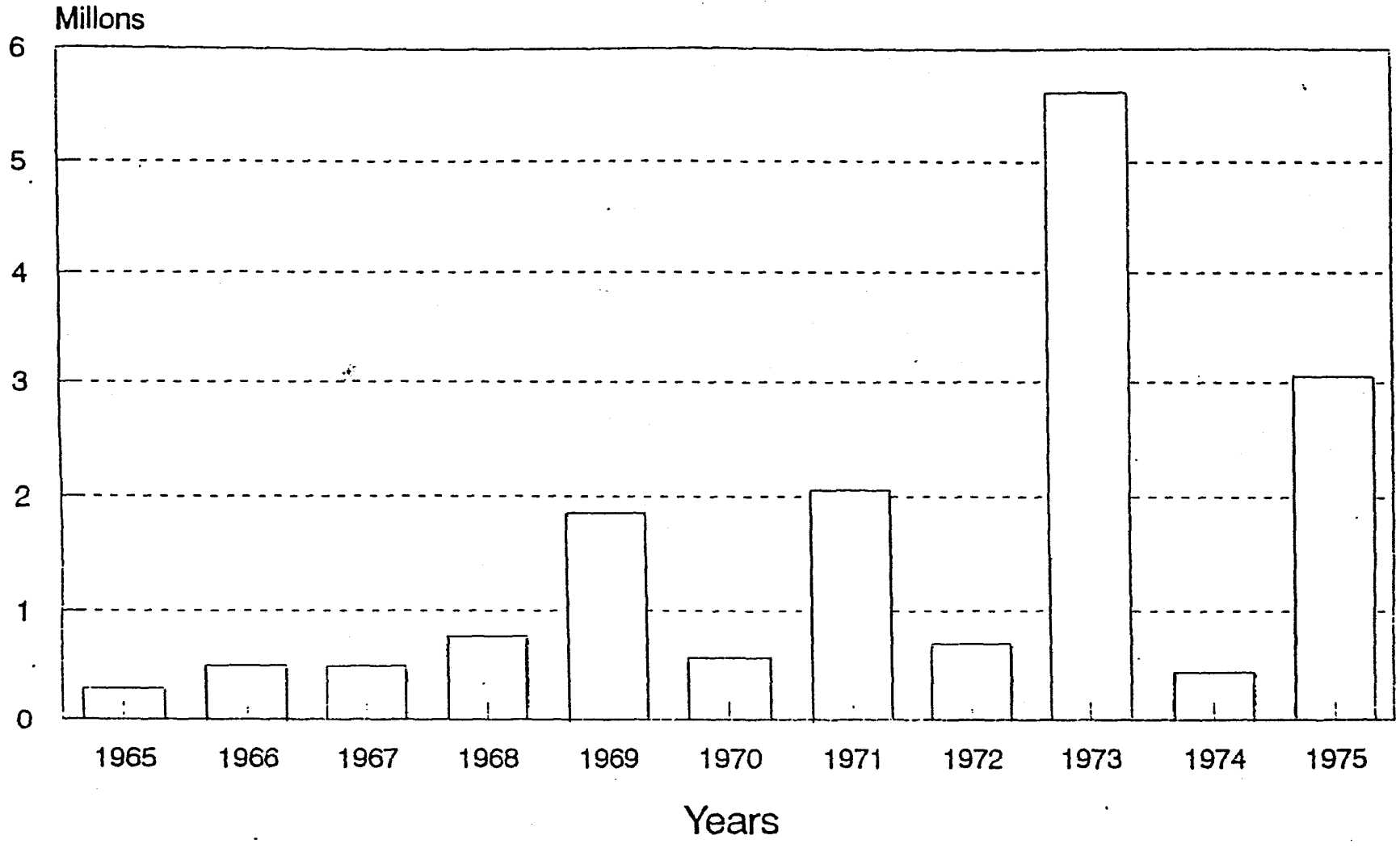

Millons
6
5
4
3
2
1
0
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
Years

Fig. 2.D

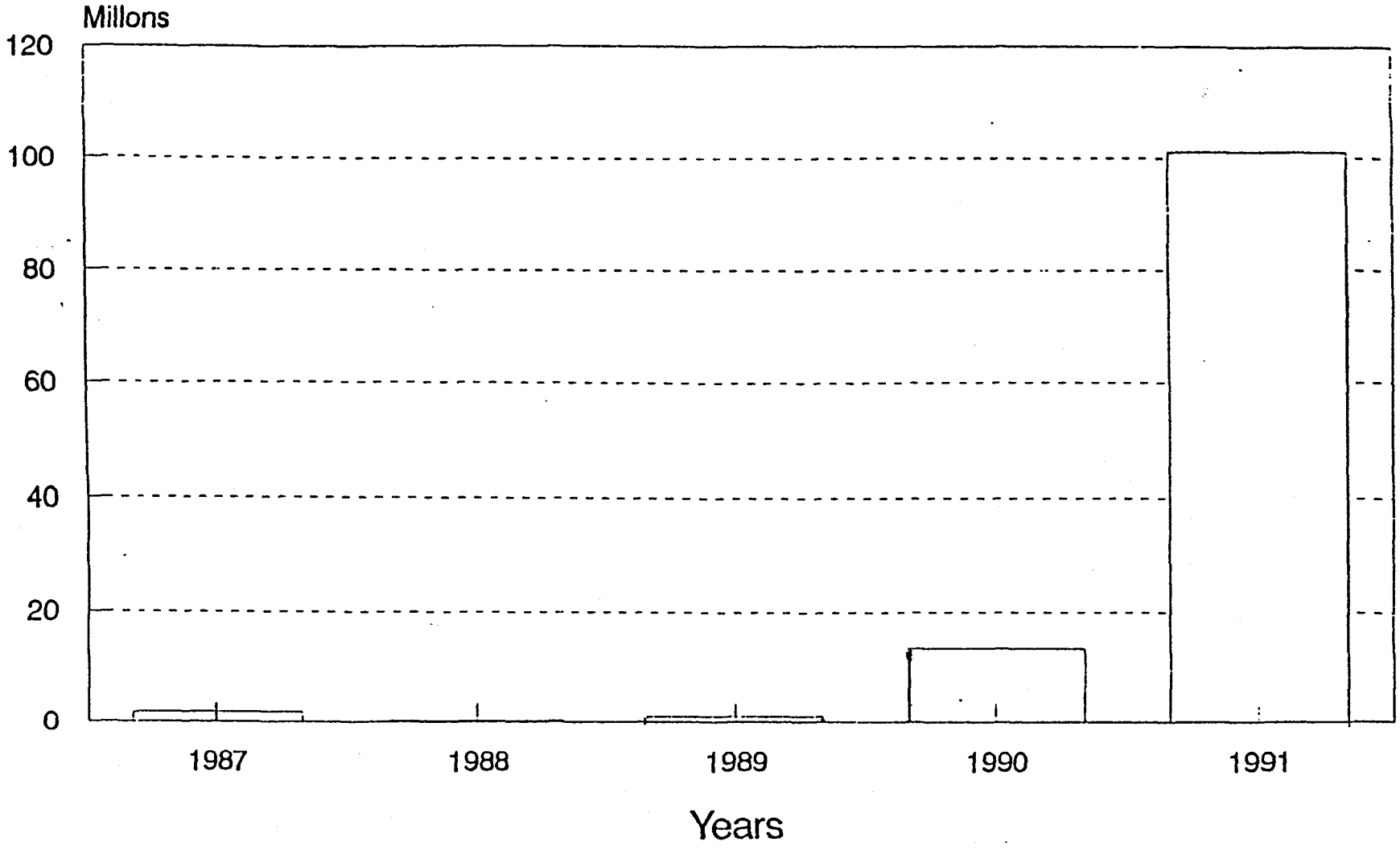


Fig. 3.A

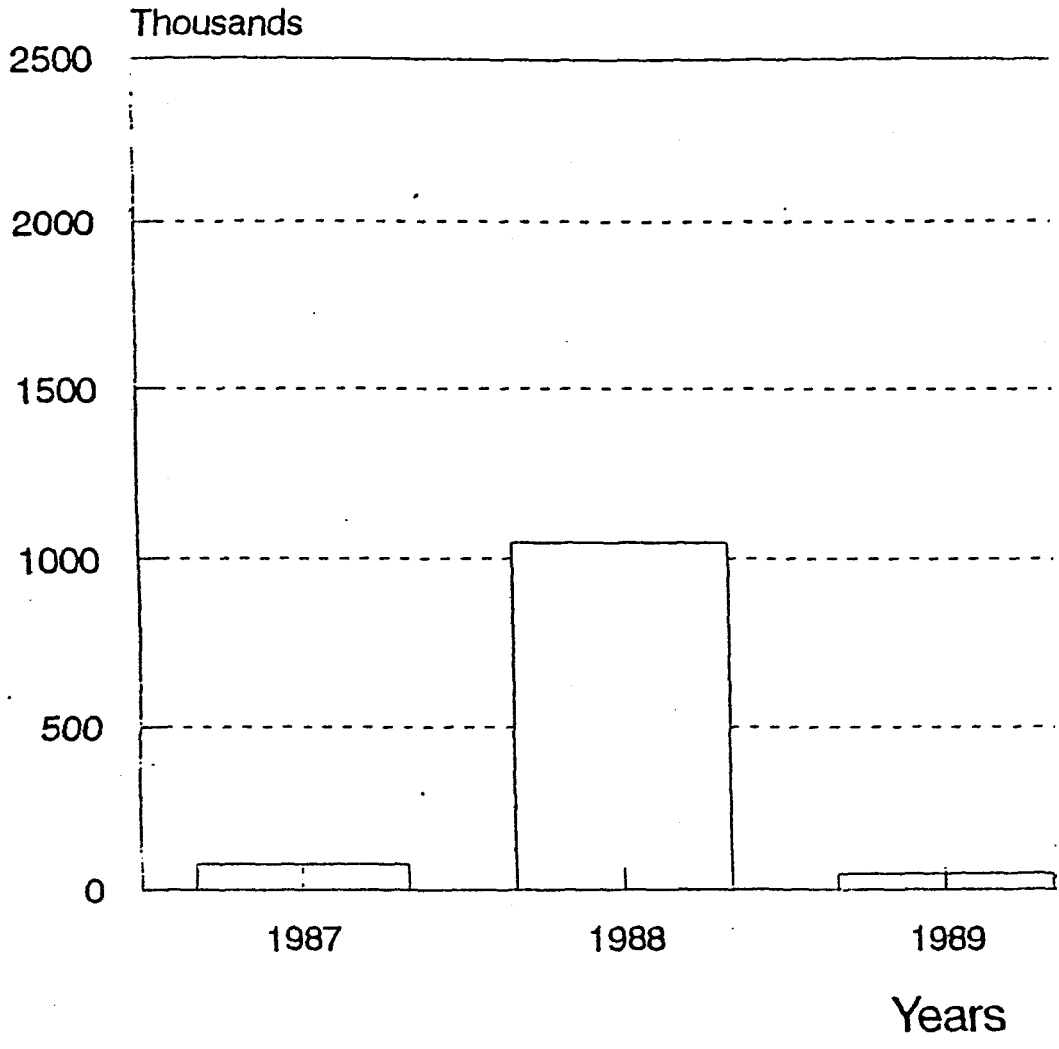
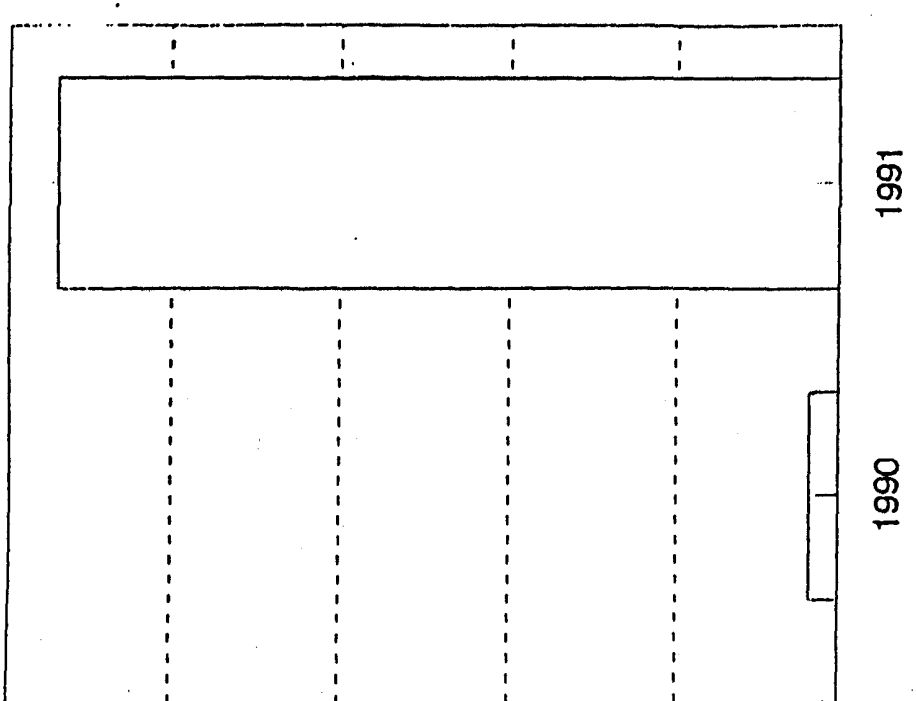
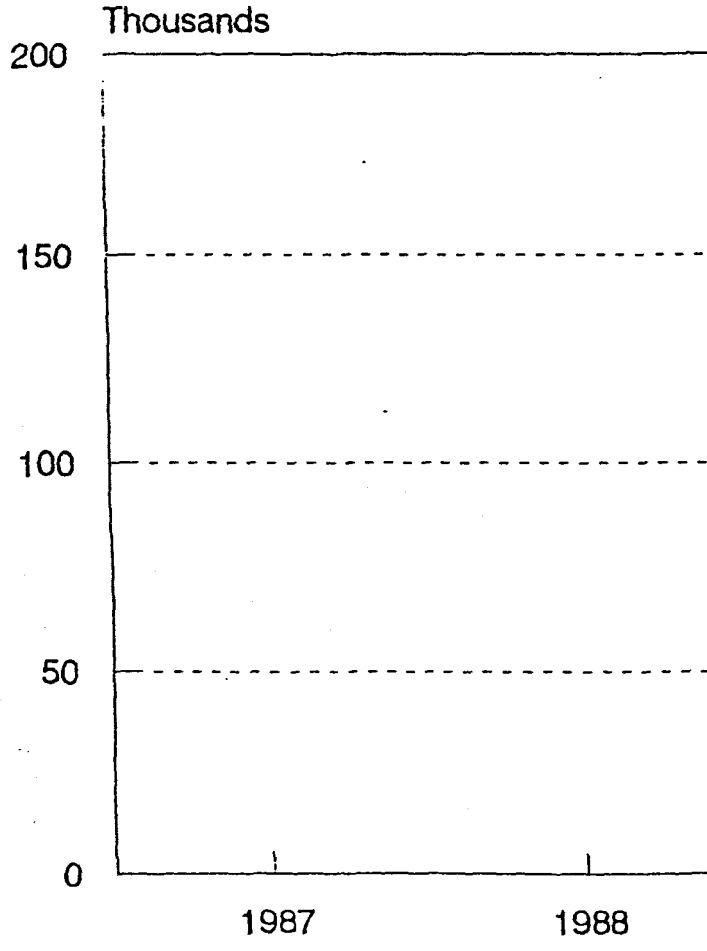


Fig. 3.B


1991
1990


Thousands
200
150
100
50
0
1987
1988

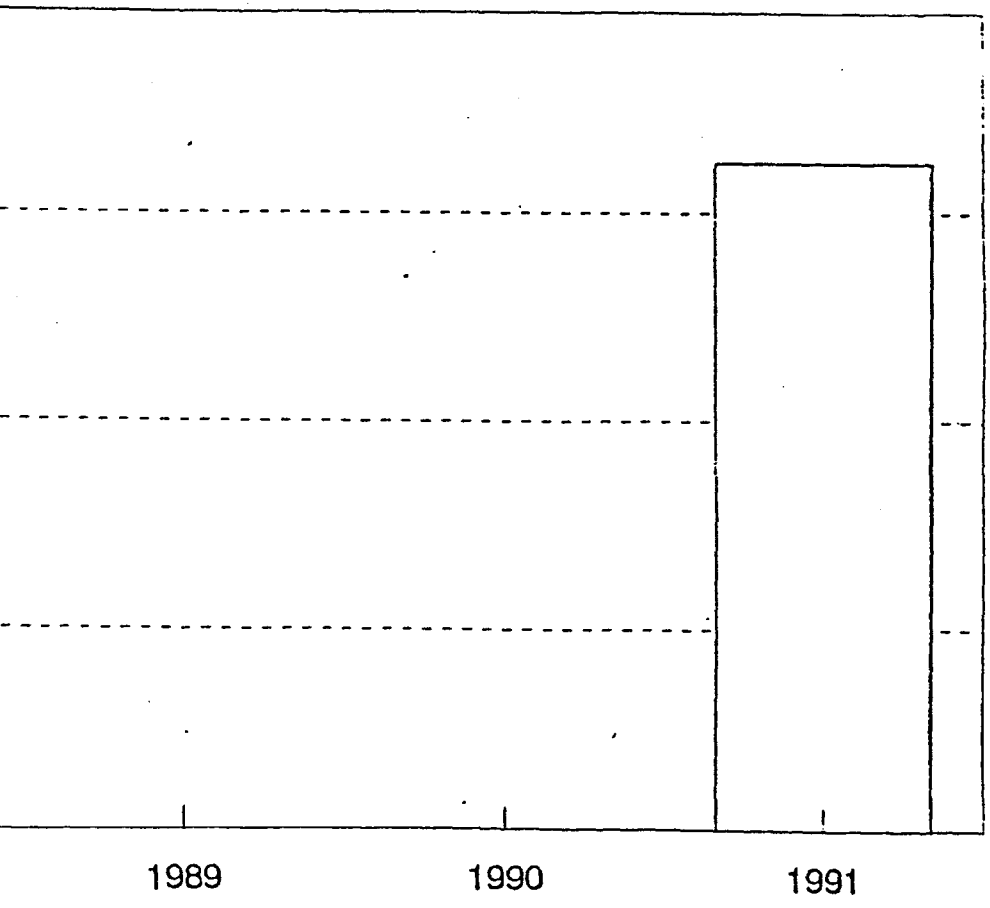
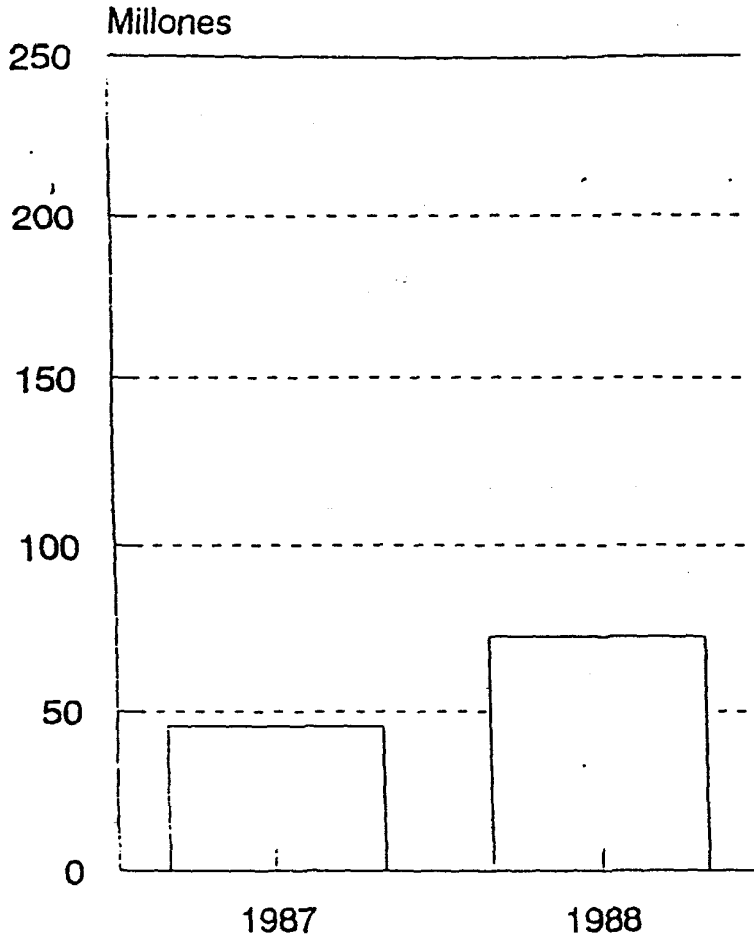


Fig. 3.C


Millones
250
200
150
100
50
0
1987
1988

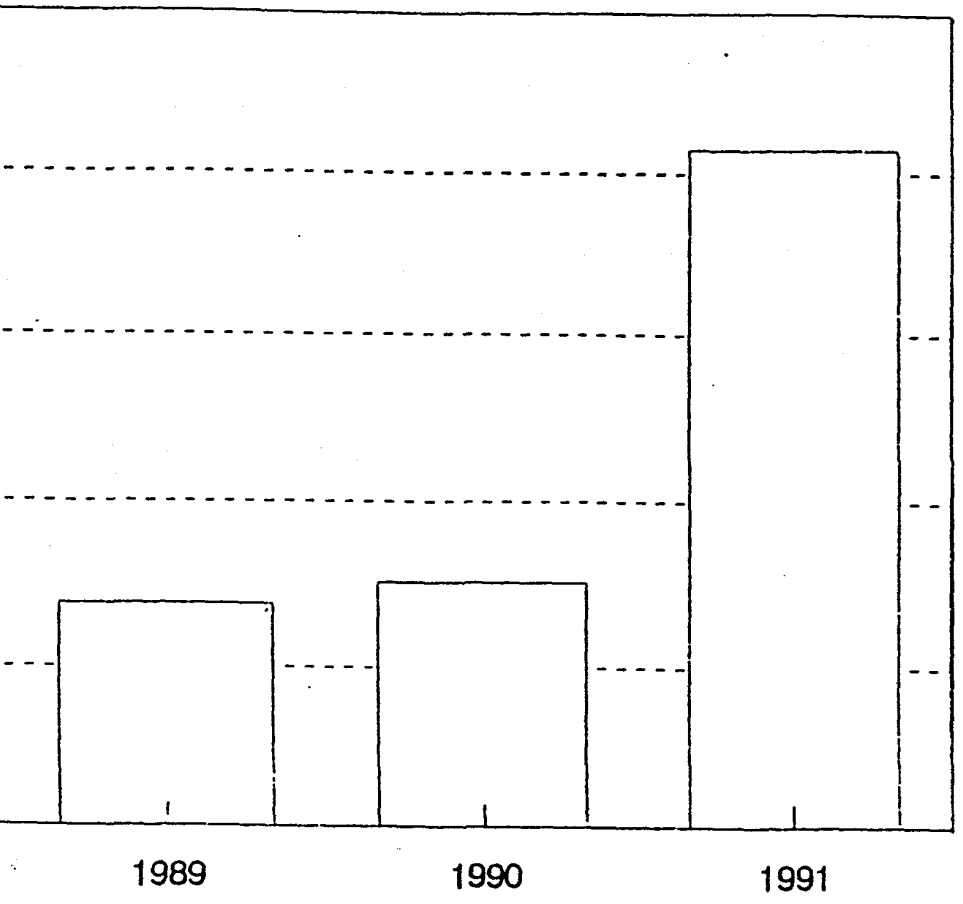


Fig. 3.D

ANNEX

ECOLOGY

Interaction between non-indigenous species

A non-indigenous species can interact in different ways with the environment that it enters. At best, it will adapt to its new surroundings and live in relative equilibrium with the existing community, without causing any appreciable change. However, when the non-indigenous species possesses certain characteristics, such as a rapid rate of growth or the ability to reproduce, adapt and spread quickly, and, above all, when there are no natural enemies, whether predators or competitors, in the new ecosystem, it will spread rapidly and colonize the surrounding territory.

Such behaviour is typical of invasive species and can lead to major changes in either the natural or human environment they have invaded.

In ancient geological eras, insects, birds and mammals carried and introduced into different habitats, animal and vegetable species from other environments. Since prehistoric times humans, too, have been responsible, either voluntarily or involuntarily, for introducing foreign species into other ecosystems.

Eduardo Rapoport regarded the introduction of non-indigenous vegetable or animal species as *contamination* by species that changed the global biogeography. On the subject, he wrote: "The fact is that we are mixing up biota from different parts of the world, and the animals and plants, despite their beauty and apparent inoffensiveness, are competing among themselves ...; it is a real Pandora's box and we cannot predict what will happen in the long run." (The technical term *biota* covers the entire flora and fauna of a particular region.)

Table I summarizes the data on the origins, distribution and way of life of non-indigenous bivalves in the River Plate. *C. fluminea* and *L. fortunei* are considered invasive species because, in addition to being non-indigenous, they are characterized by their early sexual maturity, their reproductive prolificacy and their ability to adapt to the environments they colonize, whether natural, man-made, fresh-water or salt.

In order to control these invasive species, we need to know about their biology, so that we can define criteria and develop methods for managing them. The methods used to control molluscs in other countries are very varied. They include electric currents, treatment of the water with chlorine (or chlorination), highly toxic poisons, electromagnetism, high temperatures and ultrasound. Many of these techniques are expensive and, in the case of poisons, there is a high risk of residual toxicity.

Since its appearance in the United States in 1938, *C. fluminea* has caused a multitude of problems. These include: the obstruction of water pipes; the accumulation of empty cases in tanks; water contamination by dead bivalves, poisons and so on, as a result of poor control procedures; the blocking of filters, an accelerated rate of silting in irrigation pipes through higher deposits of sediment and empty cases, and contamination of building materials such as sand and gravel.

Furthermore, the changes taking place in the indigenous mollusc population have to be taken into account. Possibly because of the clam's recent arrival, Argentina had never before experienced a similar problem. Although *C. fluminea*, like other species of Corbicula, first appeared in the River Plate in the early 1970s, its presence has now been recorded not only in the River Plate itself, but also in many other sites within the greater estuary, such as the rivers Carcaraña, Paraná and Uruguay, as well as in bodies of water connected or adjacent to them, including some in the Argentine provinces of Córdoba, Santa Fe, Entre Rios, Corrientes, Misiones, Chaco and Formosa.

L. fortunei is one of the few species of freshwater mollusc of the Mytilidae family originating in China and South East Asia. When it was first seen near the Argentine bank of the River Plate, in 1991, records show that there were five specimens per square metre. Figure 4 shows variations in the numbers of *L. fortunei* in the locality where it was first observed (Balneario Bagliardi). In May 1992, the figure was 31,200 per square meter, and in May 1993, this had increased to 82,200, more than twice the number recorded the previous year.

In appearance and way of life, *L. fortunei* resembles the mussel (*Brachidontes rodriguezi*, d'Orbigny) found on wharves, jetties and rocks along the Argentine bank, sometimes numbering more than 150,000 per square metre. In the River Plate estuary, *L. fortunei* exhibits two characteristics that make it a major invasive species: because of its epibyssate habit it has no competitors in the freshwater area near the river bank, and it is able to adapt and reproduce very successfully. As a result, future generations of the mollusc could affect running water systems, as was the case in the United States and Canada with the mussel *Dreissena polimorpha*.

When *L. fortunei* first appeared in the water purification plant in La Plata in 1994, it was successfully controlled and thus prevented from affecting the normal running of the plant. Samples taken from a pumped well in Punta Lara on the banks of the River Plate, contained a large quantity of *L. fortunei* which had attached themselves to the walls and protective cover of the pump. Specimens were also found clinging to the sides of the sedimentation tanks of the plant mentioned above, as well as in the mouth of the inlet pipe, where they were seen by divers. It was noted that the mollusc could travel a distance of some 30 metres along pipes and ducts from the pumped well to the sedimentation tank. It was also able to withstand the chemical and physical effects of water purification procedures.

Up until the end of 1993, *L. fortunei* had not spread further north than Punta Lara and did not inhabit any other South American rivers. By the end of 1994, it had been found at Punta Piedras, in water outlets at Bernal and in the port of Buenos Aires. It was also seen for the first time on the opposite bank of the River Plate, at Colonia (Uruguay). At the end of 1995 it was discovered in the River Paraná de las Palmas, as far up as Zárate, and even higher up in the same river, in the Paraná Inferior. All of this is evidence of its ability to adapt to different surroundings, including polluted zones such as the river banks of Buenos Aires itself.

To the factors already responsible for the extinction of indigenous molluscs, such as changes in the river bed and their natural habitats, can now be added the influx of non-indigenous bivalves. An action plan must be drawn up both in order to prevent the extinction of indigenous species and to protect them from invasion by non-indigenous species.

If non-indigenous molluscs continue to spread rapidly and without any form of control, the characteristics which enable them to so, together with the likely increase in international trade following progress in the Mercosur accords and a general lack of awareness of the consequences of a proliferation of invasive species, all give cause for alarm as to the impact of non-indigenous species on the natural and human environment.

Dr G. A. Darrigran

TABLE I

INVASIVE BIVALVES OF THE RIVER PLATE

SPECIES	Limnoperma fortunei	Corbicula fluminea	Corbicula largillierti
ORIGIN	rivers, Far East	Far East	Far East
WAY OF LIFE	epibyssate	infaunal (epibyssate in juvenile state)	infaunal
MAXIMUM SIZE	30 mm.	42 mm.	33 mm.
LIFE SPAN	36 months	36 months	30 months
SEX	dioecious	hermaphrodite	hermaphrodite
INCUBATION	free-swimming	branchial	branchial
INTRODUCTION (1)	River Plate, 1991	River Plate, 1970	River Plate, 1970
FIRST RECORDED	Pastorino et al., 1993	Ituarte, 1981	Ituarte, 1981
DENSITY (2)	14,300/m^2	180/m^2	25/m^2
PRESENT DISTRIBUTION	between Zárate and Punta Piedras	River Plate estuary	River Plate estuary

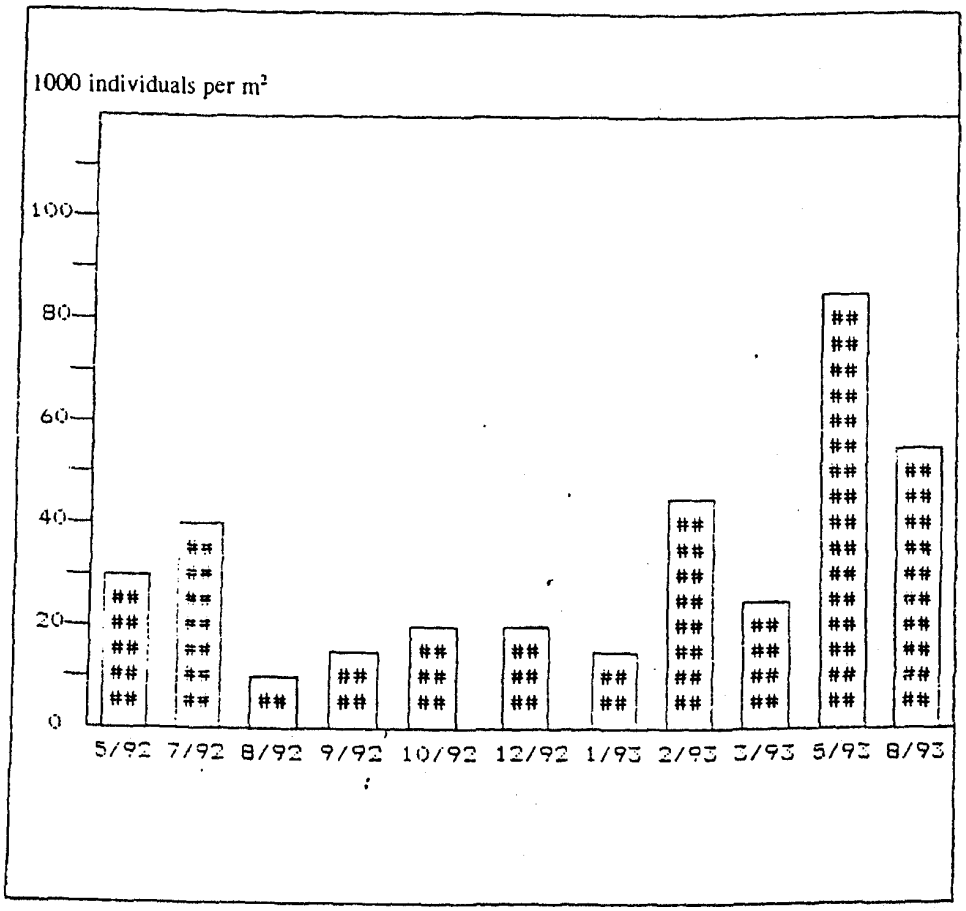
(1) Place and approximate year of arrival in South America.
(2) Measured on the Argentine bank of the River Plate.

REFERENCES:

PASTORINO, G., DARRIGRAN, G., MARTIN, S., and LUNASCHI, L. 1993. *Limnoperma fortunei* (Dunker, 1857) (Mytilidae), nuevo bivalvo invasor en aguas del Río de la Plata. Neotropica, 39, 34:101-102.

ITUARTE, C. 1981. Primera noticia acerca de la introducción de pelecipodos asiáticos en el área rioplatense (Mollusca: Corbiculidae). Neotropica, 27, 77:79-83.

Fig. 4



Approximate variations in the average concentration of *Limnoperma fortunei* in Balneario Bagliardi (Sampling station 4 on Fig. 1,A) measured between May 1992 and September 1993.