Journal of South American Earth Sciences 70 (2016) 174–187

Contents lists available at ScienceDirect

Journal of South American Earth Sciences

journal homepage: www.elsevier.com/locate/jsames

A Pleistocene (MIS 5e) mollusk assemblage from Ezeiza (Buenos Aires Province, Argentina)

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ARTICLE INFO

Article history:
Received 16 November 2015
Received in revised form
12 May 2016
Accepted 19 May 2016
Available online 21 May 2016

Key words:
Mollusks
Paleoecology
Biogeography
MIS 5e
Pleistocene
Argentina

ABSTRACT

A fossil assemblage collected around 3.5 m amsl from Ezeiza, Buenos Aires province, have AMS ^{14}C ages of ca. 33,000 to ca. 40,000 yr BP, whereas in the literature is a report of a conventional ^{14}C age of >43,000 yr BP. An OSL age from the overlying deposit corresponds to ca. 22,000 yr. The samples contain marine fossils: mollusks, balanids and corals (*Astrangia*). La Coronilla (Uruguay, attributed to MIS 5e) is the locality most related to Ezeiza faunistically, despite is not the nearest one. In consequence, the relationship should be addressed to a more similar age and environment than others. The fauna indicates a higher water temperature than today. In Ezeiza exclusively cold water taxa are absent, and we found seven warm taxa with their southern distribution limit displaced northwards today, plus other six at their southern distribution limit. Around 60% of all the species and more than 70% of the individuals are of warm-temperate waters. In sum, although prima facie the numerical ages would locate the deposit in MIS3, faunistic, temperature, and height evidences show that the Ezeiza mollusk assemblage belong to MIS5e. A stronger than presently Brazil warm current, reaching Southern latitudes, may explain the changes in geographical ranges.

1. Introduction

Pleistocene marine and estuarine mollusk assemblages are known in northeastern Argentina since the XIX century (v.gr. Ameghino, 1889), and they have not been exempt of debates. Most of these debates were concerned with the existence of one or more transgressions and their litostratigraphic/chronostratigraphic units (see historical accounts in Aguirre and Whatley, 1995; Isla et al., 2000; Fucks et al., 2010). The development of modern facies models and dating methods made most of the controversies obsolete, but new ones have arisen. Particularly, several ^{14}C dates of around 30–40 ka BP have been questioned by some authors, and taken only as minimum ages (e.g. Tonni and Fidalgo, 1979; Martínez et al., 2001; Fucks et al., 2005), on the basis of the height of the deposits and the inferred (high) paleotemperatures. They propose that these deposits represent the Marine Isotopic Stage (MIS) 5, and more precisely MIS 5e, the most recent lapse warmer than today. A similar situation occurred in Patagonia, where ESR dating on mollusk shells (e.g. Schellmann and Radtke, 2000) provided older ages than the ^{14}C ones (e.g. Codignotto et al., 1988).

Although The Last Interglacial is considered for some authors (e.g. Masson-Delmotte et al., 2011) a not good analogue for future climatic change, taking into account that orbital and anthropogenic forcing are different, it is a valid way to evaluate the effects of a warmer than today climate (Capron et al., 2014).

Here we show another case study from Ezeiza, Rio Matanza basin, near Buenos Aires City (Fig. 1). Ameghino (1880–1881, 1889), Rusconi (1930) and Frenguelli (1957) made some brief commentaries about the Quaternary of the Río Matanza hydrographical basin, but there is only one previous (unpublished) work (Di Micco, 1990) that deals with the locality studied here.

This new Pleistocene mollusk assemblage reopens the debate whether some southern South America deposits with ^{14}C dating around 30 ka BP belong to MIS3 (accepting this age), or to MIS5 (if they are interpreted as minimum ages). In this vein, the goals of this paper are to give ^{14}C and OSL ages for the Ezeiza deposits and to describe and compare the mollusk assemblage with others in the region, discussing its paleoclimatic and chronological meaning.

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http://dx.doi.org/10.1016/j.jsames.2016.05.008
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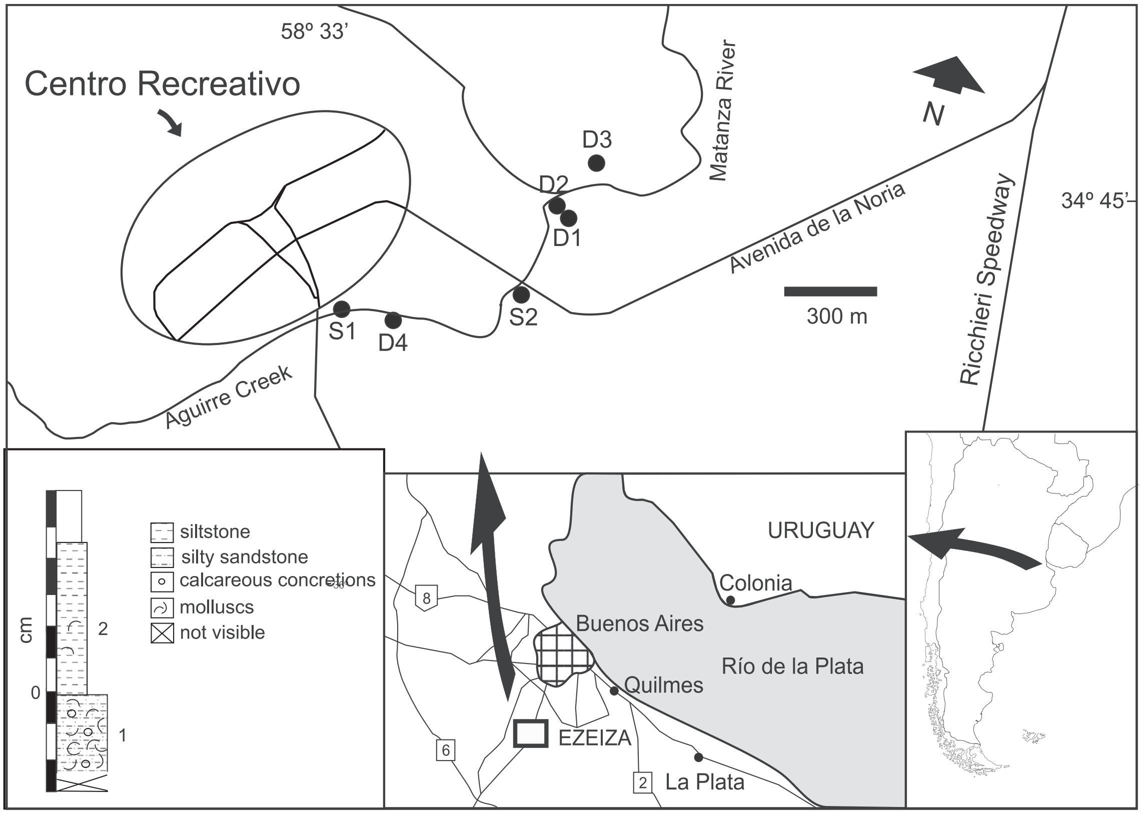

Fig. 1. Geographic location and stratigraphic section of the samples (S1 and S2), including Di Micco (1990)'s ones (D1 to D4).

2. Geographical and geological setting

The studied locality is situated near Buenos Aires City, at the "Centro Recreativo Nacional Ezeiza". It is situated in the Rio Matanza-Riachuelo Basin, a plain with an average slope of 0.35 m/km. The basin is present below the 35 m over mean sea level, is about 85 km length and covers a surface of about 2300 km^2. The Matanza-Riachuelo Basin is geomorphologically situated over Precambrian rocks from the Brazilian shield. The basin is filled with Cenozoic continental and marine sediments, and the present landscape is mainly due to the loessic nature of the Quaternary (Pampeano) sediments and related paleosols. The Post-Pampeano sediments are situated in the coastal area and represent the advance and retreat of the sea since the Late Pleistocene. (Frenguelli, 1957; Russo et al., 1979; Pereyra, 2004; ACUMAR, 2009; Nabel, 2010).

Two sites with mollusk shells were found. The first (Site 1) is at the margin of the Aguirre Creek (34°45.82′S-58°33.01′W) and the second (Site 2) at the margin of a small artificial channel, tributary to the first one (34°45.68′S-58°32.89′W) (Fig. 1).

Site 1 correspond to an excavation in the margin of the creek and is composed of green-grayish fine, silty sand (Fig. 1). The fossiliferous bed is about 3.5 m above sea level. The lithology and height are the same of Di Micco (1990)'s bed 2 of her section 4, located very close to our site (Fig. 1). Shells are overall well preserved, without signs of abrasion, but fragmented ones are frequent. Venerids have seldom missing the juvenile portion of the outer layer. Right and left valves of bivalves are in similar number in each species, and there are specimens with articulated valves (notably *Plicatula gibbosa* Lamarck, 1801). Epiobionts are rare, and when present, they are represented by balanomorphs situated in the outer side of cemented bivalves (*P. gibbosa*, *Ostrea puelchana* d' Orbigny, 1842). Specimens size ranges from millimetres to centimeters, although there are not shells larger than around 3 cm.

The fossiliferous bed of Site 2 is about 0.5 m higher than site 1 (Fig. 1). Although it has the same mollusk fauna of Site 1, it was discarded for the faunistic studies because of the taphonomic alterations caused by reworking and formation of soil.

3. Material and methods

A bulk sample of about 10 dm^3 was taken from Site 1. All fossils were recovered by sieving (smaller sieve of 1 mm) and the remainder sediment was inspected too; mollusks were classified to the lower taxonomic level possible, and the shells counted. Fragments of gastropods were taken into account when retaining the apex; right and left valves of bivalves were counted separately taking into account the maximum value as the number of individuals. Macroscopic inspection at the outcrop revealed that large rare species were absent. Specimens were deposited in the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" (Buenos Aires, Argentina).

Two shells of *Chione subrostrata* (Lamarck, 1818) in good condition were selected for ^{14}C dating at the AMS facility, Dpt. of Physics, University of Arizona. Site 2, containing only redeposited shells, was dated by OSL at the University of Illinois, Chicago.

Present distribution and depth range of mollusk taxa were taken from Rosenberg (2009), Scarabino (2003) and Huber (2010). Thermal ranges were inferred from the biogeographic distribution of taxa. Substrate information was taken from Scarabino et al. (2006a,b), Mikkelsen and Bieler (2007) and Rios (2009).

We compared the new locality with others in two ways: first, with broad areas of the Southwestern Atlantic coast, and second, with individual localities or small clusters of nearby localities.

For the first approach, we used Martínez et al. (2013) operative biogeographical areas for the South western Atlantic Pleistocene -plus Rio Grande do Sul (Lopes et al., 2013), not included in that paper- being from North to South: Rio Grande do Sul (RGS), Uruguay (UY), Buenos Aires (BA), San Jorge Gulf (SJG) and Tierra del Fuego (TF) (Fig. 2). For Buenos Aires, Pleistocene localities or groups of localities with acceptable constrained ages and at least five mollusk species, mentioned in Aguirre and Whatley (1995), Aguirre and Fucks (2004), Martínez et al. (2001), Lopes et al. (2013) and Charó et al. (2013) were considered.

Similarity and dissimilarity among the malacological content of Ezeiza and other Pleistocene localities was evaluated with presence-absence data using both the Dice association coefficient and the Raup and Crick (1979) index. The Dice association coefficient is defined by the following equation: $2a/(2a + b + c)$, where a is the number of taxa shared by the samples and b and c are the taxa present in one sample and absent in the other. The Raup and Crick index is defined as the probability that k_{exp} will be less than or equal to k_{obs}, where k_{exp} is the theoretically possible values of k generated by Monte Carlo simulations, k_{obs} is the number of taxa actually shared by assemblages, and k is the number of taxa common to both assemblages. Although the Dice coefficient provides minimum distortion in binary data (Archer and Maples, 1987; Maples and Archer, 1988), the Raup-Crick index was also calculated because it uses a randomized Monte Carlo procedure.

These data were analyzed by means of multivariate analysis: Q-mode Cluster Analysis and NMDS. These methods have proved to be useful by Martínez and del Río (2002a,b), and by Kreft and Jetz (2010), among others. Taxonomic Diversity (Clarke and Warwick, 1998, 1999; Hammer and Harper, 2006) was also evaluated, taking into account three levels above the species one (genus, family, superfamily).

Concerning abundance, there are not enough data in the literature to do comparisons. Therefore, only individual estimations for Ezeiza and comparison with Uruguayan localities (data from Martínez et al., 2001) are shown. Shannon, Equitability, Chao1 indices, and an individual rarefaction curve were calculated.

The software PAST, ver. 3.05 (Hammer et al., 2001) was used to perform all the analyses.

4. Composition and faunal relationships

The samples revealed the presence of bivalves, gastropods, chitons (*Chaetopleura* sp.) and corals (*Astrangia* sp.), the two latter

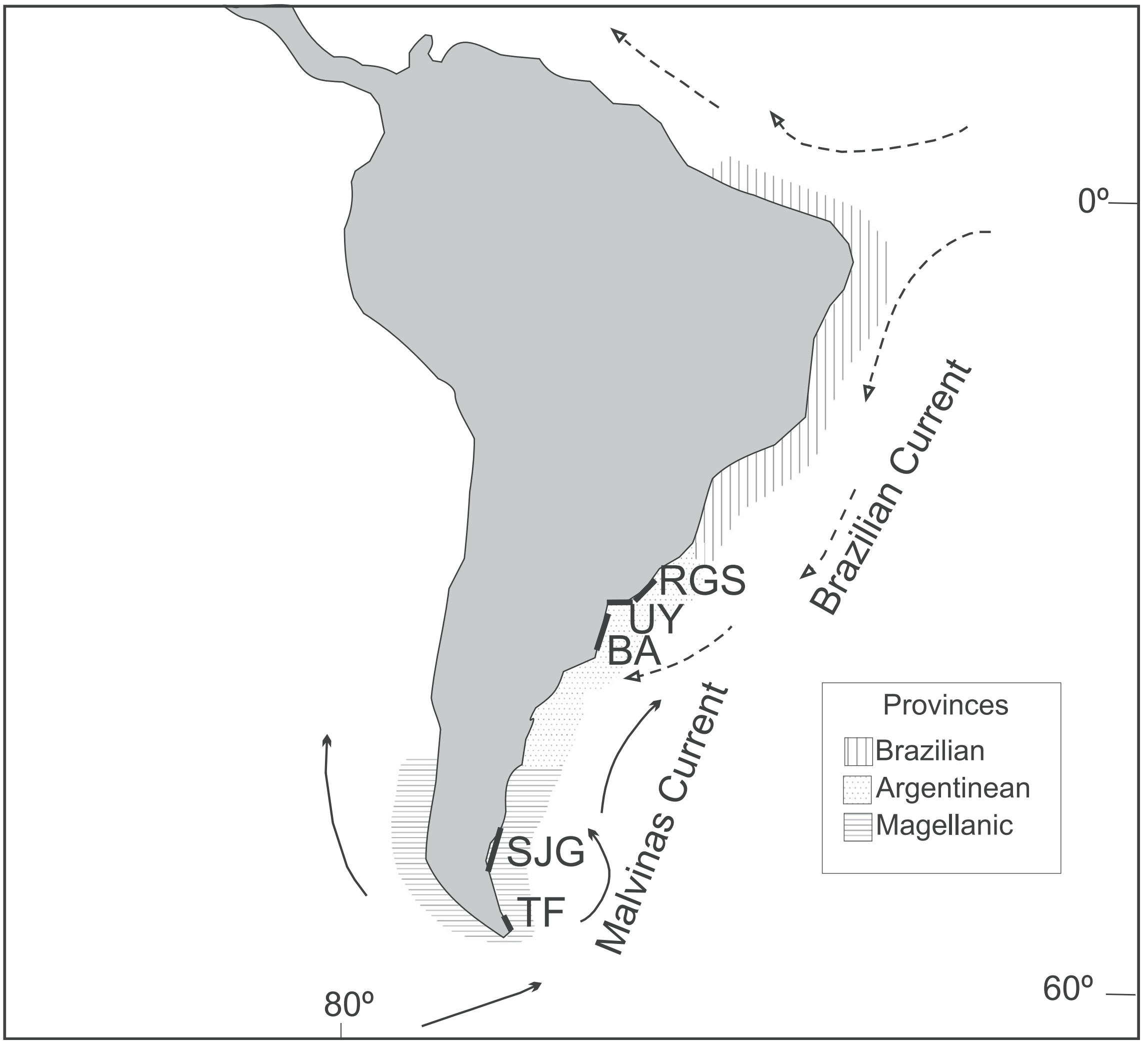

Fig. 2. Present malacological provinces of the Southwestern Atlantic Ocean and areas used for comparisons among regions (see Martínez et al., 2013). RGS: Rio Grande do Sul, UY: Uruguay, BA: Buenos Aires province, SJG: San Jorge Gulf, TF: Tierra del Fuego.

Table 1
Species of mollusks present in the sample, collection numbers, and number of specimens in each lot.

Species	Collection number	n
Gouldia cerina (C. B. Adams, 1845)	MACN-Pi 5828	1316
Chione subrostrata (Lamarck, 1818)	MACN-Pi 5829	264
Pitar rostratus (Philippi, 1844)	MACN-Pi 5830	151
Tegula patagonica (d' Orbigny, 1835)	MACN-Pi 5831	120
Anomalocardia brasiliana (Gmelin, 1791)	MACN-Pi 5832	92
Caryocorbula caribaea (d' Orbigny, 1853)	MACN-Pi 5833	88
Plicatula gibbosa Lamarck, 1801	MACN-Pi 5834	86
"Clausinella gayi"	MACN-Pi 5835	73
Bostrycapulus odites R. Collin, 2005	MACN-Pi 5836	72
Ostrea puelchana d' Orbigny, 1842	MACN-Pi 5837	71
Carditamera cf. *plata* (Ihering, 1907)	MACN-Pi 5838	39
Ennucula puelcha (d' Orbigny, 1842)	MACN-Pi 5839	25
Laevicardium sp.	MACN-Pi 5840	12
Lunarca ovalis (Bruguière, 1789)	MACN-Pi 5841	10
Trachycardium muricatum (Linnaeus, 1758)	MACN-Pi 5842	8
Corbula sp.	MACN-Pi 5843	7
Bittiolum varium (Pfeiffer, 1840)	MACN-Pi 5844	7
Crassinella lunulata (Conrad, 1834)	MACN-Pi 5845	5
Angulus gibber (Ihering, 1907)	MACN-Pi 5846	4
Noetia bisulcata (Lamarck, 1819)	MACN-Pi 5847	3
Phlyctiderma sp.	MACN-Pi 5848	3
Nucula pisum Sowerby I, 1833	MACN-Pi 5849	2
Calliostoma sp.	MACN-Pi 5850	2
Iselica globosa (H. C. Lea, 1843)	MACN-Pi 5851	2
Boonea cf. *seminuda* (C. B. Adams, 1839)	MACN-Pi 5852	2
Turbonilla sp.	MACN-Pi 5853	2
Limidae indet.	MACN-Pi 5854	1
Macoma sp.	MACN-Pi 5855	1
Cyclinella tenuis (Récluz, 1852)	MACN-Pi 5856	1
Sphenia sp.	MACN-Pi 5857	1
Seila adamsii (H. C. Lea, 1845)	MACN-Pi 5858	1

very scarce.

Di Micco (1990) mentioned *Plicatula spondiloidea* (sic) (Meuschen, 1781), *Tegula patagonica* (d' Orbigny, 1835), *Arca* (*Argina*) *campechiensis* Gmelin, 1791, *Crepidula protea* (d' Orbigny, 1841), *Pitaria rostratum* (Philippi, 1844), and *Ostrea puelchana* for her Profile 4. These taxa were found by us (see Tables 1 and 2, with updated nomenclature), with the exception of *Crepidula protea*; it is almost certainly an identification problem, since we found specimens of the roughly similar species *Bostrycapulus odites* R. Collin, 2005. Apart from this case, we sum 25 new species for the locality, mostly of small size.

As stated in the introduction, Frenguelli (1957) mentioned some species for the "Belgranense" of the Rio Matanza basin, without more specifications. He indicates the presence of *Pectunculus longior* Sowerby I, 1833, *Pitaria rostrata, Anomalocardia brasiliana* (Gmelin, 1791), *Chione portesiana* (d' Orbigny, 1842), *Mactra isabelleana* d' Orbigny, 1846, *Cardium muricatum* Linnaeus, 1758, *Ostrea spreta* d' Orbigny, 1846, *Purpura hemastoma* (Linnaeus, 1767) and *Neomphalius patagonicus* (d' Orbigny, 1835). From this list, we did not find *P. longior* (= *Glycymeris longior* (Sowerby I, 1833)), *M. isabelleana*, *O. spreta* (= *Ostreola equestris* (Say. 1834)) and *Purpura haemastoma* (=*Stramonita haemastoma* (Linnaeus, 1767)). Surely Frenguelli covered a broader area than us, and this may explain the species not present in Ezeiza. Conversely, as in the Di Micco ś case, he did not pay attention to the small mollusks.

Taxa found in this instance are shown in Tables 1 and 2, along with their abundance (most abundant illustrated in Fig. 3), and present geographic and bathymetric distribution. There are 31 species of mollusks (23 bivalves and eight gastropods); four of them (*Chione subrostrata, Bittolium varium* (Pfeiffer, 1840), *Cyclinella tenuis* (Récluz, 1852) and *Seila adamsii* (H. C. Lea, 1845)), and one

Table 2
Species of mollusks present in the sample and distributional and ecological characteristics considered in the text.* First reference for the Argentinean Quaternary, ** the valves correspond to what has been mentioned in the regional literature as *Clausinella gayi* (Hupé, 1854), but it is clearly another species, probably juveniles of *Pitar* sp., *** species presently distributed northern wards, **** species in the limit of its southern distribution.

Species	n	%	Geographic range	Depth	Substrate
Gouldia cerina ***	1316	53.26	35°N–30°S; 92.3°W–0°W	8–174 m (live 8–11 m)	soft
Chione subrostrata */**/***	264	10.68	23°S–23°S; 43°W	0–30 m	soft
Pitar rostratus	151	6.11	22°S–38.7°S; 62.2°W–41.57°W	10–100 m	soft
Tegula patagonica	120	4.86	23°S–54°S; 66°W–0°W	0–57 m	hard
Anomalocardia brasiliana	92	3.72	18°N–39°S; 82°W–32.3°W	0.3–5 m	soft
Caryocorbula caribaea	88	3.56	42°N–43°S; 91°W–6°W	0.9–823 m (live 3.7–11 m)	soft
*Plicatula gibbosa*****	86	3.48	35.3°N–34°S; 94°W–35.3°W	0–120 m (live 7–11 m)	hard
*"Clausinella gayi"***	73	2.95	–	–	soft
Bostrycapulus odites	72	2.91	5°S–45.8°S; 66°E – 18.33°W	0–46 m (live 0–46 m)	hard
Ostrea puelchana	71	2.87	22°S–42°S; 62.5°W–43°W	10–100 m	hard
Carditamera plata	39	1.58	23°S–39°S; 62°W–43°W	17–70 m	soft
Ennucula puelcha	25	1.01	22.93°S–55.5°S; 68°W–41.57°W	5–1850 m	soft
Laevicardium sp. */***	12	0.49	southern limit of southern species 28°S	–	soft
Lunarca ovalis ****	10	0.4	42°N–35°S; 91°W–35°W	0–11 m (live 1–11 m)	soft
Trachycardium muricatum	8	0.32	35°N–42°S; 91°W–35°W	0–11 m	soft
Corbula sp.	7	0.28	–	–	soft
Bittiolum varium */***	7	0.28	38°N–30°S; 97.77°W–34.9°W	0–11 m (live 0–11 m)	soft
Crassinella lunulata ***	5	0.2	42°N–28°S; 91°W–41°W	0–110 m (live 7–11 m)	soft
Angulus gibber	4	0.16	23°S–43°S; 64.28°W–43°W	13–55 m	soft
Noetia bisulcata ****	3	0.12	34°N–35°S; 82°W–29°W	0–10 m	soft
Phlyctiderma sp.	3	0.12	–	–	soft
Nucula pisum	2	0.08	23°S–53.5°S; 74.1°W–44°W	0–52 m	soft
Calliostoma sp.	2	0.08	–	–	hard
Iselica globosa ****	2	0.08	28°N–35°S; 92.3°W–36°W	0–550 m (live 5 m)	n/a
Boonea cf. *seminuda* ****	2	0.08	46.5°N–35°S; 97.32°W–34.9°W	–	n/a
Turbonilla sp.	2	0.08	–	–	n/a
Limidae indet.	1	0.04	–	–	soft
Macoma sp.	1	0.04	–	–	soft
*Cyclinella tenuis**/***	1	0.04	37°N to 28°S; 91°W to 35°W	1–66 m (live 7 0.3 m)	soft
Sphenia sp.	1	0.04	–	–	soft
Seila adamsii */****	1	0.04	41.6°N–35°S; 97.35°W–34.9°W	0–80 m (live 0–20 m)	n/a

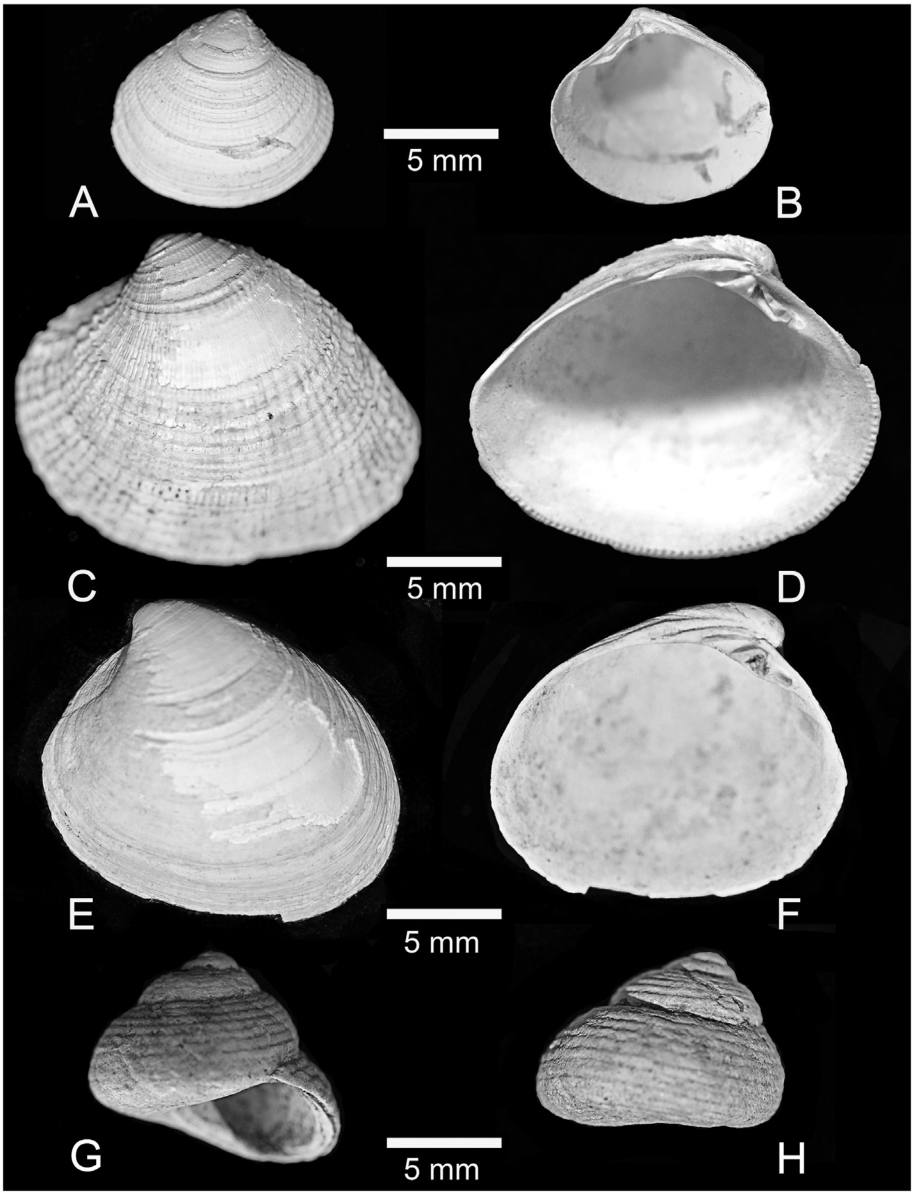

Fig. 3. Commonest species of Ezeiza. *Gouldia cerina* (C. B. Adams, 1845) MACN-Pi 5828a, external (A) and internal (B) views; *Chione subrostrata* (Lamarck, 1818) MACN-Pi 5829a, external (C) and internal (D) views; *Pitar rostratus* (Philippi, 1844) MACN-Pi 5830a, external (E) and internal (F) views; *Tegula patagonica* (d' Orbigny, 1835) MACN-Pi 5831a, ventral (G) and dorsal (H) views.

genus (*Laevicardium*), are recognized for the first time for the Argentinean Quaternary. As said in the preceding paragraph, Frenguelli (1957) mentioned *Chione portesiana* (=*Chione subrostrata*) for his "Belgranense" of Buenos Aires area, but unfortunately he did not give any precise locality for his faunal references.

Martínez et al. (2013) concluded that Pleistocene mollusks faunas from the Southwestern Atlantic Ocean were less rich and diverse than Holocene ones, but on the basis of their similar Taxonomic Diversity Indices, these authors predicted that this perception will change once the knowledge of new-dated Pleistocene deposit increases. The new findings in Ezeiza support this claim.

Both the rarefaction curve (not reaching the asymptote but flattening out) (Fig. 4) and the Chao1 index (32.67) show that the studied sample is representative of the fossilized association, although one or two rare species could still be found. As seen in Tables 1 and 2 and Fig. 5, *Gouldia cerina* (C. B. Adams, 1845) is clearly the most abundant species, being more than half of the total individuals. Far from it follows *Chione subrostrata*, with around eleven per cent of individuals, and *Pitar rostratus* with around a six per cent of them. These three species account for the 70% of individuals of the sample. The remaining 28 species have a representation below the 5%. It is not surprising then that the Shannon index is near the middle of its range (1.855, ln(31) = 3.434) and the Equitability too (0.5402).

Ezeiza, being only a single locality and outcrop, has acceptable species richness when compared with the whole areas referred in section 3 (Table 3). Moreover, when comparing the richness of Ezeiza with that of other localities or groups of neighboring outcrops (Table 4), is only outnumbered by Rio Grande do Sul (a group of localities).

The mollusk assemblage of Ezeiza is especially related to

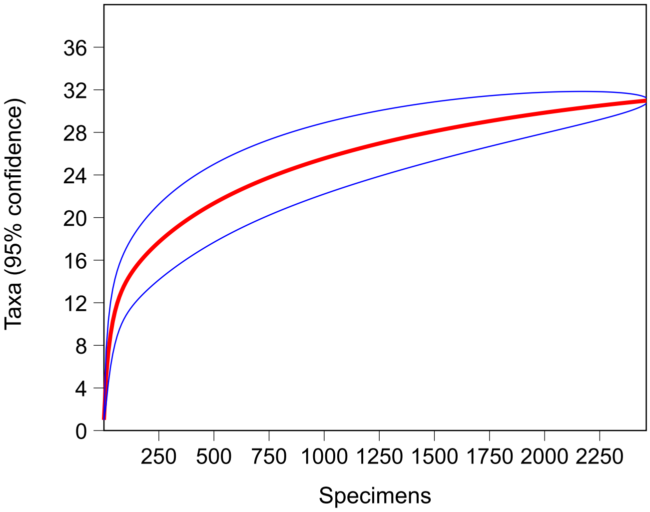

Fig. 4. Individual rarefaction and 95% confidence envelope of the studied sample.

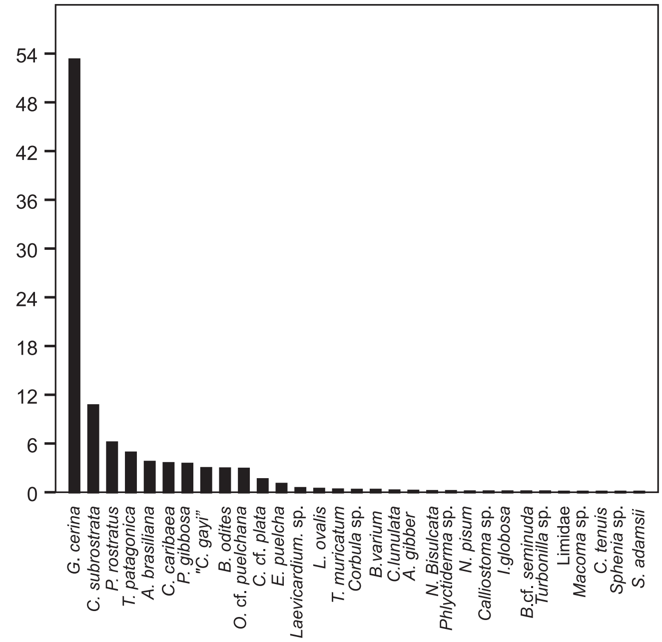

Fig. 5. Relative abundance (%) of the mollusk species.

Uruguay and Rio Grande do Sul (Figs. 6 and 7, Tables 5 and 6). In the cluster diagram using as OTUs the broad areas, Ezeiza joins to a group containing Buenos Aires and the cluster Rio Grande do Sul – Uruguay – (Dice index, Fig. 6A), or to the group Uruguay-RGS (Raup and Crick index, Fig. 6C). Moreover, in the NMDS (with any of the indices) the nearest point to Ezeiza is Uruguay, and consequently the minimum spanning trees join these areas (Fig. 6B and D). These relationships are even more evident when splitting the regions in localities or smaller areas. In these cases, the highest association indices of Ezeiza are those related with the Uruguayan localities (Table 6). The cluster diagrams (Fig. 7A and C) and the NMDS (Fig. 7B and D) show ever Ezeiza closer to La Coronilla than to any other locality, and in second place of similarity is Nueva Palmira. La Coronilla is not the nearest locality to Ezeiza, in consequence, the similarity should be addressed to a similar (fine tuning) age and environment. However, species frequencies are different. While Ezeiza is dominated by *Gouldia cerina*, *Chione subrostrata* and *Pitar rostratus*, the trophic nucleus of La Coronilla is composed by *Ostreola equestris*, *Caryocorbula caribaea* (d'Orbigny, 1853) and *Bostrycapulus odites* ("*Crepidula aculeata auct.*") (Martínez et al., 2001). Indeed, Ezeiza is richest, more diverse and more equal in species frequencies.

The values of the Taxonomic Distance of Ezeiza are in the middle of the range of the regional Pleistocene areas and/or localities (Table 7).

Another similitude between Ezeiza and the Uruguayan assemblages is the presence of corals of the genus *Astrangia* (Rojas and Martínez, 2008).

5. Paleoecology

All the species are shallow marine inhabitants. Some are euryhaline (*Ostrea puelchana*, *Anomalocardia brasiliana*, *Mactra isabelleana*), but there is not any genuine brackish-water species (such as *Heleobia australis* (d'Orbigny, 1853) or *Erodona mactroides* Bosc, 1802 in the present Rio de la Plata estuary). It is clear that the mollusks represent a coastal marine environment, perhaps with some weak fresh water influence, but far from the fresh-water/estuarine environment present today in the nearby Rio de la Plata.

There are species from soft substrates (v.gr. *Ennucula puelcha* (d'Orbigny, 1842), *Pitar rostratus*, *Chione subrostrata*, *Carycorbula caribaea*), and from consolidated ones too (v.gr. *Ostrea puelchana*, *Plicatula gibbosa*, *Bostrycapulus odites*). In addition, there are species that can be associated with the presence of other invertebrates without fossils here, such as sponges or non coralline cnidarians (*v*.gr. *Boonea* cf. *seminuda*, *Turbonilla* sp., *Seila adamsii*). This assemblage is composed by species from different habitats, although these habitats should not be far apart; for example, Scarabino et al. (2006b) detected the presence of consolidated microhabitats in a dominantly soft substrate. A shell itself can be a microhabitat for an encrusting or boring species. There is also available in the Argentinean coast well cemented Pampeano loess (locally known as "tosca"). Not surprisingly, since in the surroundings there are not truly hard ("rocky") substrates, there are not taxa typical of this substrate in the region (e.g. *Mytilus*, *Brachidontes*, *Echinolittorina)*. In any case, the most abundant species are inhabitants of soft substrates (burrowers) (see Table 2).

There are seven taxa from warm waters with their southern distribution limit displaced northwards today, including the two most abundant in the sample (*Gouldia cerina*, *Chione subrostrata*, *Anomalocardia brasiliana*, *Cyclinella tenuis*, *Crassinella lunulata* (Conrad, 1834), *Laevicardium* sp., *Bittiolum varium*). *Anomalocardia brasiliana* has its southern distributional limit at 39° S according to Rosenberg (2009), but in fact it is not found alive southern to Santa Catarina State (Brazil) (Scarabino, 2003; Scarabino and Zaffaroni, 2004; Lopes and Simone, 2012). Six species are at their southern distribution limit (*Noetia bisulcata* (Lamarck, 1819), *Plicatula gibbosa*, *Lunarca ovalis* (Bruguière, 1789), *Boonea* cf. *seminuda*, *Iselica globosa* (H. C. Lea, 1843), and *Seila adamsii*). There is not any taxa characteristic of cold waters ("magellanic"), although some scarcely represented ones reach relatively high latitudes (*Tegula patagonica* (d'Orbigny, 1842), *Ennucula puelcha*, *Nucula pisum* Sowerby I, 1833).

There are then a lot of arguments to say that there was unequivocally a significant higher temperature of the water than today: seven warm taxa with their southern distribution limit displaced northwards today, other five at their southern distribution limit, the fact that around 60% of all the species and more than 70% of the individuals are of warm-temperate waters, and the absence of strictly cold taxa. Three of them (*Tegula patagonica*, *Ennucula puelcha* and *Nucula pisum*) reach cold waters but their northern distributional limit is about 23° S.

Table 3
Presence-absence matrix of mollusk species used for comparisons among regions. EZ: Ezeiza, RGS: Rio Grande do Sul, UY: Uruguay, BA: Buenos Aires province, SJG: San Jorge Gulf, TF: Tierra del Fuego.

				EZ	RGS	UY	BA	SJG	TF
ceciliana	*Patelloida*	Lottioidea	Lottidae	0	0	0	0	1	0
magellanica	*Nacella*	Nacellidae	Nacelloidea	0	0	0	0	1	0
deaurata	*Nacella*	Nacellidae	Nacelloidea	0	0	0	0	1	0
delicatissima	*Nacella*	Nacellidae	Nacelloidea	0	0	0	0	1	0
radiosa	*Fisurella*	Fissurellidae	Fissurelloidea	0	0	0	0	1	0
picta	*Fisurella*	Fissurellidae	Fissurelloidea	0	0	0	0	1	0
oriens	*Fisurella*	Fissurellidae	Fissurelloidea	0	0	0	0	1	0
patagonica	*Diodora*	Fissurellidae	Fissurelloidea	0	1	1	1	0	0
coppingeri	*Calliostoma*	Calliostomatidae	Trochoidea	0	0	0	1	0	0
patagonica	*Tegula*	Turbinidae	Trochoidea	1	1	1	1	1	0
atra	*Tegula*	Turbinidae	Trochoidea	0	0	0	0	1	0
australis	*Heleobia*	Hydrobiidae	Rissooidea	0	0	1	1	0	0
odites	*Bostrycapulus*	Calyptraeidae	Calyptraeoidea	1	1	1	1	0	0
protea	*Crepidula*	Calyptraeidae	Calyptraeoidea	0	0	0	1	1	0
cachimilla	*Crepidula*	Calyptraeidae	Calyptraeoidea	0	0	0	0	1	0
dilatata	*Crepidula*	Calyptraeidae	Calyptraeoidea	0	0	0	0	1	0
argentina	*Crepidula*	Calyptraeidae	Calyptraeoidea	0	0	0	1	0	0
isabelleana	*Notocochlis*	Naticidae	Naticoidea	0	0	0	1	1	0
dubia	*Finella*	Scaliolidae	Cerithioidea	0	0	1	0	0	0
varium	*Bittiolum*	Cerithiidae	Cerithioidea	1	0	0	0	0	0
adamsii	*Seila*	Cerithiopsidae	Triphoroidea	1	0	0	0	0	0
pulla	*Eumetula*	Cerithiopsidae	Triphoroidea	0	0	0	0	1	0
globosa	*Iselica*	Amathinidae	Pyramidelloidea	1	0	1	0	0	0
gemmulosa	*Chrysallida*	Pyramidelloidea	Pyramidellidae	0	0	1	0	0	0
jadisi	*Boonea*	Pyramidelloidea	Pyramidellidae	0	0	1	0	0	0
seminuda	*Boonea*	Pyramidelloidea	Pyramidellidae	1	0	0	0	0	0
uruguayensis	*Turbonilla*	Pyramidelloidea	Pyramidellidae	0	0	1	0	0	0
argentina	*Turbonilla*	Pyramidelloidea	Pyramidellidae	0	0	0	0	0	0
americana	*Turbonilla*	Pyramidelloidea	Pyramidellidae	0	0	1	0	0	0
lessoni	*Siphonaria*	Siphonariidae	Siphonarioidea	0	0	1	1	1	0
nicocheanus	*Risomurex*	Muricidae	Muricoidea	0	0	0	1	1	0
monodon	*Acanthina*	Muricidae	Muricoidea	0	0	0	0	1	0
haneti	*Urosalpinx*	Muricidae	Muricoidea	0	0	0	1	0	0
cala	*Urosalpinx*	Muricidae	Muricoidea	0	0	0	1	0	0
haemastoma	*Stramonita*	Muricidae	Muricoidea	0	0	1	1	0	0
geversianus	*Trophon*	Muricidae	Muricoidea	0	0	0	0	1	1
muriciformis	*Xymenopsis*	Muricidae	Muricoidea	0	0	0	0	1	1
sertulariarum	*Costoanachis*	Columbellidae	Buccinoidea	0	0	1	0	0	0
isabellei	*Parvanachis*	Columbellidae	Buccinoidea	0	0	1	0	0	0
plumbea	*Pareuthria*	Buccinidae	Buccinoidea	0	0	0	0	1	0
powelli	*Pareuthria*	Buccinidae	Buccinoidea	0	0	0	0	1	0
cerealis	*Pareuthria*	Buccinidae	Buccinoidea	0	0	0	0	1	0
deformis	*Buccinanops*	Nassariidae	Buccinoidea	0	0	0	1	0	0
globulosus	*Buccinanops*	Nassariidae	Buccinoidea	0	0	1	1	1	0
paytensis	*Buccinanops*	Nassariidae	Buccinoidea	0	0	0	1	1	0
cochlidium	*Buccinanops*	Nassariidae	Buccinoidea	0	1	0	1	0	0
duartei	*Buccinanops*	Nassariidae	Buccinoidea	0	1	0	0	0	0
puelcha	*Olivella*	Olividae	Volutoidea	0	0	0	1	0	0
tehuelcha	*Olivella*	Olividae	Volutoidea	0	0	0	1	0	0
carcellesi	*Olivancillaria*	Olividae	Volutoidea	0	1	1	1	0	0
auricularia	*Olivancillaria*	Olividae	Volutoidea	0	0	0	1	0	0
urceus	*Olivancillaria*	Olividae	Volutoidea	0	1	1	0	0	0
deshayesiana	*Olivancillaria*	Olividae	Volutoidea	0	1	1	0	0	0
dufresnei	*Zidona*	Volutidae	Volutoidea	0	1	1	1	0	0
ancilla	*Adelomelon*	Volutidae	Volutoidea	0	0	0	1	0	0
brasiliana	*Pachycymbiola*	Volutidae	Volutoidea	0	1	1	1	0	0
ferussacii	*Pachycymbiola*	Volutidae	Volutoidea	0	0	0	0	1	0
magellanica	*Odontocymbiola*	Volutidae	Volutoidea	0	0	0	0	1	0
martini	*Prunum*	Marginellidae	Volutoidea	0	0	0	1	0	0
lemniscatus	*Lamniconus*	Conidae	Conoidea	0	1	0	0	0	0
gemmulata	*Terebra*	Terebridae	Conoidea	0	1	0	0	0	0
iheringi	*Conus*	Conidae	Conoidea	0	0	0	1	0	0
bidentata	*Cylichnella*	Cylichnidae	Philinoidea	0	0	1	0	0	0
pisum	*Nucula*	Nuculidae	Nuculoidea	1	0	0	0	0	0
puelcha	*Ennucula*	Nuculidae	Nuculoidea	1	0	0	0	0	0
grayi	*Ennucula*	Nuculidae	Nuculoidea	0	0	0	1	0	0
ovalis	*Lunarca*	Arcidae	Arcoidea	1	1	1	0	0	0
chemnitzii	*Scaphaarca*	Arcidae	Arcoidea	0	1	0	1	0	0
bisulcata	*Noetia*	Noetiidae	Arcoidea	1	1	1	1	0	0
brasiliana	*Anadara*	Arcidae	Arcoidea	0	1	0	0	0	0
brasiliana	*Arcinella*	Chamidae	Chamoidea	0	1	0	0	0	0
longior	*Glycymeris*	Glycymerididae	Glycymeridoidea	0	1	0	1	0	0
sp.	*Limaria*	Limidae	Limoidea	0	0	1	0	0	0

Table 3 (*continued*)

				EZ	RGS	UY	BA	SJG	TF
atra	*Aulacomya*	Mytilidae	Mytiloidea	0	0	0	0	1	1
edulis	*Mytilus*	Mytilidae	Mytiloidea	0	0	0	0	1	0
rodriguezii	*Brachidontes*	Mytilidae	Mytiloidea	0	0	0	1	1	0
purpuratus	*Perumytilus*	Mytilidae	Mytiloidea	0	0	0	0	1	0
equestris	*Ostreola*	Ostreidae	Ostreoidea	0	1	1	1	1	0
puelchana	*Ostrea*	Ostreidae	Ostreoidea	1	1	0	0	0	0
rhizophorae	*Crassostrea*	Ostreidae	Ostreoidea	0	1	1	1	0	0
gibbosa	*Plicatula*	Plicatulidae	Plicatuloidea	1	1	1	1	0	0
tehuelchus	*Aequipecten*	Pectinidae	Pectinoidea	0	1	1	1	1	0
guppyi	*Americardia*	Carditidae	Carditoidea	0	0	0	1	0	0
compressa	*Cyclocardia*	Carditidae	Carditoidea	0	0	0	0	1	0
plata	*Carditamera*	Carditidae	Carditoidea	1	0	0	0	0	0
patagonica	*Diplodonta*	Ungulinidae	Lucinoidea	0	0	0	1	0	0
semiasperum	*Phlyctiderma*	Ungulinidae	Lucinoidea	0	0	0	1	0	0
concentricum	*Neolepton*	Neoleptonidae	Cyamioidea	0	0	0	0	0	1
rochebrunei	*Rochefortia*	Galeommatoidea	Lasaeidae	0	0	0	0	0	1
muricatum	*Trachycardium*	Cardiidae	Cardioidea	1	1	1	1	0	0
sp.	*Laevicardium*	Cardiidae	Cardioidea	1	0	0	0	0	0
isabelleana	*Mactra*	Mactridae	Mactroidea	0	1	1	1	0	0
guidoi	*Mactra*	Mactridae	Mactroidea	0	1	0	0	0	0
janeiroensis	*Mactra*	Mactridae	Mactroidea	0	1	0	0	0	0
marplatenis	*Mactra*	Mactridae	Mactroidea	0	1	0	0	0	0
edulis	*Mulinia*	Mactridae	Mactroidea	0	0	0	1	1	0
tehuelchus	*Solen*	Solenidae	Solenoidea	0	0	0	1	0	0
gibber	*Angulus*	Tellinidae	Tellinoidea	1	0	0	1	0	0
uruguayensis	*Macoma*	Tellinidae	Tellinoidea	0	0	0	1	0	0
proficua	*Semele*	Semelidae	Tellinoidea	0	0	1	0	0	0
purpurascens	*Semele*	Semelidae	Tellinoidea	0	1	0	0	0	0
lioica	*Abra*	Semelidae	Tellinoidea	0	0	1	0	0	0
plebeius	*Tagelus*	Solecurtidae	Tellinoidea	0	0	1	1	0	0
subrostrata	*Chione*	Veneridae	Veneroidea	1	1	1	0	0	0
paphia	*Chione*	Veneridae	Veneroidea	0	1	0	0	0	0
gayi	*Clausinella*	Veneridae	Veneroidea	1	0	1	0	1	0
brasiliana	*Anomalocardia*	Veneridae	Veneroidea	1	1	1	1	0	0
rostratus	*Pitar*	Veneridae	Veneroidea	1	1	1	1	1	0
purpurata	*Amiantis*	Veneridae	Veneroidea	0	1	0	1	0	0
exalbidus	*Retrotapes*	Veneridae	Veneroidea	0	0	0	0	1	0
antiqua	*Ameghinomya*	Veneridae	Veneroidea	0	0	0	0	1	0
cerina	*Gouldia*	Veneridae	Veneroidea	1	0	0	0	0	0
tenuis	*Cyclinella*	Veneridae	Veneroidea	1	0	0	0	0	0
lunulata	*Crassinella*	Crassatellidae	Crassatelloidea	1	0	0	0	0	0
sp.	*Sphenia*	Myidae	Myoidea	1	0	0	0	0	0
caribaea	*Caryocorbula*	Corbulidae	Myoidea	1	1	1	0	0	0
patagonica	*Corbula*	Corbulidae	Myoidea	0	0	0	1	0	0
mactroides	*Erodona*	Erodonidae	Myoidea	0	1	0	1	0	0
abbreviatta	*Panopea*	Hiatellidae	Hiatelloidea	0	0	0	1	0	0
lanceolata	*Cyrtopleura*	Pholadidae	Pholadoidea	0	1	0	0	0	0

In the Uruguayan Pleistocene deposits, (the most similar to Ezeiza as seen in section 4), warmer than present conditions were postulated by Martínez et al. (2001), on the basis of mollusks. Additionally, in the most similar one (La Coronilla) Rojas and Urteaga (2011) reported chitons indicating warmer waters too.

Regarding the Pleistocene of Argentina, the closest locality where the mollusks were studied is Pilar, 50 km NNW to Ezeiza. In this place, Fucks et al. (2005) did not found evidence of higher temperature, but it must be taken into account that the inferred environment was noticeably more brackish, a fact that difficult the faunistic comparisons.

At a global scale, the Last Interglacial (approximately 129–116 ka, Capro et al. 2014; Govin et al., 2015), and specifically the peak MIS 5e, is the lapse closest in time with temperatures higher than present ones, 2° and 5° warmer than today in middle and high latitudes of the Northern Hemisphere and 2°–5° (Bradley et al., 2013) or at least 4°(Bakker et al., 2014) or 6° (Sime et al., 2009) in Antarctica. Martínez et al. (2001) interpreted some mollusk Uruguayan assemblages as belonging to MIS 5e on the basis of their geographic distribution (and related temperatures), and consequently a more intense influence of the warm Brazil current in the area than today. This interpretation can be done likewise with the Ezeiza deposits.

6. Age and height

Reported ages and related data are shown in Table 8. As seen there, the AMS ^{14}C ages from Site 1 have around 6000 years of difference between them [33,700 ± 550 yr BP (AA90344) vs. 39,900 ± 1200 yr BP (AA104700)]. Di Micco (1990) reported a conventional ^{14}C age of more than 43,000 yr BP (AC0922). The OSL age from the overlying Site 2 is younger (22,100 ± 1320 yr).

Along the years, there have been reported for the coast of Argentina and Uruguay several ^{14}C datings (conventional or AMS) which gave ages from around 30,000 yr to more than 40,000 yr BP (see references in the following paragraphs).

Some researchers judge that the ^{14}C method, if not giving analytically infinite ages, must be literally read, and the datings signaling MIS3 (as those from Ezeiza just indicated) need not further considerations and are reliable (v. gr. González et al., 1986,

Table 4
Presence-absence matrix of mollusk species used for comparison among localities. EZ: Ezeiza, NP: Nueva Palmira, LC: La Coronilla, CA PI: Punta Indio, FQ: Faro Querandí, BB: Bahía Blanca, CV: Canal Villalonga, LP: Los Pocitos, RGS: Rio Grande do Sul.

				EZ	NP	LC	CA	PI	FQ	BB	CV	LP	RGS
patagonica	*Diodora*	Fissurellidae	Fissurelloidea	0	0	0	0	1	0	0	0	0	1
spp.	*Calliostoma*	Calliostomatidae	Trochoidea	1	0	0	0	0	0	0	0	0	0
patagonica	*Tegula*	Turbinidae	Trochoidea	1	0	1	0	1	0	1	1	1	1
australis	*Heleobia*	Hydrobiidae	Rissooidea	0	1	0	0	0	0	1	1	1	0
odites	*Bostrycapulus*	Calyptraeidae	Calyptraeoidea	1	0	1	0	0	1	1	1	1	1
protea	*Crepidula*	Calyptraeidae	Calyptraeoidea	0	0	0	1	0	1	0	0	0	0
argentina	*Crepidula*	Calyptraeidae	Calyptraeoidea	0	0	0	0	0	0	0	1	0	0
isabelleana	*Notocochlis*	Naticidae	Naticoidea	0	0	0	0	1	0	1	1	0	0
dubia	*Finella*	Scaliolidae	Cerithioidea	0	0	1	0	0	0	0	0	0	0
varium	*Bittiolum*	Cerithiidae	Cerithioidea	1	0	0	0	0	0	0	0	0	0
adamsii	*Seila*	Cerithiopsidae	Triphoroidea	1	0	0	0	0	0	0	0	0	0
globosa	*Iselica*	Amathinidae	Pyramidelloidea	1	0	1	0	0	0	0	0	0	0
gemmulosa	*Chrysallida*	Pyramidelloidea	Pyramidellidae	0	0	1	0	0	0	0	0	0	0
jadisi	*Boonea*	Pyramidelloidea	Pyramidellidae	0	0	1	0	0	0	0	0	0	0
seminuda	*Boonea*	Pyramidelloidea	Pyramidellidae	1	0	0	0	0	0	0	0	0	0
uruguayensis	*Turbonilla*	Pyramidelloidea	Pyramidellidae	0	0	1	0	0	0	0	0	0	0
americana	*Turbonilla*	Pyramidelloidea	Pyramidellidae	0	0	1	0	0	0	0	0	0	0
argentina	*Turbonilla*	Pyramidelloidea	Pyramidellidae	0	0	0	0	0	0	0	0	1	0
sp.	*Turbonilla*	Pyramidelloidea	Pyramidellidae	1	0	0	0	0	0	0	0	0	0
lessoni	*Siphonaria*	Siphonariidae	Siphonarioidea	0	1	0	0	0	0	0	0	1	0
haneti	*Urosalpinx*	Muricidae	Muricoidea	0	0	0	1	1	0	0	0	0	0
haemastoma	*Stramonita*	Muricidae	Muricoidea	0	1	0	0	1	0	0	0	0	0
sertulariarum	*Costoanachis*	Columbellidae	Buccinoidea	0	0	1	0	0	0	0	0	0	0
isabellei	*Parvanachis*	Columbellidae	Buccinoidea	0	0	1	0	0	0	0	1	0	0
plumbea	*Pareuthria*	Buccinidae	Buccinoidea	0	0	0	0	0	1	0	1	0	0
globulosus	*Buccinanops*	Nassariidae	Buccinoidea	0	1	0	1	0	0	1	1	0	0
cochlidium	*Buccinanops*	Nassariidae	Buccinoidea	0	0	0	1	1	0	0	1	0	1
duartei	*Buccinanops*	Nassariidae	Buccinoidea	0	0	0	0	0	0	0	0	0	1
deformis	*Buccinanops*	Nassariidae	Buccinoidea	0	0	0	1	1	0	1	0	0	0
tehuelcha	*Olivella*	Olividae	Volutoidea	0	0	0	0	0	1	1	1	1	0
carcellesi	*Olivancillaria*	Olividae	Volutoidea	0	0	0	1	0	1	0	1	0	1
urceus	*Olivancillaria*	Olividae	Volutoidea	0	0	0	0	0	1	0	0	1	1
deshayesiana	*Olivancillaria*	Olividae	Volutoidea	0	0	0	0	0	0	0	0	0	1
dufresnei	*Zidona*	Volutidae	Volutoidea	0	0	0	0	1	0	0	1	0	1
ancilla	*Adelomelon*	Volutidae	Volutoidea	0	0	0	0	0	1	0	0	0	0
brasiliana	*Pachycymbiola*	Volutidae	Volutoidea	0	0	0	1	1	0	0	0	1	1
gemmulata	*Terebra*	Terebridae	Conoidea	0	0	0	0	0	0	0	0	0	1
lemniscatus	*Lamniconus*	Conidae	Conoidea	0	0	0	0	0	0	0	0	0	1
iheringi	*Conus*	Conidae	Conoidea	0	0	0	1	0	0	0	0	0	0
bidentata	*Cylichnella*	Cylichnidae	Philinoidea	0	1	0	0	1	0	0	0	0	0
pisum	*Nucula*	Nuculidae	Nuculoidea	1	0	0	0	0	0	0	0	0	0
puelcha	*Ennucula*	Nuculidae	Nuculoidea	1	0	0	0	0	0	0	0	0	0
ovalis	*Lunarca*	Arcidae	Arcoidea	1	1	1	0	0	0	0	0	0	1
chemnitzii	*Scaphaarca*	Arcidae	Arcoidea	0	0	0	1	0	0	0	0	0	1
brasiliana	*Anadara*	Arcidae	Arcoidea	0	0	0	0	0	0	0	0	0	1
bisulcata	*Noetia*	Noetiidae	Arcoidea	1	1	0	1	1	0	0	0	0	1
brasiliana	*Arcinella*	Chamidae	Chamoidea	0	0	0	0	0	0	0	0	0	1
longior	*Glycymeris*	Glycymerididae	Glycymeridoidea	0	0	0	1	1	1	0	0	0	1
sp.	*Limaria*	Limidae	Limoidea	0	0	1	0	0	0	0	0	0	0
rodriguezii	*Brachidontes*	Mytilidae	Mytiloidea	0	0	0	0	1	1	1	0	0	0
equestris	*Ostreola*	Ostreidae	Ostreoidea	0	1	1	0	1	0	0	0	0	1
puelchana	*Ostrea*	Ostreidae	Ostreoidea	1	0	0	0	0	0	0	0	0	1
rhizophorae	*Crassostrea*	Ostreidae	Ostreoidea	0	0	0	0	0	0	0	0	0	1
gibbosa	*Plicatula*	Plicatulidae	Plicatuloidea	1	0	1	0	0	0	0	0	0	1
tehuelchus	*Aequipecten*	Pectinidae	Pectinoidea	0	0	1	1	1	0	1	0	0	1
guppyi	*Americardia*	Carditidae	Carditoidea	0	0	0	0	1	1	0	0	0	0
sp.	*Phlyctiderma*	Ungulinidae	Lucinoidea	1	0	0	0	0	0	0	0	0	0
plata	*Carditamera*	Carditidae	Carditoidea	1	0	0	0	0	0	0	0	0	0
muricatum	*Trachycardium*	Cardiidae	Cardioidea	1	0	1	1	1	0	0	0	0	1
sp.	*Laevicardium*	Cardiidae	Cardioidea	1	0	1	0	0	0	0	0	0	0
isabelleana	*Mactra*	Mactridae	Mactroidea	0	1	1	1	1	1	0	0	0	1
guidoi	*Mactra*	Mactridae	Mactroidea	0	0	0	0	0	0	0	0	0	1
marplatenis	*Mactra*	Mactridae	Mactroidea	0	0	0	0	0	0	0	0	0	1
janeiroensis	*Mactra*	Mactridae	Mactroidea	0	0	0	0	0	0	0	0	0	1
gibber	*Angulus*	Tellinidae	Tellinoidea	1	0	0	0	0	1	0	0	0	0
Macoma sp.	*Macoma*	Tellinidae	Tellinoidea	1	0	0	0	0	0	0	0	0	0
proficua	*Semele*	Semelidae	Tellinoidea	0	0	1	0	0	0	0	0	0	0
purpurascens	*Semele*	Semelidae	Tellinoidea	0	0	0	0	0	0	0	0	0	1
lioica	*Abra*	Semelidae	Tellinoidea	0	0	1	0	0	0	0	0	0	0
plebeius	*Tagelus*	Solecurtidae	Tellinoidea	0	1	0	0	0	0	0	0	0	0
subrostrata	*Chione*	Veneridae	Veneroidea	1	1	0	0	0	0	0	0	0	1
paphia	*Chione*	Veneridae	Veneroidea	0	0	0	0	0	0	0	0	0	1
gayi	*Clausinella*	Veneridae	Veneroidea	1	0	1	0	0	0	0	0	0	0

Table 4 (*continued*)

				EZ	NP	LC	CA	PI	FQ	BB	CV	LP	RGS
brasiliana	*Anomalocardia*	Veneridae	Veneroidea	1	1	0	0	0	0	0	0	0	1
rostratus	*Pitar*	Veneridae	Veneroidea	1	1	0	1	1	1	1	0	0	1
purpurata	*Amiantis*	Veneridae	Veneroidea	0	0	0	1	1	1	0	0	0	1
cerina	*Gouldia*	Veneridae	Veneroidea	1	0	0	0	0	0	0	0	0	0
tenuis	*Cyclinella*	Veneridae	Veneroidea	1	0	0	0	0	0	0	0	0	0
lunulata	*Crassinella*	Crassatellidae	Crassatelloidea	1	0	0	0	0	0	0	0	0	0
spp.	*Sphenia*	Myidae	Myoidea	1	0	0	0	0	0	0	0	0	0
caribaea	*Caryocorbula*	Corbulidae	Myoidea	1	1	1	0	0	0	0	0	0	1
patagonica	*Corbula*	Corbulidae	Myoidea	0	0	0	0	0	1	0	0	0	0
mactroides	*Erodona*	Erodonidae	Myoidea	0	0	0	0	1	0	0	0	0	1
lanceolata	*Cyrtopleura*	Pholadidae	Pholadoidea	0	0	0	0	0	0	0	0	0	1

1988a,b; Weiler and González, 1988; Weiler, 1988, 1993; Tonni et al., 2010).

Other authors interpreted these ages as too young to be reliable according to the context (*v.gr.* Tonni and Fidalgo, 1979; Martínez et al., 2001; Schnack et al., 2005; Toledo, 2011; Isla et al., 2000; Martínez et al., 2001; Rabassa et al., 2008), and considered that the questioned deposits belong really to MIS 5 (ca. 130,000–115,000 yr), and more precisely to its peak, MIS5e. They consider that is a contradiction between a MIS 3 age and the higher than present sea level height and warm temperatures evidences in the studied sections. Although there were various sea raisings during MIS 3, by far none of them reached the present sea level, being their maximum height at least about 40 m below present sea level, with a sea temperature lower than today. By the contrary, during MIS5e sea level was higher and temperature warmer than today (e.g. Schaefer et al., 2005; Lambeck et al., 2014; Grant et al.,

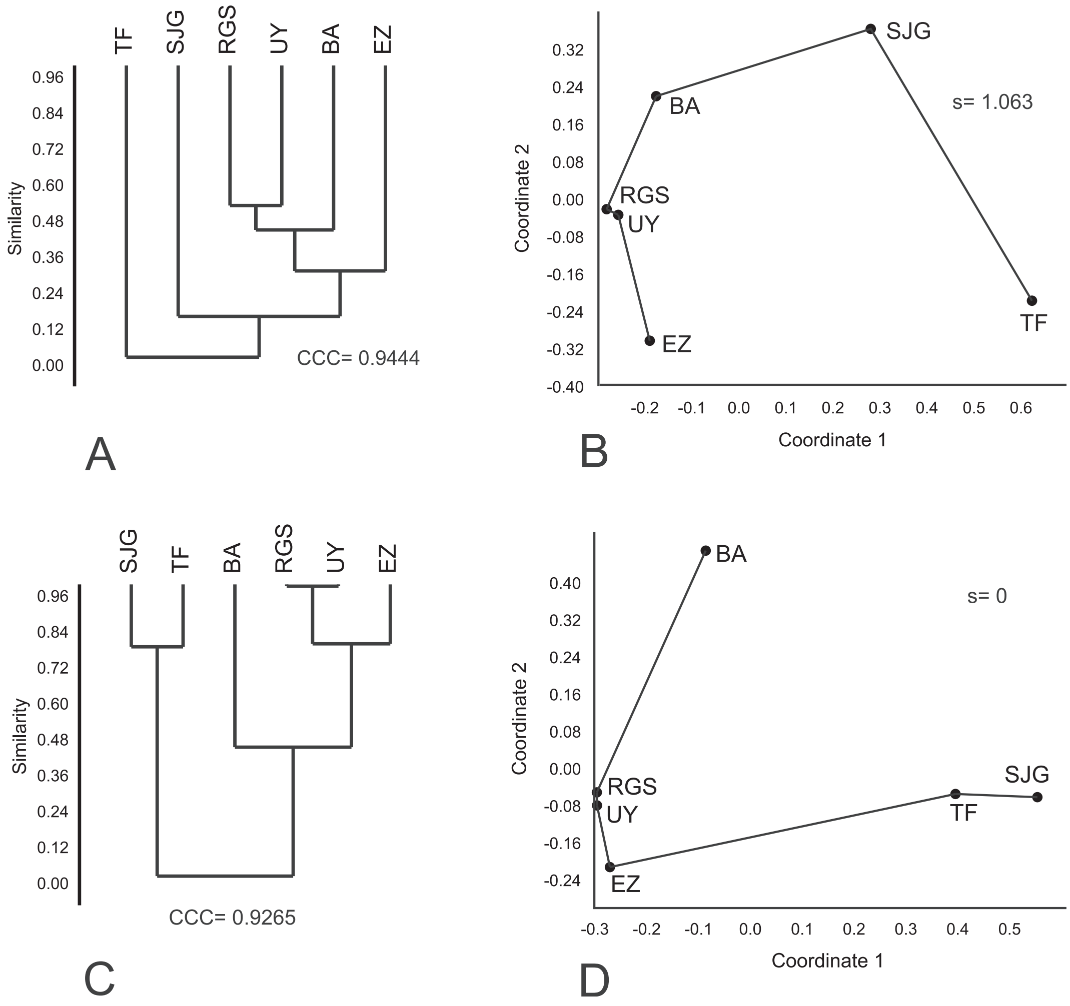

Fig. 6. Multivariate analyses considering presence-absence of mollusk species in the regions indicated in Fig. 2 and Table 3. A. Cluster analysis (Dice coefficient), B. NMDS (Dice coefficient), C. Cluster analysis (Raup & Crick coefficient), D. NMDS (Raup & Crick coefficient). ccc: cophenetic correlation coefficient, s: stress.

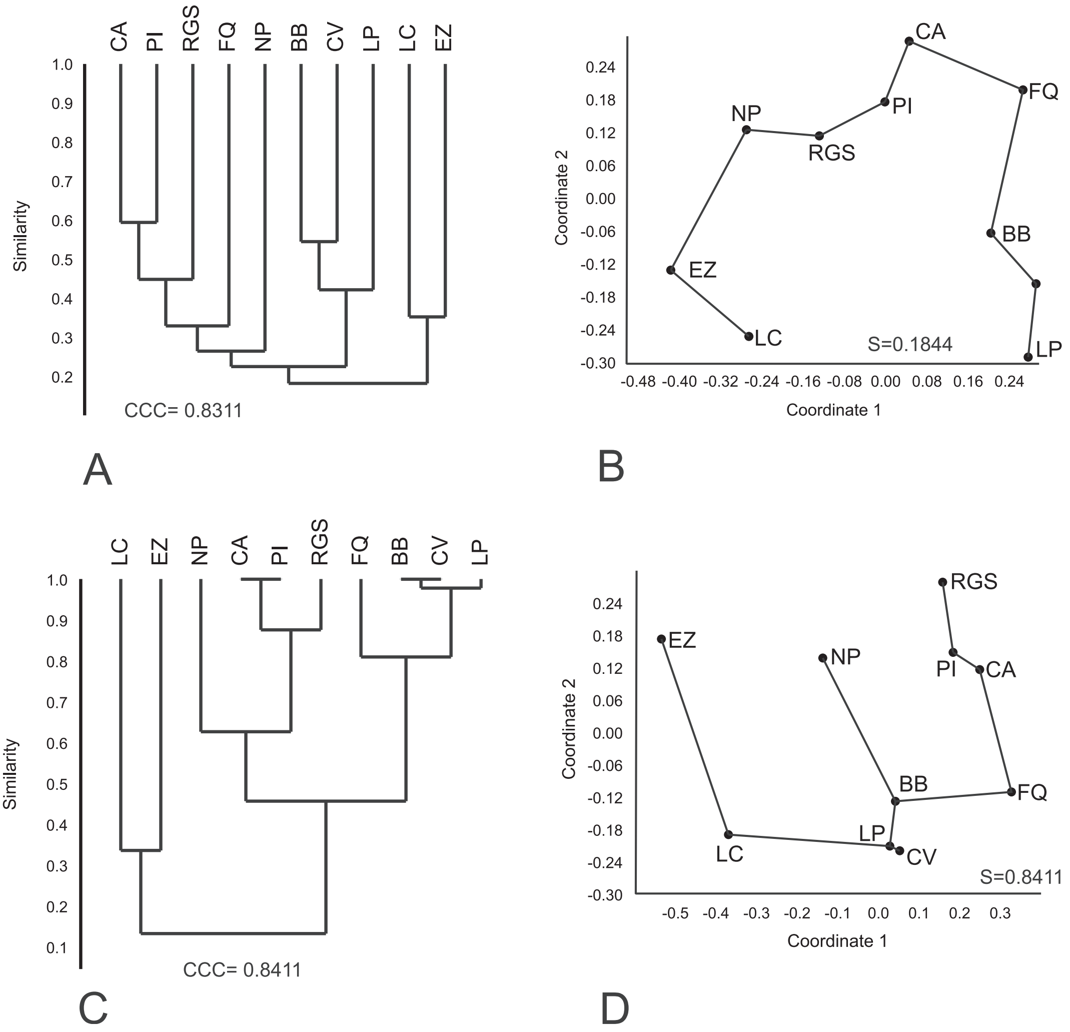

Fig. 7. Multivariate analyses considering abundance of mollusk species in the localities indicated in Table 4. A. Cluster analysis (Dice coefficient), B. NMDS (Dice coefficient), C. Cluster analysis (Raup & Crick coefficient), D. NMDS (Raup & Crick coefficient). ccc: cophenetic correlation coefficient, s: stress. EZ: Ezeiza, NP: Nueva Palmira, LC: La Coronilla, CA PI: Punta Indio, FQ: Faro Querandí, BB: Bahía Blanca, CV: Canal Villalonga, LP: Los Pocitos, RGS: Rio Grande do Sul.

2012, 2014; Medina-Elizalde, 2013; Jouzel et al., 2007; Muhs et al., 2002; Shackleton et al., 2003; Hearty et al., 2007; Kopp et al., 2009; Dutton and Lambeck, 2012; Murray-Wallace, 2002; Zazo et al., 2003, 2007; O'Leary et al., 2013; Govin et al., 2015).

Table 5
Dice and Raup & Crick coefficients among regions. Abbreviations as in Table 2 and Figs. 2 and 6.

	EZ	RGS	UY	BA	SJG	TF
Dice						
EZ	1					
RGS	0.35483871	1				
UY	0.38095238	0.53333333	1			
BA	0.21052632	0.45454545	0.4494382	1		
SJG	0.095238095	0.10666667	0.18421053	0.26966292	1	
TF	0	0	0	0	0.13953488	1
Raup & Crick						
EZ	1					
RGS	0.7425	1				
UY	0.858	0.9935	1			
BA	0.0145	0.7155	0.619	1		
SJG	0	0	0	0.003	1	
TF	0.099	0.0375	0.0405	0.0155	0.7865	1

Isla et al. (2000) and Zárate et al. (2009) dated by OSL a section located around 40 km from Ezeiza, where they recognized a marine 5e bed and the subsequent development of a paleosol. This deposit is at a height similar to ours.

Raised marine deposits with MIS 3 compatible ages are found in Antarctica, but they are explained by glacioisostatic phenomena (regional ice thickening) (Hodgson et al., 2009 and references therein). Ezeiza is situated in a tectonic stable area (Casa et al., 2014; Violante et al., 2014), and the studied deposit is around 3.5 m over present sea level. This height is within the estimations for the sea level during MIS 5e, which range from around +3 to around +9 m above present sea level. (Medina-Elizalde, 2013; Hearty et al., 2007; Murray-Wallace, 2002; Waelbroeck et al., 2002; Sidall et al., 2007; Muhs et al., 2011; Dutton and Lambeck, 2012).

Besides, Toledo (2011) make reference to reworked 5e sediments and coquinas during the 75, 50, and 30 ka lowstands, opening a question about the effect of this erosion and redeposition over the rejuvenation and dispersion of ^{14}C ages (see also Murray-Wallace and Woodroffe, 2014). At Ezeiza, these phenomena are plausible. Site 2, with a OSL age still younger than the ^{14}C ones from Site 1 (Table 8), may be interpreted in this way (see also Ahr et al., 2013 for pedogenesis and bioturbation effects on OSL dating), since

Table 6
Dice and Raup & Crick coefficients among localities. Abbreviations as in Table 3 and Fig. 7.

	EZ	NP	LC	CA	PI	FQ	BB	CV	LP	RGS
Dice										
EZ	1									
NP	0.27906977	1								
LC	0.35294118	0.22222222	1							
CA	0.13333333	0.26666667	0.15789474	1						
PI	0.16	0.34285714	0.23255814	0.59459459	1					
FQ	0.13636364	0.13793103	0.10810811	0.38709677	0.33333333	1				
BB	0.15384615	0.25	0.1875	0.30769231	0.38709677	0.32	1			
CV	0.09756098	0.15384615	0.17647059	0.21428571	0.24242424	0.2962963	0.54545455	1		
LP	0.10810811	0.18181818	0.13333333	0.08333333	0.13793103	0.26086957	0.44444444	0.4	1	
RGS	0.33333333	0.31372549	0.30508475	0.41509434	0.48275862	0.26923077	0.17021277	0.20408163	0.17777778	1
Raup & Crick										
EZ	1									
NP	0.3995	1								
LC	0.3385	0.286	1							
CA	0.0065	0.573	0.0675	1						
PI	0.0015	0,7675	0.1025	0.9985	1					
FQ	0.0115	0.1745	0.0195	0.888	0.7135	1				
BB	0.1395	0.693	0.3515	0.8485	0.9565	0.8675	1			
CV	0.014	0.2825	0.2025	0.4315	0.4785	0.773	0.9995	1		
LP	0.114	0.528	0.2645	0.18	0.29	0.7865	0.987	0.972	1	
RGS	0.0115	0.5065	0.0705	0.864	0.8695	0.2195	0.1245	0.153	0.3175	1

Table 7
Taxonomic diversity indices among regions (A) and localities (B).

	EZ	RGS	UY	BA	SJG	TF
A						
Diversity	3.906	3.886	3.925	3.925	3.878	3.8
Lower limit	3.826	3.853	3.855	3.849	3.845	3.5
Upper limit	3.957	3.943	3.943	3.935	3.943	4
Distinctness	3.906	3.886	3.925	3.925	3.878	3.8
Lower limit	3.865	3.883	3.887	3.875	3.874	3.6
Upper limit	3.978	3.964	3.964	3.954	3.961	4

	EZ	NP	LC	CA	PI	FQ	BB	CV	LP	RGS
B										
Diversity	3.899	3.923	3.918	3.892	3.957	3.867	3.933	3.788	3.857	3.886
Lower limit	3.796	3.725	3.766	3.717	3.776	3.714	3.644	3.667	3.536	3.811
Upper limit	3.936	3.978	3.944	3.967	3.952	3.971	4	3.985	4	3.926
Distinctness	3.899	3.923	3.918	3.892	3.957	3.867	3.933	3.788	3.857	3.886
Lower limit	3.863	3.802	3.836	3.807	3.841	3.788	3.767	3.769	3.692	3.874
Upper limit	3.973	4	3.982	3.992	3.981	3.99	4	4	4	3.966

it corresponds to MIS2 (Last Glacial Maximum) (Jouzel et al., 2007; Clark et al., 2009). At this time, the sea level was about 80–120 m below present one (Guilderson et al., 2000; Grant et al., 2014), and the coastline of the Pampean region was about 160 km far (Ponce et al., 2011). Therefore, the base level of the rivers were lowered and erosion and redeposition were significant processes.

Gasparini et al. (in press) suggest that the lower deposits exposed at the "Nicolás Vignona III" quarry (upstream in the Matanza river, about 21 km Southhwest of Centro Recreativo Ezeiza), can represent either the MIS3 highstand or the MIS5e one (Soibelzon et al., 2012; Gasparini et al., 2013; had considered only the MIS3 alternative). If the MIS5e hypothesis is correct, these deposits should have been at the margin of the ancient estuary, according to their fossiliferous content (see also Calvo-Marcilese et al., 2014).

In sum, prima facie ages obtained for Ezeiza would locate the deposit in MIS3, but faunistic, temperature, and height evidences show that the Ezeiza mollusk assemblage belong to MIS5e.

Considering that this contradiction between ^{14}C ages and other (and stronger) lines of evidence is repeated in various localities in the Southwestern Atlantic coast, it is evident that there is some factor that is rejuvenating the ^{14}C system in mollusks.

7. Conclusions

Ezeiza represents a new Quaternary mollusk assemblage for Argentina, more similar to analogous Uruguayan assemblages than to Argentinean ones. It is interpreted as belonging to MIS 5e and not to MIS 3 or MIS2, as ^{14}C datings would suggest. It has a warm water marine mollusk fauna, with some species that have today their southern range limit displaced to the north. The mollusk assemblage indicates a soft substrate with consolidated microhabitats. Four species and one genus are mentioned for the first time for the Argentinean Quaternary.

Table 8
Ages obtained for Ezeiza.

14C						
Lab number	locality	material	method	d13C	14C age BP	source
AC0922	4	shells	conventional	?	>43,000	Di Micco, 1990
AA90344	Ezeiza1	*Chione subrostrata*	AMS	0.4	33,700±550	this paper
AA104700	Ezeiza1	*Chione subrostrata*	AMS	−1.9	39,900±1200	this paper
OSL						
Lab number	locality	equival. dose (grays)	cosmic dose (mGrays/yr)	total dose (mGrays/yr)	years from 2010	
UIC2941	Ezeiza 2	50.81 ± 3.11	0.016 ± 0.002	2.31 ± 0.12	22,100 ± 1320	this paper

Acknowledgements

Paula Mariela Silva and Héctor Fernando Méndez (Museo de Ciencias Naturales del ISFD35 (Monte Grande, Buenos Aires, Argentina) gave notice of the outcrops and collaborated in field work. Nilda Weiler (CENPAT-CONICET, Argentina) gave useful comments. Mariana Demicheli (Facultad de Ciencias, Montevideo) helped with the picking and specimen counting. Celeste Martínez provided language help. Darío Lazo and an anonymous reviewer improved an earlier version of this paper. Projects ANCyP PICT 57, PIP 320 and CSIC 615 provided financial support.

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