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First approximation to paleodemography through age-at-death profiles in hunter-gatherers from Southern Patagonia during middle-late Holocene

Jorge Suby [a, *], Leandro Luna [b], Claudia Aranda [c], Gustavo Flensborg [d]

[a] INCUAPA-CONICET- Department of Archaeology, National University of the Center of Buenos Aires Province, Bioarchaeology Research Group (GIB), 508 Street # 881, 7630, Quequén, Argentina
[b] University of Buenos Aires-CONICET, Institute of the Cultures (IDECU), Faculty of Philosophy and Letters, Bioarchaeology Research Group (GIB), Moreno 350, 1091, Buenos Aires, Argentina
[c] Ethnographic Museum J. B. Ambrosetti, Faculty of Philosophy and Letters, University of Buenos Aires, Bioarchaeology Research Group (GIB), Moreno 350, 1091, Buenos Aires, Argentina
[d] INCUAPA-CONICET. Faculty of Social Sciences, National University of the Center of Buenos Aires Province, Bioarchaeology Research Group (GIB), del Valle Av. 5737, B7400JWI, Olavarría, Argentina

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ABSTRACT

The aims of this paper is threefold: 1) to explore the spatial and temporal variations in age-at-death profiles of human remains from Southern Patagonia in order to test and discuss the hypothetical increasing demography during the late Holocene; 2) to evaluate probable biases in the skeletal samples derived from preservation issues, social organization features and/or mortuary behavior, and 3) to compare the results with those reported for other hunter-gatherer societies from Pampa and Patagonia regions, offering valuable insights about the age-at-death profiles and paleodemographic for other Southern South American hunter-gatherers with different social characteristics. Age-at-death profiles from Southern Patagonia below 50°S, corresponding to the middle-late Holocene (i.e., after ca. 5500 years before present -YBP-), were constructed from a skeletal series of 119 individuals. Sex and age distribution of the entire sample was firstly analyzed, and two other age-at-death profiles were thereafter built, dividing the sample by region (Santa Cruz/Magellan, Northern Tierra del Fuego and Southern Tierra del Fuego) and by chronology (5500–3500 YBP, 3500–1000 YBP, 1000–400 YBP and after 400 YBP). The results show an attritional profile with two peaks, the first one between 1.1 and 10 years-old and the other for the 20.1–35 age group. A low number of newborns younger than 1 year-old is observed. This could be the result of a low mortality rate for this age interval and a high parental care during the first period of childhood, although taphonomical and mortuary biases cannot be completely excluded. Adult males and females are similarly represented in each age category. Juvenile Index data are higher than 0.17 between 5500 and 400 YBP periods, suggesting population growth, with a particular demographic increase between 5500–3500 and 1000–400 YBP periods. During the contact period, fertility is dramatically reduced. The age-at-death profile is similar to other hunter-gatherer past populations from Pampa and Patagonia regions. Despite the differences regarding mobility strategies, social organization, demographic dynamics and mortuary behavior known for those societies, all profiles show a comparable bimodal attritional pattern, although some variation in the most represented age-groups and demographic growth is observed.

1. Introduction

Several approaches to assessing demographic changes in past human populations from Southern Patagonia have been proposed during the last decade. Probability distribution of radiocarbon dates as well as molecular, isotopic and morphometric analyses were

* Corresponding author.
E-mail addresses: jasuby@conicet.gov.ar, jasuby@gmail.com (J. Suby), lunaranda@gmail.com (L. Luna), clauaranda@gmail.com (C. Aranda), gflensbo@soc.unicen.edu.ar (G. Flensborg).

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considered as proxies to infer population variations in size, residential mobility and dynamic population during middle and late Holocene. Among these studies, García Guraieb et al. (2015) offered the first comprehensive analyses of age-at-death profiles for the Salitroso Lake area (north-west of Santa Cruz province, Argentina), that was discussed together with molecular, isotopic and mortuary patterns. The authors suggested that paleoenvironmental changes (e.g., MCA), reduced the residential mobility and increased the demographic growth during the last millennium in the area (García Guraieb et al., 2015). Zubimendi et al. (2015) also detected evidence of increasing occupation density during the last ca. 1500 YBP in the northern coast of Santa Cruz province through probability distribution of radiocarbon dates. Molecular studies published by de Saint Pierre et al. (2012) suggested that hunter-gatherers from Tierra del Fuego-Patagonia showed a slight increase in population size in the last 2000 YBP, possibly associated to the movement of the Mapuche people to the south.

Through a biogeographical approach, Barberena (2008) proposed the existence of temporal variations in demography during different periods of the Holocene in the Southern extreme of the continent, with a steady pattern of increasing population density during the last ca. 4000–3500 YBP and a stronger archaeological signal between 1200 and 1000 YBP. These interpretations were based on the probability distribution of radiocarbon dates, stable isotope analysis and the patterns of mobility between the inland and the coast. More recently, Pallo and Ozán (2014) also proposed an increment of demography during last ca. 1500 YBP based on the chronological distribution of archaeological sites from Fuego-Patagonia as a proxy of demographic changes. No relationship between climatic and demographic changes was found, with the exception of a regional dryer period, possibly associated with the Medieval Climatic Anomaly between 700 and 500 YBP (Stine, 1994, 2000; Haberzetll et al., 2005), which coincides with increasing signals of human occupation in the archaeological record (Pallo and Ozán, 2014). In the same vein, Zangrando (2009) and Tivoli and Zangrando (2011) suggested that the observed changes in subsistence patterns (i.e., intensification in the consumption of birds and fishes) and spatial areas of foraging were a result of an increment of the demographic density in the Beagle Channel region (Southern extreme of Tierra del Fuego) since 1500 YBP. These results are coincident with those reported by Perez et al. (2016), who recently studied the radiocarbon frequency distributions and molecular data from different areas of Patagonia. The authors propose that human population size steadily increased since 4000 YBP, reaching a maximum about ca. 1000 YBP, particularly in the region analyzed in this paper.

Despite the importance of these valuable efforts to understand the paleodemographic changes during the Holocene in the Southern extreme of Patagonia, age-at-death profiles from human skeletal remains were not considered so far, which offer alternative and complementary independent data to evaluate this topic (Hassan, 1981; Paine, 1997; Hoppa, 2002; Chamberlain, 2006; Frankenberg and Konigsberg, 2006; Milner et al., 2008; de Saint Pierre et al., 2012; Ubelaker, 2014; Perez et al., 2016). Such kind of data is highly relevant to discuss previous research and to understand the social dynamics in this region in conjunction with other independent lines of evidence, sustaining or rejecting previous hypotheses derived from other sources of archaeological data. In the present study, age-at-death profiles are provided as a proxy to infer demographic patterns of past populations and its changes over time. At the same time, they are useful tools to detect biases in sex and age-at-death distributions from skeletal series.

This paper has three major aims. First, to explore the spatial and temporal variations in age-at-death profiles of human remains from Southern Patagonia, divided in Southern Santa Cruz/Magellan, Northern and Southern of Tierra del Fuego regions (Fig. 1) during the middle-late Holocene (after ca. 5500 YBP). This analysis will be useful in order to test and discuss the hypothetical increasing demography during the late Holocene, particularly after 1000 YBP. Second, to evaluate probable biases in the skeletal samples available for further bioarchaeological and paleopathological research derived from preservation problems, social organization features and/or mortuary behavior. Third, to compare the results from Southern Patagonia with those reported from other hunter-gatherer societies from Pampa and Patagonia regions. This comparison will offer valuable data about the age-at-death profiles and paleodemography trends in hunter-gatherers from Southern South America with different social and archaeological characteristics.

Considering the previously published chronological and molecular distributions of data, it is our hypothesis that variations and increasing population growth is expected during middle and late Holocene until the beginning of the colonization process, when dramatic social and biological changes produced a declination in population size. As no age-at-death profiles are available from Southern Patagonia so far, the hypotheses about this matter are based in curves for other hunter-gatherer societies. In this sense, we expect low life expectancy and balanced representation of skeletons by sex, preferably from young and middle adults. Moreover, low frequency of infants can be expected, due to both taphonomic and mortuary biases.

2. Paleoenvironmental, biocultural and bioarchaeological context

Southern Patagonia is geographically and ecologically diverse. Its Western and Southern margins are occupied by the Andes mountain chain, bordered by forests of *Araucaria araucana* in the north and *Nothofagus* sp. at the south. In contrast, the extra-mountain region in the continent and in the Central-Northern area of the Tierra del Fuego Island is characterized by desert steppes crossed by a few mayor rivers (Oliva et al., 2001; McCulloch et al., 2005). At present, the Southwestern archipelago is a densely forested strip with irregular coasts, cooler and rainier than the north, with mean temperature variations between ca. 1 and 9 °C and precipitations from 800 to 4000 mm a year. In contrast, the Atlantic coastline shows a high environmental and ecological variation due to its wide extension, from temperate deserts and steppes in the north, with precipitations below 400 mm, to a subhumid climate in the south (Bailey, 1989; Oliva et al., 2001; McCulloch et al., 2005).

Paleoenvironmental information suggests a relative climatic stability during the last ca. 5000 YBP (the temporal span discussed here), though some local specific changes in temperature and humidity were proposed for the late Holocene, probably related to the Medieval Climatic Anomaly (ca. 700–550 YBP) and the Little Ice Age (ca. 540–180 YBP). The first phenomenon was characterized by a warmer and arid event in the area, immediately followed by the second one, evidenced by a decline in temperatures and an increment of precipitation (Stine, 2000; Haberzetll et al., 2005; Borromei et al., 2007).

The archaeological record offers clear evidence of human occupation since the Final Pleistocene (ca. 11.000 YBP) in Southern continental Patagonia and Northern Tierra del Fuego (Massone, 1987; Prieto, 1991; Miotti et al., 2003; Paunero, 2003; Massone and Prieto, 2004) and since the middle Holocene (ca. 7800 YBP) in Southern Tierra del Fuego (Orquera and Piana, 2009). Detailed reviews of the chronological data available have been previously presented (Borrero, 1999; Orquera and Piana, 2009; Steele and Politis, 2009). However, the bioarchaeological record only covers the last ca. 6500 YBP, being the taphonomical biases and the

organizational and behavioral characteristics of hunter-gatherer groups the most probable causes for the lack of more ancient remains (Dillehay, 1997; Guichón et al., 2001; Barberena, 2008).

Ethnographic chronicles (e.g., Hyades and Deniker, 1891; Gusinde, [1937] 1986; Emperaire [1958] 2002; see also Orquera and Piana, 1999, 2009; Saletta, 2015), mentioned two main different lifestyles for human populations from Southern Patagonia: terrestrial hunter-gatherers (Tehuelches or Aonikenk in the continent and Selk'nam in Northern Tierra del Fuego) and marine hunter-gatherers (Kaweshkar and Yamana in the littoral of Southern Tierra del Fuego). These dichotomical terrestrial-marine modes of subsistence were largely discussed since the late 1980's (Borrero, 1989-1990) and were outscored during the following years by new analyses of the archaeological data that showed a wider and more complex scenario, in which intermediate lifestyles were also identified. In fact, analyses of stable isotope and zooarchaeological data informed that although terrestrial foods constituted the main resources for human consumption in continental and Northern insular areas of Southern Patagonia, many marine species were also consumed at least seasonally near the coasts (Borrero and Barberena, 2006; Barberena, 2008; Borrero and Charlín, 2010; Santiago et al., 2011; Morello et al., 2012; Saletta, 2015). In the same way, archaeological evidence from Southern Tierra del Fuego showed that human populations that inhabited the Beagle Channel and the Cape Horne regions substantially consumed marine resources using canoes for hunting and fishing oceanic species, even though terrestrial resources were also exploited (e.g., Orquera and Piana, 1999; Tessone et al., 2003; Yesner et al., 2003; Orquera, 2005; Panarello et al., 2006; Orquera and Piana, 2009; Tivoli and Zangrando, 2011; Saletta, 2015). In summary, although hunter-gatherers with extreme economic patterns in a macro-regional scale were recognized, the archaeological data also suggest a continuum of groups with intermediate economies, which implies the variable exploitation of terrestrial and marine resources.

Small population sizes and high residential mobility were proposed for human populations from continental Southern Patagonia and Northern Tierra del Fuego, mainly based on the spatial and temporal distributions of the archaeological evidence (e.g., Borrero, 2001; Barberena, 2008; Borrero et al., 2009; Morello et al., 2012; Pallo and Ozán, 2014). Similar features were defined for Southern

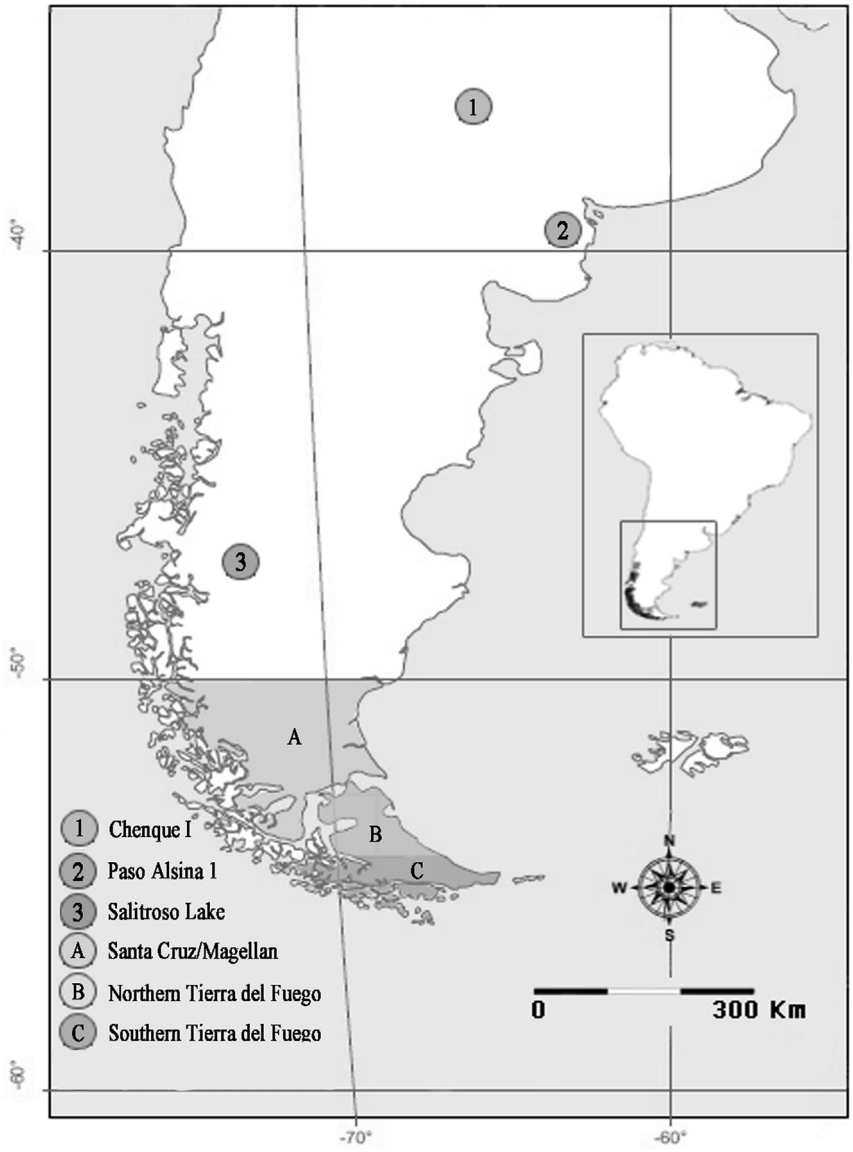

Fig. 1. Location of three regions of Southern Patagonia and sites from Pampa and Patagonia regions considered in this paper.

Patagonia, but with more logistics mobility strategies (e.g., Zangrando, 2009; Tivoli and Zangrando, 2011). Probably related to the high mobility pattern, secondary mortuary practices and cemeteries or formal areas of disposal were not discovered in Southern Patagonia in the pre-Hispanic period (Guichón et al., 2001; Barberena, 2008). Instead, the burials generally include isolated individuals, with the exception of a few cases of multiple burials, like Orejas de Burro (L'Heureux and Barberena, 2008), Cañadón Leona 5 (L'Heureux and Amorosi, 2009), Cerro Sota (L'Heureux and Amorosi, 2010), Río Bote 1 (Franco et al., 2010) and Margen Sur (Santiago et al., 2011) sites. This pattern of mortuary behavior is clearly different from the numerous multiple pre-Hispanic burials detected at archaeological sites from Northern areas (e.g., Northwest Patagonia, Cuyo region, Western Pampas, Eastern Pampa-Patagonia transition, Central and Northern coasts of Santa Cruz province, among others; Castro and Moreno, 2000; Mena and Reyes, 2001; Della Negra and Novellino, 2005; Mendonça et al., 2010; Berón et al., 2012; Flensborg et al., 2015; García Guraieb et al., 2015).

3. Materials and methods

Skeletons from Southern Patagonia (Figs. 1 and 2) recovered below 50°S latitude were included in the analysis, preferably with reliable archaeological data and radiocarbon dating. Human remains from mission cemeteries were not included in this research because important differences in lifestyles are recognized, compared to a strictly hunter-gatherer way of life. In this paper, 119 individuals were considered (Table 1), 58 of which were directly analyzed by the authors for sex determination and age-at-death estimation, while published information was considered for the remaining 61. In these last cases, only data with reliable description about the methods employed were included. Although methodological interobserver biases cannot be completed discarded, the methods used by the different authors are mostly coincident with those applied here (see below). Moreover, sex and age-at-death of the skeletons studied by L'Heureux et al. (2003), L'Heureux and Barberena (2008), Guichón (1994), Martin et al. (2004), Guichón et al. (2000) and Schinder and Guichón (2003) were also revised by one of the authors (JAS), and both sets of results were similar (Suby, 2014a and b). For that reason, published data and information produced in this paper are assumed to be comparable.

Sex was determined for skeletons older than 15 years-old (Lewis, 2006), following the traditional methods described by Buikstra and Ubelaker (1994) for the morphological features of the coxal bone and the skull. Individuals sexed as probably males and probable females were included in the male and female categories, respectively. Skeletons older than 20 years-old were considered adults (Buikstra and Ubelaker, 1994). Immature age-at-death was obtained recording dental calcification, dental eruption, maximum long bone lengths and epiphyseal fusion patterns (Fazekas and Kòsa, 1978; Ubelaker, 1989; Buikstra and Ubelaker, 1994; Scheuer and Black, 2000). For adults, this information was obtained analyzing the morphological changes of the auricular surface and the pubic symphysis, and cranial suture closure (Todd, 1921a; b; Lovejoy et al., 1985; Meindl and Lovejoy, 1985; Brooks and Suchey, 1990). In all cases, a multifactorial approach was used when more than one variable was available for recording, and the mean value of all the estimated ages-at-death for a single individual was considered as the most probable value.

Age-at-death profiles were generated according to the following age groups: 0–1; 1.1–5; 5.1–10; 10.1–15; 15.1–20; 20.1–35; 35.1–50; +50.1 years old. The curves were created for the entire sample and classified by sex for those individuals older than 15 years old. As Southern Patagonia is characterized by isolated burials from different archaeological sites (see *Paleoenvironmental, Biocultural and Bioarchaeological Context*), they were usually grouped together by geographic, paleodietary or ethnographic criteria for analytic purposes, in order to manage bigger samples (e.g., Borrero and Barberena, 2006; Santiago et al., 2011; Alfonso-Durruty et al., 2015; de la Fuente et al., 2015). In this case, the skeletons were grouped following geographic and chronological criteria, and two additional age-at-death profiles were constructed, firstly dividing the sample by region (Santa Cruz/Magellan, Northern Tierra del Fuego and Southern Tierra del Fuego), and secondly by chronology. In the last case, the sample was divided into four different periods: between 5500 and 3500 YBP, between 3500 and 1000 YBP, between 1000 and 400 YBP and after 400 YBP (i.e., the beginning of the social contact with Europeans).

As the proportion of immature skeletons in relation to the number of adults is a *proxy* of population growth rate, the juvenile index (*JI*), or $^{15}P^{5}$, was calculated as the number of individuals between 5 and 14 years-old divided by the total number of individuals above the 5 years-old (Bocquet-Appel and Masset, 1982; Jackes, 1992; Bocquet-Appel and Bacro, 1997; Bocquet-Appel and Naji, 2006; Kohler and Reese, 2014). This index is expected to be higher in the context of increasing demographics than in a trend of a decreasing population (Bocquet-Appel and Ibañez, 2002). Only *JI* greater than 0.17 were considered as predictive of growing populations (Bocquet-Appel and Naji, 2006). Although this approach was originally designed specifically to study cemetery samples (e.g., Bocquet-Appel, 2002) and may introduce some bias when used in samples excavated in archaeological sites without formal areas of disposal, there are no other alternative methods to address this issue so far.

The results obtained for the sample between 1000 and 400 YBP from Southern Patagonia were compared with data from hunter-gatherer burials of the same period reported for Chenque I site (Western Pampas; Luna, 2008, 2012), Paso Alsina 1 site (Eastern Pampa-Patagonia transition; Flensborg et al., 2015), and Salitroso Lake area (Northwest of Southern Patagonia; García Guraieb et al., 2015) (Fig. 1), in order to explore general macro-regional trends in sex and age-at-death distributions among hunter-gatherer populations of Southern South America. Chenque I site is a cemetery that includes 42 primary and secondary burials, simple and multiple structures of inhumation, with a high quantity of fragmented and commingled human remains. In this landscape, at least a minimum number of 216 individuals belonging to at least two biologically different populations were buried between ca. 1050–300 YBP (Luna, 2008, 2012; Berón et al., 2012). Paso Alsina 1 is a formal disposal area of inhumations located in the Eastern

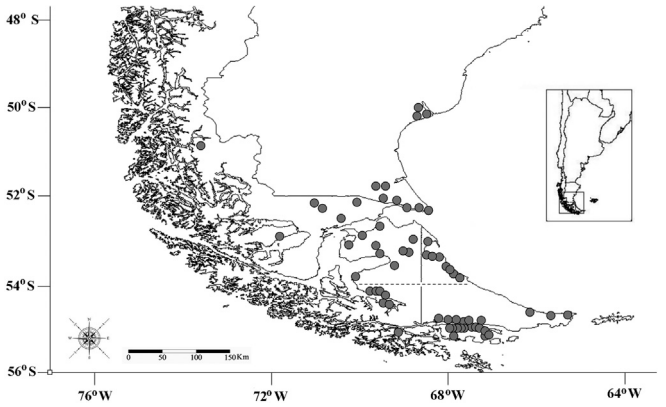

Fig. 2. Location of archaeological sites with human remains from Southern Patagonia, below latitude 50°S. Dot line divides Northern from Southern Tierra del Fuego.

Pampa-Patagonia transition, composed by several multiple secondary burials grouped into bundles. A minimum number of 77 individuals corresponding to the same biological population were simultaneously buried ca. 500 YBP (Flensborg et al., 2015; Luna et al., 2017). Finally, Salitroso Lake is a mortuary area of ca. 200 km^2 in the Northwest Santa Cruz province, with numerous burials in chenques, niches and under boulders. The skeletons were dated from ca. 2600 to 350 YBP, although most of them, entirely represented by chenques, are restricted between 800 and 350 YBP. This is the span considered in this paper.

Some age groups considered by those authors differ from the ranges used here, which forced to recalculate some published data in order to re-distribute the results in the categories defined in this paper. In addition, individuals classified by the original authors into general categories, such as adult or non-adult, were not considered. Statistical differences between skeletal series were tested using Kolmogorov-Smirnov analyses with the R statistical program (version 3.1.3) and also graphically observed with a Ward cluster.

4. Results

Among the studied skeletons, 72 (60.5%) were aged as adults and 47 (39.5%) as non-adults (Table 2). Moreover, 42 skeletons (35.3%) were sexed as males and 36 (30.3%) as females. Males were slightly more represented than females in all age groups excepting the +50.1 category, which included only one female (Table 2; Fig. 3).

The age-at-death profile showed a bimodal pattern with two peaks, the first one between 1.1 and 10 years-old, and the other for the 20.1–35 age group (Fig. 3). Only 4.2% (5 out of 119) died before 1 year-old, while the highest frequency of non-adult individuals is recorded between the 1.1 and 15 years-old groups (ca. 8–11% each), with a very similar number of individuals in the 1.1–5, 5.1–10 and 10.1–15 age intervals. On the contrary, the percentage decreases in the 15.1–20 years-old age group (5.1%). The highest frequency was observed among 20.1–35 years-old individuals, the second peak of the profile, in comparison with the previous and the next age groups. Most of the individuals died between 20.1 and 50 years-old (71 out of 119; 59.66%) while only one died after 50.1 years-old (Table 2).

4.1. Regional comparison

Human skeletons are more represented in Southern Tierra del Fuego (42%; 50 out of 119) for all age groups, followed by Santa Cruz/Magellan (33.6%; 40 out of 119) and Northern Tierra del Fuego (24.4%; 29 out of 119) (Table 3). For the non-adult age groups, the highest frequencies of individuals correspond to Santa Cruz/Magellan and Northern Tierra del Fuego regions. The percentages reach 50 and 41.4% respectively, which contrast with a much lower value for Southern Tierra del Fuego (30%). However, individuals younger than 1 year-old are not represented in the sample from Northern Tierra del Fuego, in contrast with Santa Cruz/Magellan (7.5%) and Southern Tierra del Fuego (4%). The frequencies of those who died between 1.1 and 5 years-old are higher in Santa Cruz/Magellan (17.5%) and Southern Tierra del Fuego (10%) than in Northern Tierra del Fuego (3.4%). In contrast, 5.1–10 years-old age group is more represented in Northern Tierra del Fuego (17.2%) and Santa Cruz/Magellan (15%) than in Southern Tierra del Fuego (4%). Frequencies decrease in the 10.1–15 years-old age group from Santa Cruz/Magellan (10%) and Northern Tierra del Fuego (10.4%) regions, and it is maintained in the Southern area (6%). Finally, immature skeletons died between 15.1 and 20 years-old are completely absent in the Santa Cruz/Magellan sample, while the percentages for the other two regions are equal as for the previous age category (Table 3; Fig. 4). In both cases, frequencies of males double those of females.

Adult percentages show substantial increments for the first category (20.1–35 years-old) in the three regions, reaching 48.3% in Northern Tierra del Fuego, 36% in Southern Tierra del Fuego and 25% in Santa Cruz/Magellan region. Most of the individuals from Northern and Southern Tierra del Fuego died between 20.1 and 35 years-old, while in Santa Cruz/Magellan the frequency is the same as in the next category. The percentages sharply decrease beyond +50 years-old in all regions (Table 3; Fig. 4). Both sexes are similarly represented in each range in the sample from Southern Tierra del Fuego. On the contrary, in Northern Tierra del Fuego females are not presented in the 35.1–50 age group, and for the 20.1–35 interval, frequencies for both sexes are similar. In the Santa Cruz/Magellan region, males are much more frequent than females in the 20.1–35 age group, while they are equally represented in the next category (Table 3). The only skeleton aged as old-adult is a female from Southern Tierra del Fuego. Finally, the *JI* is very similar between Santa Cruz/Magellan and Northern Tierra del Fuego (0.33 and 0.29 respectively), while for Southern Tierra del Fuego it is much lower (0.12).

4.2. Temporal comparison

When the whole sample is chronologically analyzed, skeletons dated between 5500 and 3500 YBP are more represented by adults (62.5%). Percentages decrease from young adults (37.5%) to middle adults (25%), and individuals older than 50 years are absent. Non-adults (37.5%) are present only in the 0–1 and 5.1–10 age categories (Table 4). High representation of adults is seen in the 3500–1000 YBP period (71.4%), in which the 35.1–50 age group shows a higher frequency of skeletons (57.1%) than that of young adults (14.3%). In addition, only two non-adults (for the 0–1 and the 5.1–10 age intervals) were identified. For the 1000–400 YBP period, higher frequencies of individuals for the 5.1–10 (31.2%) and the 20.1–35 (37.5%) years-old ranges, than for the other categories, were recorded (Table 4). During the post-contact period (<400 YBP), the highest percentage is observed for the 20.1–35 years-old category (78.5%), and for non-adults only one individual was identified. Kolmogorov-Smirnov statistical analyzes showed no significant difference between 5500 and 3500 YBP and 3500–1000 YBP periods ($p < 0.1$), and between 3500 and 1000 YBP and 1000–400 YBP periods ($p < 0.1$). On the contrary, statistical difference was found between 1000 and 400 YBP and <400 YBP periods ($p < 0.05$). JI values are variable for the three pre-contact periods (0.17–0.38), being higher in the 5500–3500 and 1000–400 YBP periods than during 3500–1000 YBP. As no skeletons between 5 and 14 years-old were recovered, JI is equal to 0 for the <400 YPB period (Table 4; Fig. 5).

4.3. Inter-sample comparison

The comparison among the results of Southern Patagonia and those from other hunter-gatherer samples from Argentina for the 1000–400 YBP period shows bimodal profiles in all cases. However, the Salitroso Lake sample is divergent in several age categories (Table 5; Fig. 6, see below). All the samples show similar frequencies of skeletons from 0 to 1 year-old (from 10.8 to 12.1%), except that from Southern Patagonia, in which no skeletons from this age group were recorded. The skeletal samples from Salitroso Lake, Chenque I and Southern Patagonia present higher percentages of individuals between 1.1 and 10 age groups (34.5%, 22.2% and 31.3% respectively) than Paso Alsina 1 sample (6.8%). The high frequency of skeletons in the 5.1–10 age group for Salitroso Lake (20.7%) and Southern Patagonia (31.3%) are very different compared

Table 1
Skeletal series from Southern Patagonia included in this paper.

Region	Skeleton/Site	Chronology (YBP)	Diet	Sex	Age (years)	References
Santa Cruz/Magellan	1. Cañadón Misionero	70 ± 30	T	M	35–45	Suby et al., 2009
N = 40	2. Rincón del Buque	830 ± 42	T	M	35–40	Suby et al., 2009
% = 33.6	3. Punta Entrada 3	1748 ± 45	T	I	8–11	Suby et al., 2009
	4. Punta Entrada 4	400 ± 30	T	I	2–4	Suby et al., 2009
	5. Cabo Vírgenes 17.1	900 ± 40	Mix	M	20–34	L'Heureux et al., 2003
	6. Cabo Vírgenes 17.2	900 ± 40	Mix	F	20–34	L'Heureux et al., 2003
	7. Orejas de Burro (sk. 1)	3565 ± 45	Mix	M	20–25	L'Heureux and Barberena, 2008
	8. Orejas de Burro (sk. 2)	3565 ± 45	Mix	M	45–50	L'Heureux and Barberena, 2008
	9. Orejas de Burro (sk. 3)	3565 ± 45	T	I	6–10	L'Heureux and Barberena, 2008
	10. Orejas de Burro (sk. 4)	3565 ± 45	L	I	4–8	L'Heureux and Barberena, 2008
	11. Orejas de Burro (sk. 5)	3565 ± 45	–	I	<0.5	L'Heureux and Barberena, 2008
	12. Cerro Johnny	390 ± 60	T	M	30–40	Borrero and Barberena, 2006
	13. Juni Aike	During contact	T	M	30–40	Borrero and Barberena, 2006
	14. Punta Daniel	1118 ± 43	Mix	M	30–40	Suby, 2014a
	15. Posesión Olimpia 2	XIX Century	T	M	30–40	Suby, 2014a
	16. Pali Aike 991/772	–	–	I	4	Soto-Heim, 1994
	17. Pali Aike 991/773	–	–	M	43	Soto-Heim, 1994
	18. Pali Aike 991/775	–	–	I	5	Soto-Heim, 1994
	19. Pali Aike 991/775	–	–	I	12	Soto-Heim, 1994
	20. Lago Sofía 1 (sk. 1)	–	–	I	Newborn	Soto-Heim, 1994
	21. Lago Sofía 1 (sk. 2)	–	–	I	3	Soto-Heim, 1994
	22. Dungenes IP 26839	–	–	I	7	Guichón, 1994
	23. San Gregorio 4 IP 10744	–	–	I	10	Guichón, 1994
	24. CL.1.1 AMNH.99.1/769	–	–	M	23–27	L'Heureux and Amorosi, 2009
	25. CL.1.2 AMNH.99.1/769	–	–	F	20–25	L'Heureux and Amorosi, 2009
	26. CL.2.1 AMNH.99.1/770	–	–	M	33–37	L'Heureux and Amorosi, 2009
	27. CL.3 AMNH.99.1/771	–	–	F	35–40	L'Heureux and Amorosi, 2009
	28. CL.4.1 AMNH.99.1/768	–	–	F	35–40	L'Heureux and Amorosi, 2009
	29. CL.4.2 AMNH.99.1/768	–	–	I	>10	L'Heureux and Amorosi, 2009
	30. CL.4.3 AMNH.99.1/768	–	–	M	14–16	L'Heureux and Amorosi, 2009
	31. CS.1 99.1/779	3645 ± 65 3755 ± 65	–	F	45–50	L'Heureux and Amorosi, 2009
	32. CS.2 99.1/780	3380 ± 70	–	F	35–50	L'Heureux and Amorosi, 2009
	33. CS.3 99.1/781	–	–	F	35–40	L'Heureux and Amorosi, 2009
	34. CS.4 99.1/782	–	–	F?	3.5–6.5	L'Heureux and Amorosi, 2009
	35. CS.5 99.1/783	–	–	F?	≥5 ± 1,5	L'Heureux and Amorosi, 2009
	36. CS.6 99.1/784/5	–	–	I	4–8	L'Heureux and Amorosi, 2009
	37. CS.8 99.1/776	–	–	M	35–40	L'Heureux and Amorosi, 2009
	38. CS.9 99.1/777	–	–	I	3–5	L'Heureux and Amorosi, 2009
	39. CS.10 99.1/778	–	–	M	9–13	L'Heureux and Amorosi, 2009
	40. Isla Englefield	–	–	I	0.25–0.5	Guichón and Santini Araujo, 1987
Northern Tierra del Fuego	41. San Genaro 4	During contact	Mix	F	25–39	Martin et al., 2004
N = 29	42. Estancia San Julio	350 ± 50	T	M	36–48	Suby and Guichón, 2010
% = 24.4	43. La Arcillosa 2	5208 ± 58	T	F	20–24	Santiago et al., 2011
	44. Chorrillos 2	265 ± 44	T	M	20–28	Santiago et al., 2011
	45. Las Mandíbulas	XIX Century	T	M	20–24	Guichón et al., 2000
	46. Las Mandíbulas	–	–	I	9–15	Guichón et al., 2000
	47. Margen Sur (sk. A)	897 ± 38	T	I	6–8	Santiago et al., 2011
	48. Margen Sur (sk. B)	897 ± 38	T	I	6–8	Santiago et al., 2011
	49. Margen Sur (sk. C)	897 ± 38	T	I	9–11	Santiago et al., 2011
	50. Margen Sur (sk. D)	897 ± 38	T	I	9–11	Santiago et al., 2011
	51. Puesto Pescador	335 ± 35	T	M	21–25	Suby et al., 2009
	52. Bahía Felipe 1	1608 ± 45	Mix	M	35–50	Suby, 2014a
	53. Bahía Felipe 2	–	Mix	F	30–40	Suby, 2014a
	54. Bahía Felipe	–	–	M	20–22	Ocampo et al., 2000
	55. Bahía Felipe	–	–	F	20–22	Ocampo et al., 2000
	56. Bahía Felipe	–	–	M	15–16	Ocampo et al., 2000
	57. Bahía Gente Grande	During contact	T	M	30–40	Suby, 2014a
	58. Punta Baxa	–	–	I	4–8	Guichón et al., 2001
	59. Lengua de Vaca	251 ± 41	Mix	F	30–40	Suby, 2014a
	60. Myren 1	640 ± 20	Mix	M	18–23	Suby, 2014a
	61. Marazzi 1	5440 ± 30	–	F	21.5–24	Morello et al., 1999
	62. Cabo Nose	980 ± 40	Ma	M	20–35	Alfonso-Durruty et al., 2011
	63. IP 33950 Cerro Los Onas	–	–	M	40–45	Constantinescu, 1997
	64. IP 50099 Cerro Los Onas	–	–	F	20	Constantinescu, 1997
	65. Cabo Domingo (SW)	–	–	F?	10–14	This paper*
	66. Río Grande	–	–	I	3–6	This paper
	67. Río Grande	–	–	F?	13–17	This paper
	68. Río Grande	–	–	M	18–22	This paper
	69. Laguna Flamenco	During contact	Mix	F	24–39	Schinder and Guichón, 2003
Southern Tierra del Fuego	70. Harberton Cementerio	During contact	Ma	M	25–35	Suby et al., 2011
N = 50	71. Imiwaia 1	640 ± 43	Ma	F	25–49	Suby et al., 2011
% = 42	72. Imiwaia 1	–	–	I	3–6	Suby et al., 2011

(*continued on next page*)

Table 1 (*continued*)

Region	Skeleton/Site	Chronology (YBP)	Diet	Sex	Age (years)	References
	73. Imiwaia 2	1363 ± 45	–	I	0–0.5	Suby et al., 2011
	74. Mischiwen 3	625 ± 25	Ma	I	13–17	Suby et al., 2011
	75. Paiashauaia 1	1504 ± 46	Ma	F	35–45	Suby et al., 2011
	76. Shamakush 6	1536 ± 46	Ma	M	35–45	Suby et al., 2011
	77. Shamakush (sk. 1)	681 ± 43	–	F	35–45	Suby et al., 2011
	78. Shamakush (sk. 2)	681 ± 43	–	F	35–45	Suby et al., 2011
	79. Shamakush (sk. 3)	681 ± 43	–	M	25–30	Suby et al., 2011
	80. Shamakush (sk. 4)	681 ± 43	–	I	3–10	Suby et al., 2011
	81. Lauta 2	–	–	F	35–40	Schinder and Guichón, 2003
	82. Caleta Falsa site 3.3	–	–	I	13–17	Guichón and Suby, 2011
	83. Caleta Falsa site 7.2	–	–	F	30–39	Guichón and Suby, 2011
	84. Caleta Falsa site 8.1	820 ± 40	Ma	M	18–23	Guichón and Suby, 2011
	85. Caleta Falsa site 8.4	–	–	M	43–49	Guichón and Suby, 2011
	86. Caleta Falsa site 8.5	–	–	I	2.5–5	Guichón and Suby, 2011
	87. Museum Gusinde Nro. OH 001	–	–	M	18–21	Aspillaga et al., 1999
	88. Museum Gusinde Nro. OH 006	–	–	F	35–45	Aspillaga et al., 1999
	89. Museum Gusinde Nro. OH 023	–	–	I	5	Aspillaga et al., 1999
	90. Museum Gusinde 024	–	–	F	35–50	Aspillaga et al., 1999
	91. Museum Gusinde S/N	–	–	I	2.5	Aspillaga et al., 1999
	92. Museum Gusinde 021	–	–	F	28–30	Aspillaga et al., 1999
	93. IP 849 - Isla Navarino	–	–	F	25–30	Aspillaga et al., 1999
	94. IP 6796 - Isla Navarino	–	–	F	22–23	Aspillaga et al., 1999
	95. IP 1863 - Isla Navarino	–	–	M	35	Aspillaga et al., 1999
	96. IP 850 - Isla Navarino	–	–	M	35–50	Aspillaga et al., 1999
	97. IP 848 - Isla Navarino	–	–	F	22	Aspillaga et al., 1999
	98. IP 6788 – Canasaca	–	–	I	9–10	Aspillaga et al., 1999
	99. IP 1249	–	–	M	35–50	Aspillaga et al., 1999
	100. IP 1754 - Canal Lennox	–	–	M	+35	Aspillaga et al., 1999
	101. IP 6795 - Isla Navarino	–	–	F	+25	Aspillaga et al., 1999; Guichón, 1994
	102. IP 6790 - Puerto Luisa	–	–	F	25	Aspillaga et al., 1999
	103. IP 27007 - Isla Navarino	–	–	F	25–35	Aspillaga et al., 1999
	104. IP 12490 - Puerto Williams	–	–	M	30	Aspillaga et al., 1999
	105. Estancia María Luisa 5	–	–	F	40–45	Tessone et al., 2011
	106. Estancia María Luisa 2	–	–	I	12–15	Tessone et al., 2011
	107. Aleph 3, Bahia Thetys	–	–	M	30–39	Tessone et al., 2011
	108. Sur de Tierra del Fuego	–	–	F	+50	This paper
	109. Isla Hoste	–	–	M	30–45	This paper
	110. Ushuaia	–	–	M	25–40	This paper
	111. Isla Navarino	–	–	F	20–30	This paper
	112. Ushuaia - Conchales (sk. 1)	–	–	F	40–50	This paper
	113. Ushuaia - Conchales (sk. 2)	–	–	M	40–50	This paper
	114. Isla Karukinka, Seno Almirantazgo (sk. 1)	–	–	F	30	Aspillaga and Ocampo, 1996
	115. Isla Karukinka, Seno Almirantazgo (sk. 2)	–	–	F	16–17	Aspillaga and Ocampo, 1996
	116. Isla Karukinka, Seno Almirantazgo (sk. 3)	–	–	M	25–30	Aspillaga and Ocampo, 1996
	117. Isla Karukinka, Seno Almirantazgo (sk. 4)	–	–	M	18–19	Aspillaga and Ocampo, 1996
	118. Isla Karukinka, Seno Almirantazgo (sk. 5)	–	–	I	5	Aspillaga and Ocampo, 1996
	119. Isla Karukinka, Seno Almirantazgo (sk. 6)	–	–	I	Newborn	Aspillaga and Ocampo, 1996

References: Sk.: skeleton; M: male; F: female; I: indeterminate; Mix: mixed; T: terrestrial; Ma: maritime; CL: Cañadón Leona; CS: Cerro Sota; IP: Instituto de la Patagonia; *Skeletons housed in the Ethnographic Museum J. B. Ambrosetti (University of Buenos Aires, Buenos Aires, Argentina). Radiocarbon date from skeleton CS.1.99.1/779 was considered to all the individuals from this synchronic multiple burial site.

to typical hunter-gatherer profiles, in which lower frequencies are usually observed (see discussion below). In the 10.1–15 age group, Salitroso Lake presents a higher percentage of individuals (12.1%) in relation to the other profiles. In the 15.1–20 age range, the skeletal series of Chenque I, Paso Alsina 1 and Salitroso Lake show similar percentages (around 10%), while for Southern Patagonia no skeletons were recovered (Table 5). On the other hand, all adult age-at-death profiles show higher frequencies in 20.1–35 years-old individuals, with a gradual decrease in the following age ranges, except for Salitroso Lake, whose higher frequency is observed in the 35.1–50 age interval. Only Chenque I and Salitroso Lake shows lower percentages of individuals older than 50 years-old (Table 5; Fig. 6). Finally, the *JI* is higher in the samples from Southern Patagonia (0.37) and Salitroso Lake (0.44) than in Chenque I (0.16) and Paso Alsina 1 (0.08). Kolmogorov-Smirnov statistical analyzes showed no significant differences between Southern Patagonia and Chenque I ($p = 0.2$), Paso Alsina 1 ($p = 0.4$) and Salitroso Lake ($p > 0.9$) samples. The cluster analysis in Fig. 7 shows the same general trends, where the Salitroso Lake sample is observed in isolation as a separated cluster.

Table 2
Number and percentages of skeletons by age interval and sex for the total sample from Southern Patagonia. References: n: number of individuals; F: females; M: males; I: indeterminate.

Age group (years)	Total (n/%)	Sex		
		F (n/%)	M (n/%)	I (n/%)
0–1	5/4.2	0/0	0/0	5/4.2
1.1–5	13/10.9	0/0	0/0	13/10.9
5.1–10	13/10.9	0/0	0/0	13/10.9
10.1–15	10/8.4	0/0	0/0	10/8.4
15.1–20	6/5.1	2/1.7	4/3.4	0/0
Total non-adults	47/39.5	2/1.7	4/3.4	41/34.4
20.1–35	42/35.3	19/16	23/19.3	0/0
35.1–50	29/24.4	14/11.8	15/12.6	0/0
+50.1	1/0.8	1/0.8	0/0	0/0
Total adults	72/60.5	34/28.6	38/31.9	0/0
Total	119/100	36/30.3	42/35.3	41/34.4

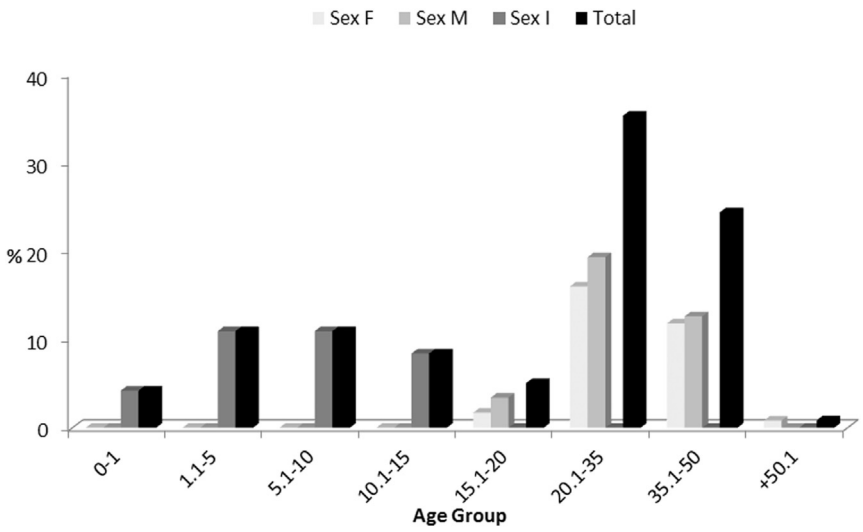

Fig. 3. Percentages of skeletons for each sex (for the +15 years sample) and age group from Southern Patagonia. References: F: females; M: males; I: indeterminate.

Table 3
Number and percentages of skeletons from Southern Patagonia classified by region and age groups. References: SC/Mag: Santa Cruz/Magellan; NTdF: Northern Tierra del Fuego; STdF: Southern Tierra del Fuego; n: number of individuals; F: females; M: males; I: indeterminate.

Age group (years)	SC/Mag (n/%)				NTdF (n/%)				STdF (n/%)			
	Total	M	F	I	Total	M	F	I	Total	M	F	I
0–1	3/7.5	–	–	3/7.5	0/0	–	–	0/0	2/4	–	–	2/4
1.1–5	7/17.5	–	–	7/17.5	1/3.4	–	–	1/3.4	5/10	–	–	5/10
5.1–10	6/15	–	–	6/15	5/17.2	–	–	5/17.2	2/4	–	–	2/4
10.1–15	4/10	–	–	4/10	3/10.4	–	–	3/10.4	3/6	–	–	3/6
15.1–20	0/0	0/0	0/0	0/0	3/10.4	2/6.9	1/3.45	0/0	3/6	2/4	1/2	0/0
Total non-adults	20/50	0/0	0/0	20/50	12/41.4	2/6.9	1/3.45	9/31	15/30	2/4	1/2	12/24
20.1–35	10/25	8/20	2/5	0/0	14/48.3	7/24.1	7/24.1	0/0	18/36	8/16	10/20	0/0
35.1–50	10/25	5/12.5	5/12.5	0/0	3/10.4	3/10.4	0/0	0/0	16/32	7/14	9/18	0/0
+50	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/2	0	1/2	0/0
Total adults	20/50	13/32.5	7/17.5	0/0	17/58.7	7/24.1	10/34.5	0/0	35/70	15/30	20/40	0/0
Total	40/100	13/32.5	7/17.5	20/50	29/100	9/31	11/37,95	9/31	50/100	17/34	21/42	12/24
JI	0.33				0.29				0.12			

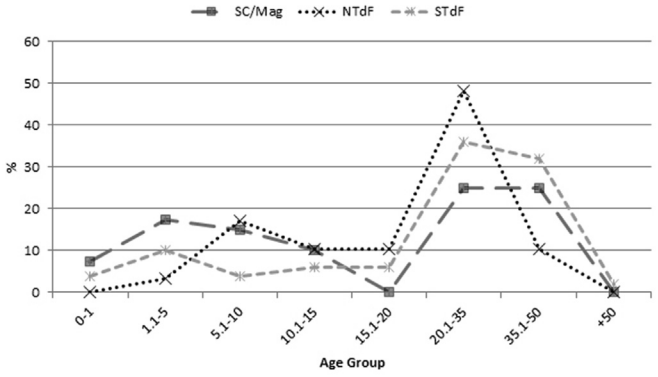

Fig. 4. Age-at-death profiles from Southern Patagonia classified by region. References: SC/Mag: Santa Cruz/Magellan; NTdF: Northern Tierra del Fuego; STdF: Southern Tierra del Fuego.

5. Discussion

Paleodemographic analyses on the basis of age-at-death profiles from human archaeological remains are not free of controversies, many of them due to the nature and the characteristics of the skeletal samples. Many criticisms were sustained since the beginning of the second half of the 20th century, mainly regarding the difficulties for age-at-death estimation, the incorrect assumptions of demographic stationarity of past populations and the actual representativeness of the skeletal series (e.g., Bocquet-Appel and Masset, 1982; Buikstra and Konigsberg, 1985; Wood et al., 1992; Frankenberg and Konigsberg, 2006; Bocquet-Appel, 2008). Many of these problems derived in theoretical debates and methodological advances, including the recognition of fertility over mortality as shapers of the age-at-death profiles, the utility of considering past populations as non-stationary, the advantages of using wider ranges of age estimations and the implementation of Bayesian statistics in the analyses (e.g., Sattenspiel and Harpending, 1983; Hoppa and Vaupel, 2002; Chamberlain, 2006; Milner et al., 2008). Based on these overcoming approaches, paleodemography is still helpful in bioarchaeological and paleopathological interpretations of skeletal remains.

Paleodemography is particularly challenging for the study of hunter-gatherer populations, due to their usual low fertility compared to agricultural groups, small population size and high residential mobility, which finally produce small size skeletal samples. Despite these difficulties, many paleodemographic research of hunter-gatherers were published during the last decades (e.g., Van Arsdale, 1978; Mensforth, 1990; Erlandson et al., 1992; Weber et al., 2002; Gerven and Kaplan, 2007; Goodale et al., 2008). Particularly in Argentina, several paleodemographic

Table 4
Number and percentages of skeletons from Southern Patagonia classified by chronology.

Age group (years)	5500–3500 YBP (n/%)	3500–1000 YBP (n/%)	1000–400 YBP (n/%)	<400 YBP (n/%)
0–1	1/12.5	1/14.3	0/0	0/0
1.1–5	0/0	0/0	0/0	1/7.15
5.1–10	2/25	1/14.3	5/31.2	0/0
10.1–15	0/0	0/0	1/6.3	0/0
15.1–20	0/0	0/0	0/0	0/0
Total non-adults	3/37.5	2/28.6	6/37.5	1/7.15
20.1–35	3/37.5	1/14.3	6/37.5	11/78.5
35.1–50	2/25	4/57.1	4/25	2/14.2
+50	0/0	0/0	0/0	0/0
Total adults	5/62.5	5/71.4	10/62.5	13/92.85
Total	8/100	7/100	16/100	14/100
JI	0.29	0.17	0.38	0

data based on skeletal remains were reported for hunter-gatherer populations from different regions, such as Pampas (Luna, 2008, 2012; Politis et al., 2014), the Eastern Pampa-Patagonia transition (Flensborg et al., 2015) and the Northwest of Southern Patagonia (García Guraieb et al., 2015).

The Southern extreme of Patagonia and Tierra del Fuego is characterized by highly mobile hunter-gatherer societies, and no formal disposal areas have been registered. As stated above, to solve this problem, archaeological and bioarchaeological studies in Southern Patagonia commonly grouped isolated skeletons taking into account different criteria, especially the spatial distribution, and in some cases paleodietary and chronological data (e.g., Borrero and Barberena, 2006; Alfonso-Durruty et al., 2015; de la Fuente et al., 2015). Although paleodemographic methods were usually used to study cemetery contexts (Bocquet-Appel, 2008), it is possible to develop an approximation for skeletal series from different archaeological sites, with the aim of identifying general trends for comparison. We do not ignore the possible biases that these artificially grouped samples may produce, but at the same time, we recognize that this is the only procedure available in order to explore some important bioarchaeological, paleopathological and paleodemographic questions about the past societies. In most of the cases, the results, including those offered in this paper, can be assumed as *proxies* of biocultural scenarios.

The sample from Southern Patagonia studied here show an attritional age-at-death profile, as is also observed in other hunter-gatherer past populations (e.g., Weber et al., 2002). However, some differences have to be remarked, particularly the highest frequency of non-adults between 1 and 10 years-old, while generally the higher percentage is identified in the 0–5 age interval (Margerison and Knusel, 2002; Chamberlain, 2006). This would indicate a slight variant of the model recurrently observed. The results indicate that

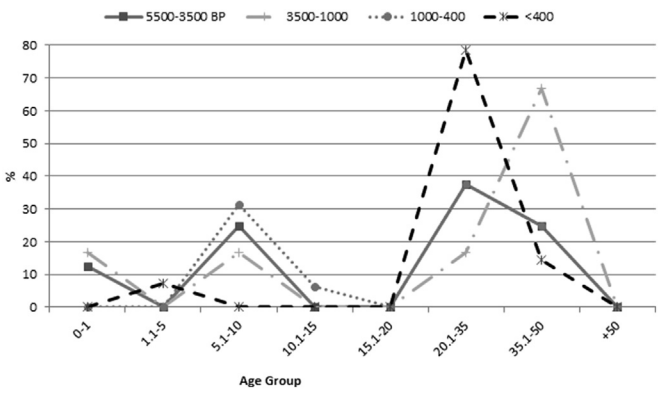

Fig. 5. Percentages of skeletons from Southern Patagonia by age group and chronology.

more than a third of the individuals in the whole sample died before adulthood and coincide with the observed frequencies for these societies (Chamberlain, 2006). Despite this fact, high fertility rates are supported by the high number of non-adults in the other age intervals and by the increasing population growth estimated by the *JI* for the Santa Cruz/Magellan and Northern Tierra del Fuego during all periods, with the exception of the most recent (>400 YBP), as discussed below.

The reduced number of individuals between 0 and 1 year-old may be caused by two different processes: differential preservation patterns of skeletal remains for this age cohort, and/or demographic dynamics. Regarding the first hypothesis, it has been suggested that non-adult skeletons are more quickly deteriorated than adult remains (Morton and Lord, 2002; Bello et al., 2006), although this taphonomical issue was also questioned by some authors (e.g., Sundick, 1978; Guy et al., 1997; Saunders, 2000; Lewis, 2006). Unfortunately, no evidence is available to support this statement at the moment, since no specific taphonomical studies were conducted on newborn and infant skeletal remains in these particular regions. In addition, it is also possible that the reduced potential for the discovery of infant graves is due to scientific bias in the identification of newborn remains. On the other hand, although in ethnographically censured hunter-gatherer populations mortality for this age interval is typically much higher than what is observed in the skeletal samples studied in this paper (e.g., about 35–40% in Yanomami, Agta, Ache, !Kung, Hiwi, etc.; Early and Peters, 1990; Hill and Hurtado, 1996; Walker et al., 2006; Hill et al., 2007), a low mortality rate in this age group cannot be discarded considering the few infants recovered in Southern Patagonia. In this sense, higher parental care during the first period of the childhood than during posterior ages could be an explanation for this trend. This fact was also ethnographically observed in Hiwi, Ache (Hurtado et al., 1992), Hadza (Pennington and Harpending, 1988) and Kung! foragers (Blurton et al., 1994), in which the fertility and the probability of survival of non-productive children are directly increased by the parental care, including the help of their siblings. In this context, while younger children are benefited by the care of their mothers and siblings, reducing their mortality, older immatures may be more exposed to die. This behavior was commonly explained as a case of kin selection, although also criticized (Kramer, 2011). Moreover, adequate health status of mothers and fetuses may have produced low mortality rates at birth, and in consequence, low frequencies of skeletons during the first year of life, as was stated in previous research (e.g., Hill et al., 2007; Pfeiffer et al., 2014). The low prevalence of systemic stress observed on the skeletons of the region could support this hypothesis (e.g., Suby, 2014a).

Most of the adults are included in the 20.1–35 years-old category. This age range corresponds to the stages of life during which

Table 5
Percentages of individuals by age-at-death from Southern Patagonia, Chenque I (Luna, 2012) and Paso Alsina 1 (Flensborg et al., 2015) sites, and Salitroso Lake (García Guraieb, 2010; García Guraieb et al., 2015). References: *Only skeletons from 800 to 350 YBP and with accurate age-at-death were considered.

Age group (years)	Southern Patagonia (n/%)	Chenque I (n/%)	Paso Alsina 1 (n/%)	Salitroso Lake* (n/%)
0–1	0/0	25/11.6	8/10.8	7/12.1
1.1–5	0/0	30/13.9	3/4.1	8/13.8
5.1–10	5/31.3	18/8.3	2/2.7	12/20.7
10.1–15	1/6.3	7/3.2	3/4.1	7/12.1
15.1–20	0/0	20/9.3	7/9.5	6/10.3
Total non-adults	6/37.5	100/46.3	23/31.08	40/69
20.1–35	6/37.5	65/30.1	31/41.9	6/10.3
35.1–50	4/25	41/19	20/27	10/17.2
+50	0/0	10/4.6	0/0	2/3.4
Total adults	10/62.5	116/53.7	51/68.92	18/31
Total	16/100	216/100	74/100	58/100
JI	0.37	0.16	0.08	0.44

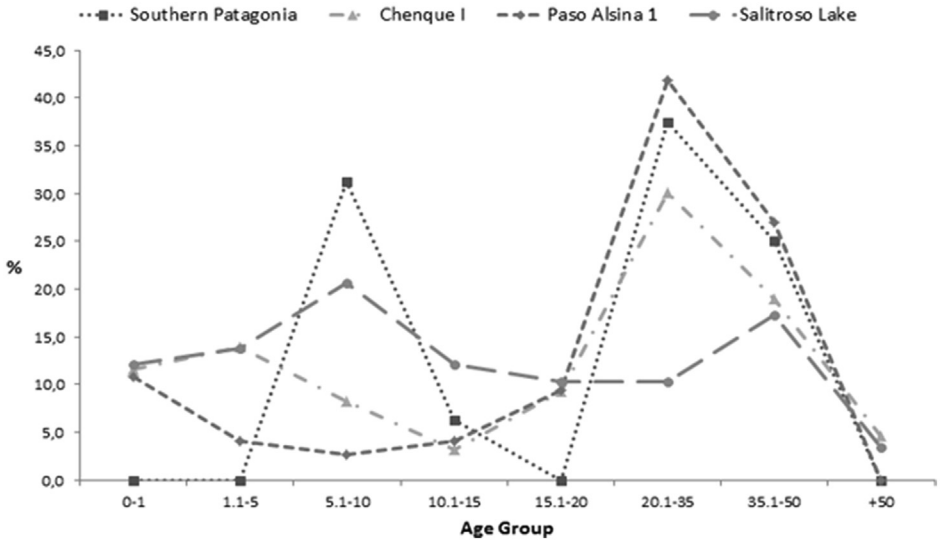

Fig. 6. Comparative age-at-death profiles from Southern Patagonia, Chenque I (Luna, 2012), Paso Alsina 1 (Flensborg et al., 2015), sites and Salitroso Lake (García Guraieb, 2010; García Guraieb et al., 2015).

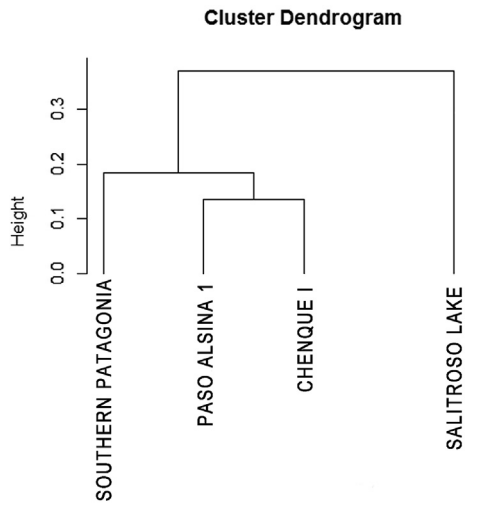

Fig. 7. Cluster analyses of the skeletal samples considered in this paper.

individuals fully perform the main roles of social reproduction and subsistence, which expose them to increased risks of morbidity and death. This pattern is usually seen in prehispanic hunter-gatherers profiles (e.g., Johnston and Snow, 1961; Lovejoy et al., 1977; Mensforth, 1990). However, it is important to caution that skeletal data may be influenced by the adult age estimation methods used, which systematically tend to under-estimate the ages of older adults (see Chamberlain, 2006 for an explanation). On the other hand, the almost absence of skeletons beyond 50 years-old from Southern Patagonia suggests that individuals usually did not live more than this age in these societies, although problems with the accuracy of the methods used for age-at-death estimations must be again taken into account, since older individuals tend to be aged as middle adults (i.e., 35.1–50 age range; Garvin et al., 2012; Milner and Boldsen, 2012). A similar number of male and female skeletons are observed for all adult intervals, what could indicate no specific causes of death by sex and no taphonomic bias.

Archaeological research had a remarkable development in Southern Patagonia mainly during the last three decades. Despite of this fact, differential intensities of exploration of the coastal and inland areas were suggested (e.g., Guichón et al., 2001; Caracotche and Ladrón de Guevara, 2006; Barberena, 2008), which result in possible regional bias in the representation of skeletal remains. However, the underexplored areas are usually small, and they recently received much more attention. For example, regions in which the archaeological record was less studied, as the Atlantic coast of Tierra del Fuego and Peninsula Mitre, was a matter of

systematical research during the last ten years (Zangrando et al., 2011; Vázquez et al., 2012). Thus, each of the three regions considered in this paper can be considered sufficiently explored to minimize this possible bias, although it cannot be completely excluded. With this in mind, no major differences are identified among age-at-death patterns from the three regions of Southern Patagonia considered here. This indicates that the suggested diversity in social organization and economic patterns (see *Paleoenvironmental, Biocultural and Bioarchaeological Context* above) did not necessarily produced divergent age-at-death profiles. Ethnographic data suggest that societies based on marine resources tend to show a higher population growth and less mobility patterns than those based on terrestrial resources (Kelly, 1995; Binford, 2001; Johnson, 2014). Borrero and Barberena (2006) notes that in the Southern extreme of the continent (called here Santa Cruz/Magellan), home ranges were relatively small for coastal hunter-gatherers, no sedentary trend or reduction of mobility is observed, even in cases where consumption of maritime resources was significant. According to the results found in the present paper, the sample from Southern Tierra del Fuego (that includes individuals probably more related to the consumption of marine resources; e.g., Tessone et al., 2003; Panarello et al., 2006; Santiago et al., 2011) does not follow the ethnographical-based model, and its profile is similar to that of the Santa Cruz/Magellan region. Besides, the samples from the continent and Northern Tierra del Fuego show much higher *JI* values (Table 3), suggesting a higher population growth than the sample from Southern Tierra del Fuego. However, the reduced number of skeletons with isotopic results makes difficult to properly analyze the age-at-death distribution based on paleodietary patterns. This fact has to be solved in the future, when more isotopic data are available.

No females older than 35 years-old were detected in Northern Tierra del Fuego. Although females could have died younger than in the other regions, the reported paleopathological evidence does not sustain this trend. Degenerative joint disease in the spine and trauma, including violent events, were in general observed in males (Constantinescu, 2003; Prieto and Cárdenas, 2007; L'Heureux and Amorosi, 2009; Suby et al., 2008; Suby and Guichón, 2010). Recent studies also show that women in Southern Patagonia were more affected by anemia than males, although the lesions were mostly slight. Moreover, individuals with maritime diets from Southern Tierra del Fuego were more frequently affected than in skeletons from the north with terrestrial diets (Suby, 2014a), so it would not be an alternative explanation. Thus, sample bias is probably the most reliable cause of the absence of females older than 35 years-old in Northern Tierra del Fuego. Nevertheless, more detailed studies about the distribution of diseases by sex and age in the three regions, as well as a bigger sample, are needed to test this particular hypothesis.

On a temporal base, a demographic increment during at least the last ca. 1500 YBP was previously suggested for Southern Patagonia (Barberena, 2008; Zangrando, 2009; Pallo and Ozán, 2014; Perez et al., 2016), although a discontinuous population growth since 3500 YBP in Southern continental Patagonia was also proposed (Barberena, 2008). The data shown in the present paper led inferring a population growth pattern for the three periods before contact, particularly between 5500–3500 and 1000–400 YBP periods, on the base of the high values of *JI* obtained. These results are in general terms coincident with some trends suggested by previous research aforementioned, particularly for the last period before contact. As we mentioned, Barberena (2008) found demographic pulses during these same periods. However, it is possible that the high population growth observed before 3500 YBP is influenced by the presence of two multiple burials recovered in continental Southern Patagonia (e.g., Cerro Sota site and Orejas de Burro Site; see Table 1; Table 1) and not only by demographic dynamics itself (Barberena, 2008), indicating possible scientific biases. In this sense, paleopathological analyses of these multiple burials could offer new insights on this matter, for example if the demographic changes were generated by the presence of diseases, increasing the mortality at local scale.

During the periods 5500–3500 and 3500–1000 YBP, higher percentages are seen for the 35.1–50 years-old category than in subsequent chronological periods (Table 4); this would suggest a higher life expectancy and increasing health conditions. These changes in the later periods 1000–400 YBP and <400 YBP, in which young adults (i.e. 20.1 to 35 years-old) are more represented than middle adults (i.e., 35.1 to 50 years-old) could suggest a possible reduction in life expectancy. However, we are aware that some taphonomic bias cannot be rejected as responsible for part of these results, including the much lower population growth inferred from the *JI* value during the contact period (<400 YBP), when non-adult remains are much less represented than previously (Table 4). This fact is contrary to the expectations based on taphonomic assumptions about the more frequent recovery of skeletons with later chronologies (Surovell and Brantingham, 2007). Although taphonomic and research biases cannot be completely excluded, lower fertility and population growth during contact can be argued, based on the *JI* values. An extremely negative effect of the contact process with Europeans can be proposed, substantially affecting the native demography and decreasing the number of births and living people. Historic surveys clearly report how they were systematically killed or incorporated into missions, producing a massive assimilation (e.g., Martinic, 1990; Casali, 2011).

Changes in mortuary practices as a consequence of the contact impact may also be hypothesized as the cause of the lower number of skeletons observed in this study, although this explanation cannot be sustained by the ethnohistoric literature of the region. Differences in the treatment of the dead were only reported for those individuals buried in missions and farms (e.g., Piana et al., 2006; García Laborde et al., 2010). Data about mortuary practices for areas such as Southern Tierra del Fuego suggest high variability and no relation with age-at-death or sex (e.g., Álvarez et al., 2008; Tessone, 2014). Thus, changes in mortuary patterns seem not to be the main cause for the absence of non-adults during the contact period. However, the reduced number of individuals with radiocarbon dating forces us to be cautious, as more chronological information is yet needed to obtain a more reliable picture of the process.

The inter-sample comparison between skeletal remains among different regions is particularly challenging, due to the important social, cultural, archaeological and taphonomic differences that model the mortuary record in every site and every region. Any inter-sample comparison should be made with extreme caution and considering the archaeological features of the samples and the biological and cultural aspects of the populations they come from. This is the case when attempts are made to make comparisons with age-at-death profiles of Pampa and Patagonia regions. Although in both regions there are numerous mortuary contexts with a significant number of individuals, only a few were studied through paleodemographic profiles (see Table 5 and Fig. 6). The studies in these regions were carried out mainly in cemeteries or in a reduced geographic bundle area. These contexts were interpreted in the framework of a process of demographic growth and complex population dynamics during the last ca. 1000 YBP (Luna, 2012; Flensborg et al., 2015; García Guraieb et al., 2015). Despite we know that some substantial bias may be included in the results reported, some general useful information could be anyway offered

in order to generate an expectation for future analyses.

The comparison of the profile from Southern Patagonia with those obtained for other hunter-gatherer societies from Argentina shows similar bimodal patterns, although some differences in the frequencies of individuals for certain age groups were observed (Fig. 6). Although in the case of the adult age categories, the age-at-death profile of Southern Patagonia is similar to some of them (e.g., Chenque I and Paso Alsina 1), the most important differences occur with non-adults. On the contrary Salitroso Lake presents a divergent pattern, although no statistically significant differences were observed. Moreover, the cluster analysis shows that the age-at-death profile from Southern Patagonia is more similar to that obtained from Chenque I and Paso Alsina 1 than Salitroso Lake samples (Fig. 7).

In the comparative analysis, Salitroso Lake presents the highest percentages in the categories of non-adults compared to the other profiles, except for the 5–10 category of age where Southern Patagonia has the highest frequency. A first peak is observed for the 1.1–5 years-old category in Chenque I and Salitroso Lake, except for Paso Alsina 1 and Southern Patagonia for this temporal period, that shows very low percentages in all non-adult ranges after 1 year-old, and Salitroso Lake, with the higher frequency located in the 5.1–10 years-old category. Among adults, most of the samples have high percentages of individuals for the 20.1–35 years-old category. An exception to this trend is again Salitroso Lake, because the peak is seen in the next category (35.1–50 years-old), which departs from the other profiles.

Only Southern Patagonia and Salitroso Lake samples show a clear pattern of demographic growth (Table 5), since only *JI* greater than 0.17 are predicted to have population growth rates greater than zero (Bocquet-Appel and Naji, 2006). Salitroso Lake offered the highest *JI* value. According to García Guraieb et al. (2015), this is caused by the reduced number of skeletons below 1 year-old, probably due to taphonomic and cultural biases. The low residential mobility proposed in this area may have also contributed to this particular demographic profile that differs from the pattern of the rest of the samples. On one hand, the very low value for Paso Alsina 1 and Chenque I are unusual, in a socio-demographic context with a significant demographic growth. This may be the result, among other causes, of cultural factors that shape the bioarchaeological record and consequently could have produced some distortion in the age-at-death profile. This includes selection of bodies and differential treatment of skeletal portions in the process of preparation of funeral bundles, the development of multiple secondary burials, among others. However, Paso Alsina 1 is the site in which the typical hunter-gatherer bimodal profile is more clearly represented, with a high frequency of individuals between 0–1 and 20.1–35 age intervals (Flensborg et al., 2015). On the other hand, Chenque I show a demographic growth close to 0, according with Bocquet-Appel and Naji (2006) criteria. As an imbalance between the frequencies of bodies and girls younger than 1 year-old was identified, indirect infanticide was proposed as part of a demographic social control, which may have contributed to considerably diminish the demographic growth (Luna, 2008).

6. Concluding remarks

This paper allowed exploring, from a novel approach, the paleodemography of hunter-gatherers from Southern Patagonia and its differences with that of other human groups that inhabited Southern South America. The present research improved the understanding about the nature of the bioarchaeological record in this region, through the construction of age-at-death profiles from human skeletal samples. The data generated is also highly relevant for the recognition of the potential for the study of health patterns and the impact of diseases among groups with different lifestyles.

Some biases in the currently available skeletal samples studied here are suggested, even though they include most of the archaeologically controlled skeleton recovered from the region. Bigger samples with chronological data are needed, as a strategy to reduce the detected biases, particularly considering their possible influence on non-adult skeleton representation during the contact period and the reduced number of females older than 35 years-old in Northern Tierra del Fuego.

The human populations from Southern Patagonia presented variations in population growth during the last 6000 YBP. The overall results allow supporting the hypothesis that an increasing population growth occurred during the middle and late Holocene, at least until the beginning of the colonization process, when the cultural and biological changes could be produced a declination of population size. During last 400 YBP fertility was dramatically reduced and young adult mortality probably increased compared to the pre-contact periods. Moreover, lower demographic growth can be suggested for Southern Tierra del Fuego than for Northern regions of Southern Patagonia, against the models that state an opposite scenario for societies with marine economies.

The demographic profiles observed from Southern Patagonia are similar in some aspects to most of the other hunter-gatherer profiles previously reported in Argentina, although some important differences in mobility, aggregation patterns and mortuary behavior are known. A remarkable trend is the absence of newborns observed after 1000 YBP in Southern Patagonia, suggesting a differential preservation pattern against this kind of remains or a higher parental care for this age group. This kind of behavior was not indicated until now for the societies from Pampa and Patagonia, although it was observed in other forager societies from South America, as Ache and Hiwi (e.g., Hurtado et al., 1992), reducing the mortality of younger children, although this proposal should be tested in future analyses.

Interestingly, human groups with very different social patterns and cultural mortuary behavior, such as those represented by Chenque I site and Southern Patagonia, showed similar demographic patterns. This could indicate some common demographic behavior among hunter-gatherer societies, probably based on its regular patterns of mobility and social structure. However, some variations from this general pattern can also explain the percentage differences in the various age categories, and also in fertility and life expectancy, for example in the Salitroso Lake sample, where low residential mobility was suggested (García Guraieb et al., 2015). Mortuary practices have to be added as an influencing factor, considering that transport of bodies and secondary burials may produce culturally biased bioarchaeological records, as was observed in Paso Alsina 1 and Chenque I sites. But even when important differences in sociocultural dynamics and mortuary practices were suggested, as Chenque I with primary and secondary individuals buried in a single site transported from different places (Luna, 2008; Berón et al., 2012) and Southern Patagonia with a pattern of simple primary burials, similar age-at-death profiles were recorded.

Paleodemography of hunter-gatherers from Southern South America had a remarkable attention during the last decade. The continuity of these analyses is profoundly associated with the recovery of new mortuary contexts (e.g., Paso Alsina 1, Chenque I and Salitroso Lake), increasing the available amount of skeletal remains. The results reported until now will be probably reinterpreted under the light of new data that is being obtained in other areas of Pampa-Patagonia and of the increasing contextual information reported to human remains recovered decades ago, for which radiocarbon dates and paleodietary information are until unavailable.

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