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Chronological database for Southern Chile (35°30'–42° S), ~33000 BP to present: Human implications and archaeological biases

Roberto Campbell [a, *], Daniel Quiroz [b]

[a] Departamento de Antropología, Universidad de Chile, Capitán Ignacio Carrera Pinto 1045, Ñuñoa, Santiago, Chile
[b] Centro de Documentación de Bienes Patrimoniales, Dirección de Bibliotecas, Archivos y Museos, Recoleta 683, Recoleta, Santiago, Chile

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ABSTRACT

A chronological database of 398 dates (247 ^{14}C dates, 148 thermoluminescence dates, and 3 obsidian hydration dates), covering the early peopling period up to the present, is presented for Southern Chile. This information is used to assess both the paleodemography, understood as human population dynamics in the past; and the "archaeo-demography", understood as the research dynamics of archaeologists in the present, of that region. From the early peopling up to the Late Archaic, information is geographically and chronologically scarce and scattered, the exception being the coast. For this latter area, it is possible to posit the existence of an occupation hiatus extending from at least around 3400 cal BP to around 2350 cal BP. After this latter date, a regional incremental trend is evident, along with the earliest presence of ceramics, as well as evidence of probable horticultural practices. On the other hand, the coast, compared to the valley and cordillera, has been the most active area for archaeological research and dating since the 1990s. This database as a whole helps to expose research biases and current gaps, in order to improve and expand our knowledge of the long history of Southern Chile's human occupation.

1. Introduction

The study of past human societies has come to rely more and more on a proper assessment of their chronological aspects. Issues such as the arrival and spread of agriculture, animals or technologies; the peopling of continents and islands; and the emergence of certain subsistence patterns or socio-political arrangements would be impossible to study without considering their chronology (Crombé et al., 2009; Wilmshurst et al., 2010; Gajewski et al., 2011; Bueno et al., 2013). In this sense, building databases of numerical dates is becoming a fundamental tool for archaeological research (Archaeological Site Index to Radiocarbon Dates from Great Britain and Ireland (2014)); Australian Archaeological Datasets, 2014; Canadian Archaeological Radiocarbon Database [CARD], 2014; The Paleoindian Database of the Americas [PIDBA], 2014). However, the accumulation and dispersion of data, investigations, and research topics makes accomplishing this goal in an exhaustive fashion increasingly difficult, even at a local scale. In this context, Southern Chile presents certain peculiarities that make constructing a thorough database a viable goal. Among these is the fact that systematic archaeological research and large-scale generation of numerical dates only started during the 1990s. Moreover, this research has been performed by a limited set of teams on a rather local scale, and it is available via research reports and/or directly from the archaeologists involved.

In this paper, we present a database of 398 numerical dates (^{14}C, thermoluminescence [TL], and obsidian hydration [OH]) for Southern Chile. This database encompasses a time span that covers the early peopling of the Americas, represented by the site of Monte Verde, up to the present. In this sense, Southern Chile has the unique quality of possessing one of the longest, if not the longest, occupational sequences in Chile and the Americas. This paper will first introduce the environmental characteristics of Southern Chile and then discuss the construction of chronological data in archaeology, introducing a distinction between what we have called "paleodemography" and "archaeo-demography". The materials and methods are then presented, as well as the geographical and chronological procedures used to deal with them. This is followed by a historiographic presentation concerning the use of numerical dating in Southern Chile, and a period-by-period discussion of the chronological data as it relates to paleodemography, archaeo-demography, and the archaeological record. Finally, we expect the

* Corresponding author.
E-mail addresses: robjjct@yahoo.com, r.campbellt@gmail.com (R. Campbell).

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creation of this database will encourage other archaeologists to expand it with new dates, as well as act as a stimulus for further systematization endeavors in neighboring areas.

2. Regional setting

In this paper, and for analytical reasons, we will treat Southern Chile as the Chilean territory that extends from around 35° 30' (Maule River) to 42° (Northern Chiloé Island section) (Fig. 1). It covers an area of 126,711 km^2, 16% of the South American Chilean territory, and has an average length of 750 km, and a maximum width of 260 km. Southern Chile is marked by major longitudinal geographical features. From west to east, these are: a coastal plain (and its adjacent islands) that in some areas has an average width of 25 km; the Coastal Range, which has several names (Cordillera de Nahuelbuta, Cordillera de Mahuidanche, Cordillera Pelada,

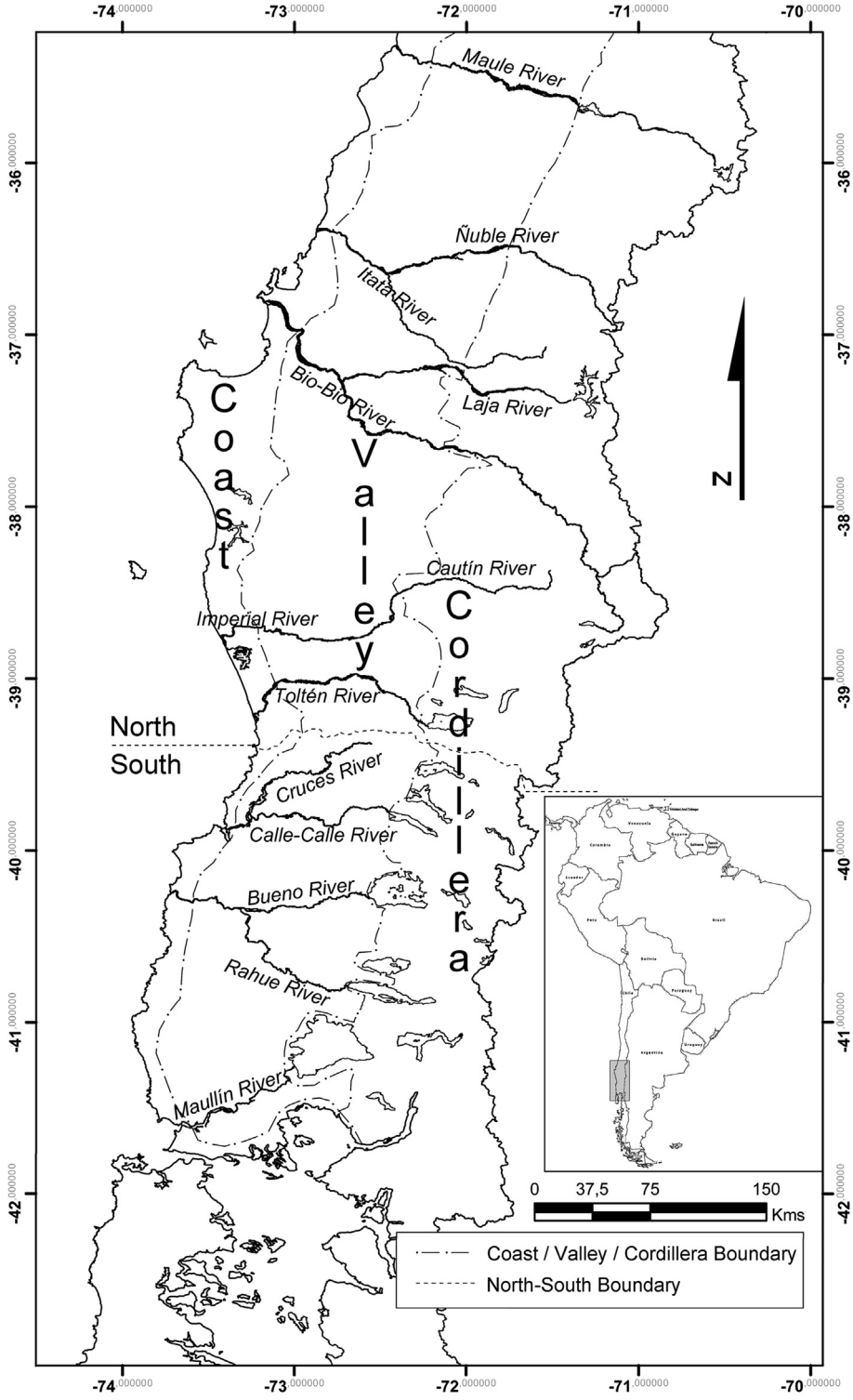

Fig. 1. Southern Chile geographical features. Main rivers and lakes, zones, and sectors.

Cordillera del Zarao) and with peaks reaching up to 1500 masl; the Intermediate Depression or Central Valley, as it is located between two longitudinal mountain ranges; a piedmont, Montaña or Precordillera, with an elevation between 600 and 1000 masl; and the Cordillera de los Andes, with maximum elevations of around 3000 masl.

For simplicity's sake, we will refer the numerical dates in relation to three major orographic zones: a) "the Coast", formed by the islands, the coastal plains, and the western flank of the Coastal Range; b) "the Valley", formed by the eastern flank of the Coastal Range and the Intermediate Depression up to an elevation of 300 masl; and c) "the Cordillera", formed by the Precordillera and the Cordillera de los Andes.

Following Aldunate's (1989) proposition, we have separated Southern Chile into northern and southern sectors, along the latitudinal ranges that divide the Toltén and Cruces river basins (about the 39° 21' S). The Northern Sector is characterized today by the coexistence of sclerophyllous and deciduous vegetation and by the presence of Araucaria forests in areas over 900 masl (Gajardo, 1994), and mostly but not exclusively by a Csb climate (Peel et al., 2007) −13 °C average annual temperature and 1240 mm average annual precipitation (Hajek and Di Castri, 1975)-, making this sector part of the Mediterranean and Temperate macrobioclimate units (Luebert and Pliscoff, 2006). Meanwhile, the Southern Sector is characterized by the coexistence of deciduous, broad-leaved, and evergreen vegetation, by the presence of several proglacial lakes, and exclusively by a Cfb climate −11 °C average annual temperature and 1987 mm average annual precipitation-, making this sector part of the Temperate macrobioclimate unit. In the last 200–500 years, both sectors have been heavily impacted by logging, extensive agriculture, livestock raising, and exotic forest plantations (Armesto et al., 2010; Lara et al., 2012). In the past, and especially prior to the last 6000 years, climatic conditions have been different, in addition to other environmental features.

The earliest evidences of human presence in Southern Chile are coincident with the last moments of the LGM (Last Glacial Maximum, 23,000 to 19,000 cal BP) or directly follow it. During that time ice caps covered part of our research area, increasing in extent from north to south. They occupied much of the cordillera zone from 35°30′ to 39°00′ S, covered it completely from 39°00′ to 41°30′ S, and to the south the Patagonian Ice Sheet covered the remaining territory of Southern Chile leaving only the northwestern of Chiloé Island ice-free (Villagrán, 1991; McCulloch et al., 2000; Abarzúa et al., 2004).

In this context, environmental studies (Latorre et al., 2007; Abarzúa, 2009; Maldonado et al., 2012; Abarzúa et al., 2014) indicate the existence of changing conditions following the LGM. The colder and wetter conditions that existed from at least 19,000 to 15,000 cal BP were followed by a more temperate and less rainy climate from 15,000 to 10,000 cal BP, accompanied by a progressive retreat of the glaciers, the extinction of the megafauna, and replacement of the cold-temperate vegetation by warm-temperate taxa. In addition, there is an increase in volcanic activity and evidence of intense fire-disturbances, phenomena not necessarily related, as the latter could be in part of anthropogenic origin (Abarzúa and Moreno, 2008). On the other hand, both volcanic activity and the glacier retreat (through river flows) were significant sediment contributors to the valley floors and coastal environments. Finally, the glacier presence and their retreat caused the formation of the several proglacial lakes in the southern sector of Southern Chile as well the archipelagic topography of the area south of 41°30′ S, and also lead to a steady sea level rise. This set of events marks the transition from the Pleistocene to the Holocene.

Then, during the early and mid-Holocene drier and warmer conditions predominate from 10,000 to 6000 cal BP, along with evidence of fire peaks and dominance of thermophilous vegetation (Abarzúa, 2009; Abarzúa et al., 2014). On the coast, the Holocene Marine Transgression modified the riverine environments, for example temporarily creating an archipelagic system at the Bio-Bio river mouth (Ilabaca, 1989; Isla et al., 2012) and merging Budi lake with the ocean (Abarzúa, 2009).

After 6000 cal BP, there was a progressive climatic stabilization towards modern conditions, marked by higher humidity, conditions that became clearly established over the last 2000 years. Concerning late-Holocene phenomena such as the Medieval Climate Anomaly (MCA, 9th to 13th centuries AD) and the Little Ice Age (LIA, mid-16th to mid-19th centuries), there is no agreement concerning their presence or impact in Southern Chile (Vanderberghe, 2012). Anthropogenic landscape modifications in Southern Chile related to cultivation (Sánchez et al., 2004; Dillehay et al., 2007; Silva, 2010, 2014; Roa et al., in press) can be dated to the last 2000 to 1000 years, and architecture (mound-building) to the last 1000 years (Dillehay, 2007, 2014; Campbell, 2011).

In addition to the above, it is important to mention the effects that the more than 30 volcanoes that occur in Southern Chile have in this territory, several of them with Terminal Pleistocene, Holocene, and historically-reported eruptions (Stern et al., 2007; Watt, 2010). Finally, it is also impossible to neglect the effects that earthquakes and tsunamis have in this territory, although there are difficulties in assessing these in the more distant past. During the last 1000 years, at least ten earthquakes >8 M_w has been identified (Cisternas, 2005; Garrett, 2013).

3. Materials and methods

3.1. Paleodemography and archaeo-demography

From our perspective, a numerical dates database is able to address two different but closely interrelated phenomena. On the one hand, it refers to the population dynamics of past peoples, which we will call "paleodemography." On the other hand, this data also touches on the research dynamics of archaeologists in the present, or what we will call "archaeo-demography." This differentiation is central, and archaeologists should be aware of it. In this sense, even though numerical dates can be used to discuss population dynamics in the past, as is the goal of this volume, this data is at the same time biased, created by the very same archaeologist and archaeological community through its research.

In this case, the aphorism "absence of evidence is not evidence of absence" proves its validity. For example, at a macro-regional scale, archaeological research is not evenly distributed in the territory, or for each of the periods identified. Therefore, one should not immediately conclude that the areas or periods with no dates imply areas or periods devoid of human occupation. This could only mean that those areas or periods have been subject to little to no research. The "archaeo-demography" affects then our grasp of the archaeological record. If after systematic research, certain areas or periods are still unable to generate sites, and therefore dates, this would imply that the "archaeo-demographic" factors were minimized, and the emergent pattern should be reflecting a clearer "paleodemographic" situation. A similar case can be raised for archaeological sites, where dating is not usually done for all of the occupational levels. Thus, it could be that a complete occupational sequence is presumed, but without successive dates to document it as such. In this scenario, this situation can be partially overcome by taking a regional approach, whereby patterns of occupation are evaluated across different sites, going beyond the "archaeo-demographic" specificities of a certain site's research and looking to minimizing them, in order to make a proper assessment of the "paleodemographic" situation.

These aspects highlight the importance, effect, and awareness that is required concerning the impact that quantity and nature of research can have when discussing numerical dates in relation to paleodemography, and vice versa. In the case of Southern Chile, this has two main consequences. On the one hand, there are sites for which no numerical dates are available, and thus they will not be considered in this paper, although their material assemblages clearly correspond to a certain period, tradition, or culture. On the other hand, there are areas and periods for which the absence of data is so critical that even a regional and/or cross-site approach is virtually useless.

3.2. Data

To build the database, we used all available data to which we had access. Most of these are reported in published papers and books. However, some are contained in unpublished reports at the Comisión Nacional de Investigación Científica y Tecnológica (CONICYT) and Consejo de Monumentos Nacionales (CMN) archives, or are stored in investigators' files. Immediate problems were that not all papers or reports provided the required information, that the researchers did not properly present the information, or that the information was not consistent throughout the papers. In some cases, we were able to contact the archaeologists themselves and gain access to the laboratory reports. In others, we contacted the laboratories directly, and they provided the necessary information. Finally, in certain cases we were unable to verify the information directly, but we nonetheless included it in as complete a manner as possible using the available data. In these last cases, the laboratory code, for example, was useful since in some instances it allowed us to differentiate different dating methods (^{14}C conventional or AMS). For these reasons, the dates we present may differ from the ones previously published. Accessing the laboratory reports was fundamental, serving as the final determining factor in resolving certain inconsistencies. Additionally, we have not used any previous calibrations indicated by the authors. Also, we have included only dates that are referenced in relation to or interpreted as human activity. This means excluding dates that the researchers have interpreted as linked to strictly environmental or non-cultural events.

The completed database consists of 398 dates. It is comprised of ^{14}C ($n = 247$; 62%), TL ($n = 148$; 37%), and OH ($n = 3$; 1%) dates. Their distribution through time is not even, as for pre-ceramic periods ^{14}C dating is used almost exclusively, whereas for ceramic periods TL dating predominates slightly. The database is presented in a Supplementary online file. For all dates, the database includes the following fields: zone, sector, locality, site, laboratory code, dating method, material dated, further information on dated material (as species), approximate year of analysis, laboratory report accessibility, and first and/or most complete references. Additionally, for radiocarbon dates, it includes: delta ^{13}C, ^{14}C age plus sigma, calibrated BP median probability, calibrated BC/AD median probability. For TL and OH dates, it includes BC/AD date plus sigma.

As regards the ^{14}C dates, different methods and materials have been used, and unfortunately, we do not have this information for every case. As such, the ^{14}C dates are comprised of 36% conventional ($n = 88$), 36% AMS ($n = 90$), and 28% unknown method ($n = 69$). If the latter group is not considered, there is an increasing historical trend toward the use of AMS dating. The nature of dated material varies, although charcoal ($n = 152$) and marine shells ($n = 40$) predominate. Organic materials (wood, $n = 19$; seaweed $n = 2$; seed $n = 2$; coprolite $n = 1$; organic sediment $n = 1$) are also used, as well as bone tissues ($n = 20$). Finally, unknown material accounts for a small sample of the dates ($n = 10$). In the case of TL dates, ceramic was the material used in all cases ($n = 148$), whereas for the OH dates, obsidian ($n = 3$) was used.

The radiocarbon dates were calibrated with the Calib 7.0 software (Stuiver et al., 2014), using the ShCal13 (Hogg et al., 2013) calibration curve for terrestrial samples (otherwise indicated), and the Marine13 (Reimer et al., 2013) calibration curve for shells. With the unknown materials, the ShCal13 calibration curve was used. This procedure allows for all of these dates to be comparable with the TL and OH dates, which are reported only in a BC/AD fashion. Concerning the nature of this comparability between different dating methods, note that most of the ^{14}C dates rely on a proper assessment of the association between the materials used to obtain those dates, primarily charcoal and shells in our case, and the human event we are interested in. In turn, the ceramics used to obtain TL dates are by themselves evidence that speaks of a determined human event, in other words, what we are dating is what we are interested in. OH dates lie in a middle position: although the dated chipped obsidians are a clear product of human action, assessment still depends on great measure on the association criteria.

Additionally, this calibration was made necessary by the fact that for coastal localities, organisms with a marine diet component (seaweeds, molluscs, birds, and humans), and therefore subject to a reservoir effect, have been dated. Given the absence of a reservoir effect assessment for Southern Chile, we use a factor of 190 ± 40 as recommended by Stuiver and Braziunas (1993). However, we apply it only in the case of molluscs (shells) and not for seaweed, birds, and humans. This is justified given the incomplete understanding of the importance of marine organisms in their diets. Therefore, in these three cases we used the ShCal13 calibration curve with no reservoir effect correction. For this reason, all of these marine-related dates must be treated with caution.

We believe that this database is still too small to achieve a reliable and clear image of the paleodemographic dynamics of Southern Chile. However, it is nonetheless useful for making some general observations about this subject and constitutes the first step for a much larger, collective project. Moreover, we expect that our review and analysis of the data will encourage researchers and help them to identify areas and periods in need of further investigation. Finally, this database must be linked to similar projects that are being developed for neighboring areas (Central Chile, Neuquén, Cuyo, Patagonia).

In a geographical sense, given the scale of our research unit, the analysis of the data will be mostly at a regional rather than a local level. We leave to local archaeologists the discussion of the particular dynamics that the database may offer for their specific research areas. For this reason as well, we do not provide many details on the context associations and cultural complexes identified in the literature for Southern Chile, except when necessary. Also, because of the macro-regional scale of our research, we designed “date localities” (Fig. 2) in order to include, but not merge, the diversity of sites and dates under study and to make the database more manageable. These date localities consist of circles -of 1000 km^2 or with a radius of 17,842 km-, distributed a minimally overlapping fashion, taking care to preserve the distinction between coast, valley, and cordillera, as well as considering other orographic features. They are in a sense completely arbitrary and therefore can be modified (in number, positioning, size) with further research or for other research goals. Thirty-three of these date localities have been drawn up, each of which contains at least one site with at least one date. They thus range from localities with a single site containing a single date, to those with up to 63 dates (Isla Mocha) or 14 sites (Calafquén). This arrangement shows, on the one hand, that from a longitudinal perspective, the coast is where most of the localities ($n = 14$, 42%), dates ($n = 232$, 58%) and sites ($n = 90$, 53%) are concentrated, followed by the valley ($n = 11$, 33%; $n = 95$, 24%;

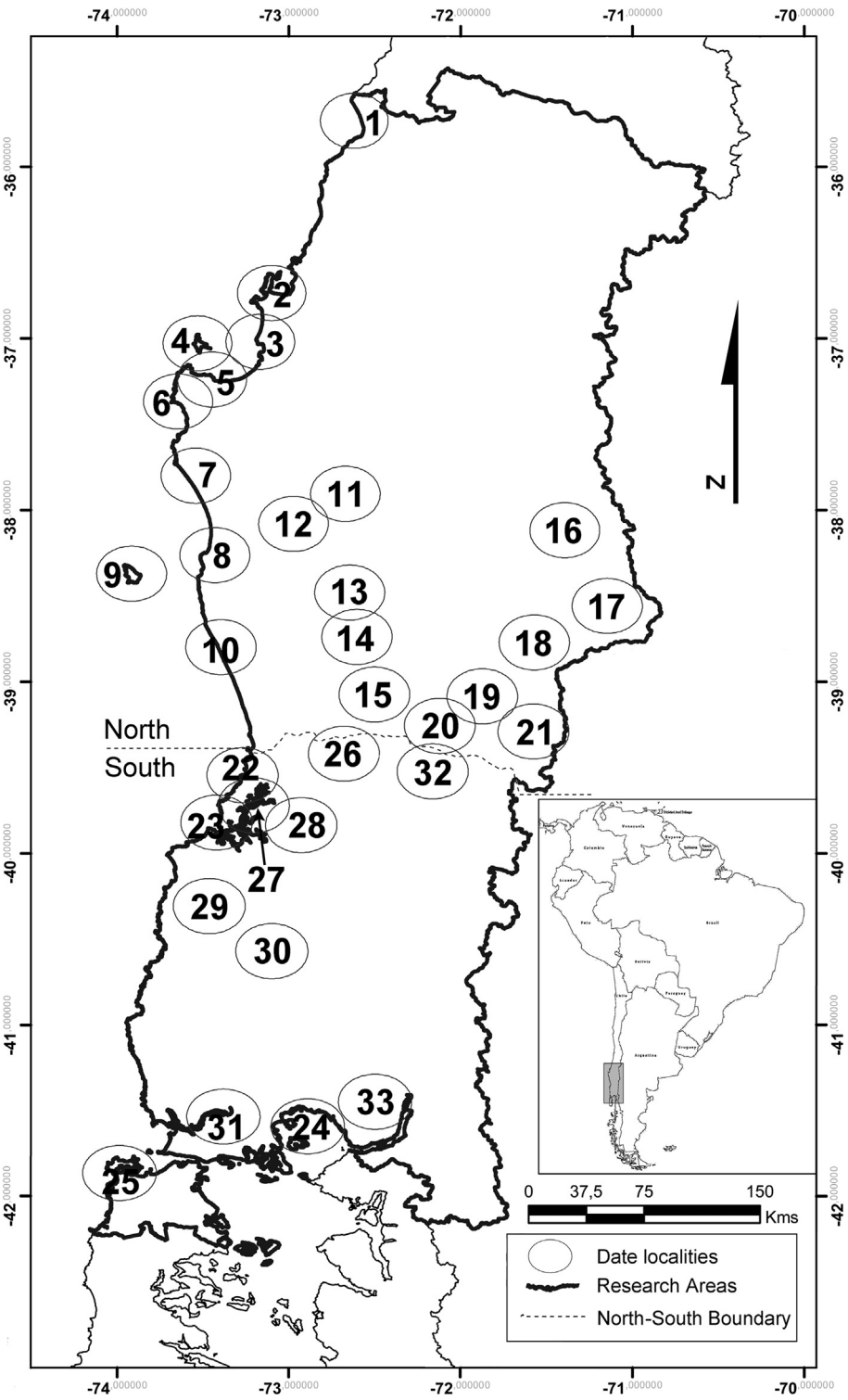

Fig. 2. Research Area and date localities for Southern Chile. Northern Sector: 1 to 21; Southern Sector: 22 to 33. Northern Sector Coast: 1 = Chanco-Pelluhue, 2 = Concepción, 3 = Coronel, 4 = Isla Santa Maria, 5 = Golfo de Arauco, 6 = Quidico-Yani, 7 = Cañete-Lebu, 8 = Tranaquepe-Tirúa, 9 = Isla Mocha, 10 = Puerto Saavedra. Northern Sector Valley: 11 = Angol, 12 = Puren-Lumaco, 13 = Galvarino-Lautaro, 14 = Temuco, 15 = Pitrufquen. Northern Sector cordillera: 16 = Central Ralco, 17 = Galletué-Liucura, 18 = Melipeuco, 19 = Colico-Caburgua, 20 = Villarica, 21 = Curarrehue. Southern Sector Coast: 22 = Chanchan, 23 = Corral-Curiñanco, 24 = Reloncavi, 25 = Quetalmahue. Southern Sector Valley: 26 = Loncoche, 27 = Valdivia, 28 = Los Lagos-Antilhue, 29 = Trinidad, 30 = Osorno, 31 = Maullin. Southern Sector cordillera: 32 = Calafquen, 33 = Lago Chapo.

$n = 37, 22\%$) and the cordillera ($n = 8, 24\%$; $n = 71, 18\%$; $n = 42, 25\%$). On the other hand, from a latitudinal perspective, the northern sector contains most of the localities ($n = 21, 64\%$), dates ($n = 274, 69\%$) and sites ($n = 122, 72\%$), in contrast to the southern sector ($n = 12, 36\%$; $n = 124, 31\%$; $n = 47, 28\%$). As a result, the northern coast is the area with the greatest concentration of localities ($n = 10, 30\%$), dates ($n = 175, 44\%$) and sites ($n = 67, 40\%$), while the southern valley and southern cordillera lie on opposite ends of the spectrum.

In a chronological sense, in order to fruitfully segregate the long occupational history of Southern Chile into smaller temporal blocks, we take into consideration the culture-historic periods propositions already advanced by different archaeologists (Adán and Mera, 1997b; Quiroz and Sánchez, 2004; García, 2005). We believe this strategy was the most appropriate because it considers the knowledge already generated. At the same time, we are completely aware that this segregation, although based in certain chronological landmarks, is an arbitrary one, as a segregation based on 1000 year-blocks would be also arbitrary, in which the long Archaic periods are unnecessarily split up and the brief Ceramic periods are over-condensed; or a segregation based on environmental or geological factors, referring, for example, to Late Pleistocene, Early, Middle, and Late Holocene. To include the dates within each of the utilized periods, we have been guided by the calibrated BC/AD median probability value for ^{14}C and the BC/AD date for TL and OH dates.

4. Results and discussion

4.1. Research historical background

The use of numerical dating techniques has been a gradual process in the archaeological research of Southern Chile. At the same time, its implementation is an informative proxy for evaluating the development and research trends of archaeology in this region (Table 1). The first numerical dates for the entire Southern Chilean territory were presented in 1973 (Tamers, 1973), as part of research efforts by the Instituto de Antropología at the Universidad de Concepción. They correspond to the coastal Archaic site of Bellavista I (Concepción) (IVIC 844 and IVIC 845) and Late Ceramic site of Tubul IA (Golfo de Arauco) (IVIC 846). Knowledge of these dates and contexts was at that time extremely fragmentary, since after the 1973 coup d'état the research was suspended and much of the information remained unpublished until the late 1990s (Seguel, 1973, 1998, 2003; Bustos et al., 1998), although it circulated informally.

Continuing with the coast, in the mid-1980s Bustos obtained at least three dates, although poorly reported (Bustos, 1985; Dillehay and Gordon, 1988; Quiroz, 2001), for Isla Quiriquina (Concepción). Later Van Meurs and Gordon (1989, 1993) obtained five dates for the Late Archaic site of Monkul-1 (Puerto Saavedra). In the 1990s, several research projects focused in particular on Isla Mocha, Chanco-Pelluhue, and Chanchan, thus distinguishing the coast from the valley and cordillera in the amount of archaeological data and, therefore, number of numerical dates available. This trend continued into the 2000s, with additional research in the aforementioned localities (except for Chanco-Pelluhue), as well as in new areas, particularly the localities of Isla Santa María, Cañete-Lebu, Corral-Curiñanco, Reloncaví, and Quetalmahue. Finally into the 2010s, this increase in research continued mainly on Isla Mocha and Isla Santa María.

In the case of the valley zone, the first numerical date was published by Gordon (1978) for the Late Ceramic site of Padre Las Casas (Gif 384) (Temuco). This was followed by a set of three dates for the Paleoindian site of Monte Verde (Maullín) (Dillehay et al., 1982), a date for the Early Ceramic site of Huimpil (Galvarino-Lautaro) (Gordon, 1985), and two dates for the Late Archaic component of the Alero Quillen 1 site (Galvarino-Lautaro) (Valdés et al., 1985). By the late 1980s, six new dates were obtained for Monte Verde (Dillehay and Collins, 1988; Dillehay and Pino, 1989). This sporadic and scattered research continued in the 1990s and into the 2010s. The valley has seen a dramatic lack of research projects and, therefore, of numerical date generation. The main exception to this tendency has been Purén-Lumaco (Dillehay, 2007), as well as the dating of museum artifacts (Adán and Mera, 1997a) and several Cultural Resources Management (CRM) and public works-related projects in different localities throughout the valley. To give an idea of the shortage of research in the valley, it is worth mentioning that 65% of the dates for this zone come from two local-scale projects (Monte Verde and Purén-Lumaco), both directed by Dillehay.

The cordillera's first three dates were obtained during the late 1970s, corresponding to the Late Ceramic and Historical components of the Pucón VI site (Villarrica) (Navarro, 1979). It was not until the 1990s that new dates were collected: one for the historic site of Casa-Fuerte Santa Sylvia (Curarrehue) (Gordon, 1992–95; Dillehay and Sauer, 2011) and two for the Early Ceramic sites of Pitrén and Challupén-2 (Calafquén) (Adán and Mera, 1997b). During the 2000s and into the 2010s, there was an increase in available dates due to the development of a number of research and public works-related projects in the cordillera. However, the research projects were concentrated for the most part in Calafquén, while the public works projects focused on Central Ralco, such that these two areas together account for 66% of the dates available for the cordillera.

From this brief historical assessment, it is clear that up to the 1990s in Southern Chile, the chronological control was very basic and the set of numerical dates was limited (Table 2). The numerical main contributor was the Maullín locality, where Monte Verde and Chinchihuapi are located. The 1990s thus mark the starting point for divergent research trajectories for the coast, valley, and cordillera. In this context, from that decade on the coast has been the preferred archaeological research area in Southern Chile. Reasons for this situation, which exemplifies clear archaeo-demographic issues, could be related to the more straightforward identification of human occupation spaces in this zone, given that many of its sites are highly visible shell middens. Additionally it is an area of relatively easy access in comparison to the cordillera. Finally, coastal archaeological sites tend to be better preserved and have better visibility than those in the valley, which have been subject to intensive agriculture since the 1880s. In this sense, doing research in the valley and cordillera entails solving more complex and numerous methodological issues. In addition, there is the inevitable fact that research tends to develop in areas where research is already being done, or where there is a significant research baseline to start from. Given these factors, the coast becomes much more

Table 1
Historical count of numerical dates for Southern Chile per zone.

Decade	Coast	Valley	Cordillera	Total
1973–1979	3	1	3	7
1980–1989	8	14	0	22
1990–1999	85	12	3	100
2000–2009	102	58	54	214
2010–today	34	10	11	55
Total	232	95	71	398

Table 2
Historical count of numerical dates for Southern Chile per decade.

Decade	Paleo-indian	Early Archaic	Middle Archaic	Late Archaic	Early Ceramic period	Late Ceramic period	Historic period	Total
1973–1979			1	1		3	2	7
1980–1989	11		1	6	1	3		22
1990–99	2		21	10	23	37	7	100
2000–09	8	3	40	37	25	72	29	214
2010–today	7	1		9	16	20	2	55
Total	28	4	63	63	65	135	40	398

attractive than the valley and cordillera, a tendency reinforced by the fact that most research in the latter two areas has been intensive, but only at a very local scale. The entire territory between the Maule and Bio-Bio rivers, except the Chanco-Pelluhue locality, has almost completely lagged behind on research efforts. All the above are archaeo-demographic factors that condition our knowledge of the past human population dynamics.

The preference for the coast also becomes clear when visualizing the distribution of date localities. Whereas the coastal localities extend through almost our entire research area (750 km), the valley and cordillera localities are mostly concentrated in about 250 km. This latter area roughly corresponds to the territory between the Bio-Bio and Calle-Calle rivers. Because of these archaeo-demographic factors, most of the current evaluation will be heavily biased toward the coast. However, the inclusion of the valley and cordillera is necessary, as it allows for the identification and proper contextualization of certain potential paleodemographic dynamics at a macro-regional scale.

4.2. Paleoindian: (36,000?) 15,000–9500 cal BC. (38,000?) 17,000–11,500 cal BP

This period is represented by 28 dates, all ^{14}C, at six sites: Monte Verde, Chinchihuapi, Pilauco, Río Bueno, Alero Marifilo, and Pucón VI (Table 3, Fig. 3). We have included as part of this count and of this period the two dates for Monte Verde Component I (Dillehay and Collins, 1988; Dillehay and Pino, 1989), which extend to over 30,000 BP (uncalibrated). These last two dates are highly controversial both in paleodemographic and archae-demographic terms. For this reason, it is difficult to refer to them extensively, but at the same time it is inappropriate not to mention them in the context of the building of an exhaustive chronological database, as ours expects to be. That said, we do not refer to those two dates again.

The remaining 26 dates provide an archaeological signal heavily concentrated in the southern sector of Southern Chile, and almost exclusively restricted to the valley zone; the only exceptions are Marifilo and Pucón VI in the cordillera. We estimate that population densities should have been very low for this period, and thus such a low representation is to be expected. However, the fact that most of our information comes from one site (Monte Verde, $n = 16$) and from one locality (Maullín, $n = 17$) speaks to a research concentration at the site and locality level. For that reason, even though we think that our image of this period is affected by paleodemographic variables, it is also true that archaeo-demographic variables have an effect. These sites suffer, to different degrees, the problems of having small artifact assemblages, limited excavations, and/or that the findings have not been comprehensively reported or researched. These aspects preclude a thorough image about them and their context. Méndez (2013) provides a discussion for these sites and puts them in chronological context with the remaining early sites (15,600–7800 cal BP) in Chile.

Archaeologically speaking, all of these sites are characterized by a very expedient and non-formalized lithic industry, the only exceptions being the El Jobo-like projectile points recovered at Monte Verde. In terms of subsistence, while the valley sites of Monte Verde (Dillehay, 1997) and Pilauco (Pino et al., 2013) are associated with extinct fauna (we do not have this information for Chinchihuapi and Río Bueno) the cordillera sites are associated with modern fauna (Velásquez and Adan, 2004; García, 2009; Navarro et al., 2010).

As regards the dated materials, the dating of coastal seaweeds for Monte Verde (Dillehay et al., 2008a, 2008b) are chronologically coincident with the remaining dates for the site. In this case, the authors (2008b:3) indicate, after presenting several arguments, that, "In summary, the Monte Verde II seaweeds are not pure marine organisms (such as shell) subject to older and deeper carbon deposits and thus not in need of correction for a marine reservoir effect."

4.3. Early Archaic: 9500–6000 cal BC. 11,500–8000 cal BP

This period is the major gap on this compilation (Table 4, Fig. 3), to the point that almost anything we can say about it is uncertain. The segregation of this period from the previous one is not unproblematic given their economic, technological, and social continuities, represented in a predominant consumption of modern fauna, an expedient toolkit, and band-scale groups. Still, the environmental changes that mark the transition from the Pleistocene to the Holocene we estimate constitute sufficiently significant landmarks to differentiate the periods.

All Early Archaic dates are ^{14}C. In contrast to the previous Paleoindian period, occupation is now present across the middle section of Southern Chile, both in the northern and southern sectors and both in the valley and cordillera zones. In a similar fashion to the Paleoindian period, we could argue for the Early Archaic that population density was also low and that people were highly mobile and, therefore, produced very subtle traces of occupation. The material assemblages are also small and non-diagnostic, comprised of, at least in the case of the cordillera localities, an expedient technology (Mera and García, 2004; García, 2009; Navarro et al., 2010). In this case, we believe that archaeo-demographic factors play a more dramatic role in our inability to approach this period. In this sense, the research projects done both at the Calafquén and Purén-Lumaco localities took a regional approach, in contrast to the site-focused research that characterizes the Paleoindian period at Maullín and Osorno. Thus, the discovery of these Early Archaic sites, although there are just four, indicates that people were there in the past, and that we must refine the research tools and conduct more thorough investigations in order to find more sites from this period and elucidate its past population dynamics.

Table 3
Date localities, number of dates, and number of sites with numerical dates for Paleoindian period. (N = Northern, S = Southern, Ct = Coast, V = Valley, Ca = Cordillera).

Locality	Sector		Zone			Dates			Sites		
	N	S	Ct	V	Ca	Ct	V	Ca	Ct	V	Ca
Villarrica	X				X			1			1
Trinidad		X		X			1			1	
Osorno		X		X			6			1	
Maullín		X		X			19			2	
Calafquén		X			X			1			1
	4	1	0	3	2	0	26	2	0	4	2
TOTAL	5		5			28			6		

Table 4
Date localities, number of dates, and number of sites with numerical dates for Early Archaic period. (N = Northern, S = Southern, Ct = Coast, V = Valley, Ca = Cordillera).

Locality	Sector		Zone			Dates			Sites		
	N	S	Ct	V	Ca	Ct	V	Ca	Ct	V	Ca
Purén-Lumaco	X			X			1			1	
Villarrica	X				X			1			1
Calafquén		X			X			2			2
	2	1	0	1	2	0	1	3	0	1	3
Total	3		3			4			4		

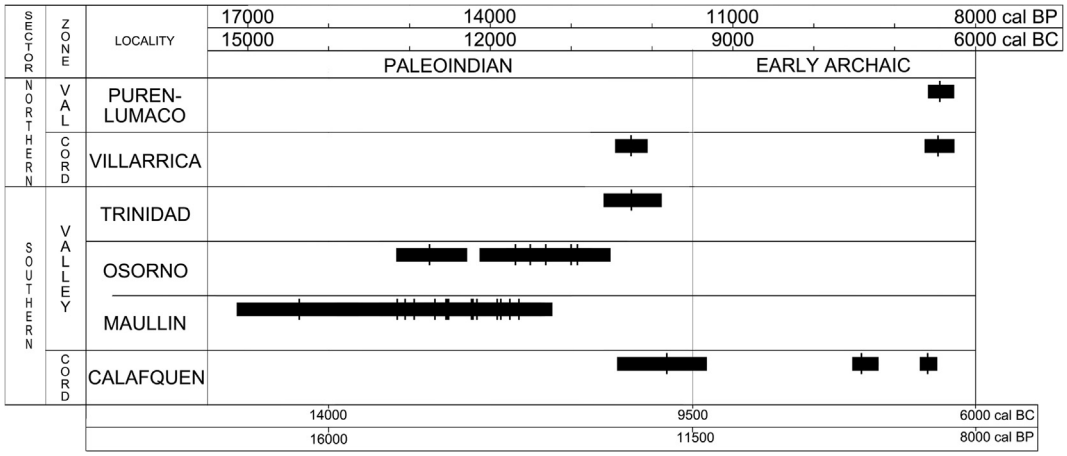

Fig. 3. Date localities with Paleoindian and/or Early Archaic dates. All dates are ^{14}C. All dates are represented with two error ranges (95% confidence level). Monte Verde Component I with dates beyond 30,000 BP is not included.

4.4. Middle Archaic: 6000–2000 cal BC. 8000–3950 cal BP

This period marks a significant change in relation to the two previous periods (Table 5, Fig. 4). All the dates are ^{14}C. The most significant shift is the appearance of coastal occupations, which encompass most of the localities, dates, and sites. Explanations for this sudden appearance usually refer to the stabilization of the sea level, after the Holocene Marine Transgression (Quiroz and Sanchez, 2004). It is argued that as a result of this, earlier coastal sites are now submerged. An alternative and more optimistic option is that on a 850 km long coast, we should be able to find sites of an earlier date. However, there is no immediate and simultaneous presence of archaeological sites on the coast.

The earliest date is in the Chanco-Pelluhue locality around 7600 cal BP or 5600 cal BC (Beta 80430, 7280 ± 70 BP). It is followed by the Coronel, Chanchan, and Reloncaví localities between 7000 and 6000 cal BP (or 5000 and 4000 cal BC); Quetalmahue and Cañete-Lebu between 6000 and 5000 cal BP (or 4000 and 3000 cal BC); and, finally, by Concepción and Arauco between 5000 and 4500 cal BP (or 3000 and 2500 cal BC).

The earliest date at a certain locality does not signify an occupation pattern, and that this apparently staggered occupation of the coast can be imputed to archaeo-demographic factors. On the other hand, and related to this last point, we must address the problem of using marine shells as dating material. For this period, this is critical for Chanco-Pelluhue, Cañete-Lebu, Coronel, and Golfo de Arauco, where all the dates come from shells, and for Concepción and Reloncaví, where they were partially used. However, even though this is an aspect to analyze and resolve in further investigations, and assuming that the contextual associations between dated materials and archaeological remains are correct, the presence of a Middle Archaic component at these six localities is undeniable. For these reasons, it is vital that via independent lines of evidence we determine the precise moment when the current coast in these different localities became available for occupation. On the other hand, it is clear that by the end of the Middle Archaic, the occupation of the coast is solid, with groups developing different and specialized toolkits (harpoons, net-sinkers, fishhooks) to exploit coastal and marine resources. These groups have been singled out as the Loanco, Cerro Las Conchas, Pahuil, and Reloca patterns for Chanco-Pelluhue (Gaete et al., 1995, 2000); the Talcahuanense tradition for Concepción, Coronel, Golfo de Arauco, and Cañete-Lebu (Menghin, 1959–60; Quiroz, 2001; Quiroz and Sánchez, 2004; Massone et al., 2011); the Chanchanense tradition for Chanchan (Menghin, 1959–60; Navarro, 1995; Navarro and Pino, 1999); and a tradition of large bi-pointed projectile points for Reloncaví and Quetalmahue (Gaete and Navarro, 2004; Ocampo and Rivas, 2004; Flores and Lira, 2006).

The situation in the valley and cordillera zones is almost as poor as in the Early Archaic. In a sense, the same evaluation already

Table 5
Date localities, number of dates, and number of sites with numerical dates for Middle Archaic period. (N = Northern, S = Southern, Ct = Coast, V = Valley, Ca = Cordillera).

Locality	Sector		Zone			Dates			Sites		
	N	S	Ct	V	Ca	Ct	V	Ca	Ct	V	Ca
Chanco-Pelluhue	X		X			12			4		
Concepción	X		X			5			4		
Coronel	X		X			3			1		
Golfo de Arauco	X		X			1			1		
Cañete-Lebu	X		X			5			1		
Purén-Lumaco	X			X			1			1	
Galvarino-Lautaro	X			X			1			1	
Chanchan		X	X			9			2		
Reloncaví		X	X			12			5		
Quetalmahue		X	X			10			1		
Calafquén		X			X			4			2
	7	4	8	2	1	57	2	4	19	2	2
Total	11		11			63			23		

Table 6
Date localities, number of dates, and number of sites with numerical dates for Late Archaic period. (N = Northern, S = Southern, Ct = Coast, V = Valley, Ca = Cordillera).

Locality	Sector		Zone			Dates			Sites		
	N	S	Ct	V	Ca	Ct	V	Ca	Ct	V	Ca
Concepción	X		X			2			2		
Isla Santa María	X		X			3			1		
Golfo de Arauco	X		X			1			1		
Cañete-Lebu	X		X			1			1		
Isla Mocha	X		X			10			5		
Puerto Saavedra	X		X			5			1		
Purén-Lumaco	X			X			21			4	
Galvarino-Lautaro	X			X			3			2	
Central Ralco	X				X			4			4
Galletué-Liucura	X				X			1			1
Melipeuco	X				X			1			1
Villarrica	X				X			2			1
Reloncaví		X	X			5			4		
Calafquén		X			X			3			3
	12	2	7	2	5	27	24	11	15	6	10
Total	14		14			62			31		

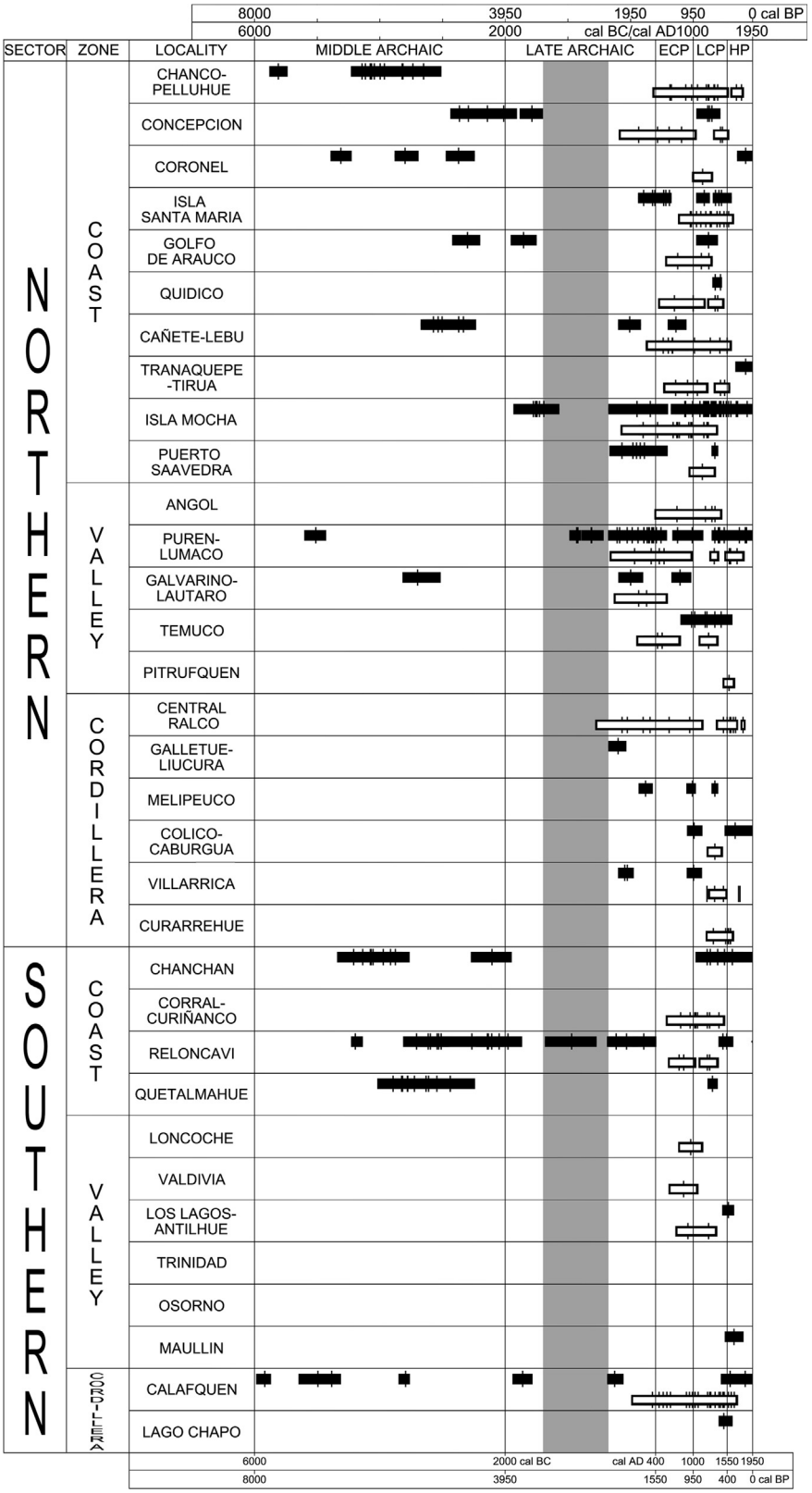

Fig. 4. Middle Archaic to Historic period dates per date locality. Solid bars correspond to ^{14}C dates, unfilled bars correspond to TL dates; the three OH dates for Villarrica are included as part of the TL dates for that locality. In gray, the proposed Late Archaic coastal hiatus. All dates are represented with two error ranges (95% confidence level).

outlined for that period can be repeated here. However, the amount of available data for the coast makes their virtual absence appear even more dramatic. For an overarching pattern, based solely on projectile point morphologies, the existence of a stemmed projectile point tradition has been proposed; this includes the Loanco pattern, the Talcahuanense tradition, and the Alero Quillen 1 site in

the valley. Contemporaneously, a lanceolate projectile point tradition is represented by the Cerro Las Conchas pattern, the Chanchanense tradition, and at Reloncaví and Quetalmahue.

The coast has been the area of focus for most research, and therefore its representation is clearly an archaeo-demographic outcome. For this reason, the under-representation of the cordillera and valley zones is another archaeo-demographic outcome, but in the opposite direction. The research accomplished at Calafquén and Purén-Lumaco show that those sites, although in a small frequency, can be found.

4.5. Late Archaic: 2000 cal BC – 400 cal AD. 3950–1550 cal BP

This period is represented by 51 ^{14}C dates and 11 TL dates (Table 6, Fig. 4). It is marked by three events: an apparent hiatus in coastal occupation, the first dates for the oceanic islands, and the earliest appearance of ceramics. The first two events must be treated in tandem. Considering that by the end of the Middle Archaic eight coastal localities had presented occupation, and that they exhibited a specialized coastal-adapted toolkit, one could argue that the Southern Chilean coast had been by then effectively occupied and that this trend should continue into the Late Archaic. It is in this context that Isla Mocha presents its earliest occupation, a very enclosed one represented by six dates for which the chronological extremes, considering two error ranges, are 3821 and 3084 cal BP (or 1872 and 1135 cal BC) (Vásquez, 1997; Quiroz et al., 2000).

After 3084 cal BP (or 1135 cal BC) and up to at least 2289 cal BP (or 340 cal BC, earlier calibrated extreme of the date GrN16325 [2630 ± 60, shell] from Monkul-1) (Van Meurs and Gordon, 1989), there is not a single date for the entire mainland northern sector coast (also including Chanchan, in the southern sector coast). This means that a coastal area of about 450 km, for which there are dates during the Middle Archaic, presents no dates for at least 800 years. We believe that this situation reflects a true paleodemographic process, and not just an archeo-demographic outcome. The coast has been systematically studied, and to this day the absence of dates has not been overcome. Quiroz (2001; Contreras and Quiroz, 2011) noted this date hiatus for the area between the Concepción and Cañete-Lebu localities, and we have now looked at the northernmost and southernmost areas of this sector and have found that the same situation is repeated. In contrast, for the southern sector coast there are dates before, during and after this hiatus at Reloncaví, whereas in Quetalmahue there are no dates during the hiatus. The situation in Reloncaví, although the dates do not overlap showing a clear continuous occupation, leads us to place, for now, the southern limit for this Late Archaic occupational hiatus somewhere between Chanchan and Reloncaví. The absence of more dates for Reloncaví and Quetalmahue may be more related to archaeo-demographic rather than paleodemographic factors.

The outlined hiatus becomes more dramatic if Isla Mocha is excluded from the scenario, and there are reasons for doing that. On the one hand, the toolkit associated with the occupation on Isla Mocha does not at all resemble the contemporaneous ones from the adjacent continental coast (Vásquez, 1997), such that it is not clear if at that time the mainland populations had the open-sea navigation techniques to reach Isla Mocha. On the other hand, the Isla Mocha toolkit much more closely resembles those of the Northern Patagonian Channels groups (which Reloncaví and Quetalmahue are geographically a part of) which had developed open-sea navigation techniques (Quiroz, 2001; Ocampo and Rivas, 2004; Contreras and Quiroz, 2011). Finally, Isla Mocha is farther from the continent than Isla Santa María, and if open-sea navigation were available for the mainland groups, we should expect to find an earlier or contemporaneous occupation at this latter island as well. Therefore, if we consider that the earliest occupation of Isla Mocha is not related to its adjacent continental coast, the starting point for this proposed hiatus could be at least 3346 cal BP (or 1397 cal BC, later calibrated extreme of the date IVIC 845 [3330 ± 80, charcoal] from Bellavista I), encompassing at least some 1050 years. At the same time, the arrival of these supposed southern navigators to Isla Mocha, as well as the limited and interrupted occupation of the island, may be related to, and could be a consequence of, this emptying of the northern sector coast in Southern Chile. It is this 1050-year hiatus, more than any other factor, which explains why this period is the most balanced among zones in relation to the amount of dates and sites. This is a period that is not monopolized by the coast.

For the cordillera, within the Late Archaic, and before the coastal occupational hiatus, there is only one date (at Calafquén), while during the hiatus there are none. However, considering the archaeo-demographic dynamics already outlined for the Paleoindian, Early Archaic, and Middle Archaic in relation to the cordillera, we are not so confident that processes occurring on the coast are reflected or are also present in the former zone. In contrast, the valley (more specifically, Purén-Lumaco) indicates a recurrent occupation of this locality during the coastal hiatus. These situations reveal that much more research is needed for both the cordillera and valley zones before more sophisticated interpretations are put forth about their paleodemographic dynamics, as they show no clear patterns at all.

After 2289 cal BP (or 340 cal BC), a new trend of occupation can be discerned in the coast and the cordillera. In the coast, between that date and 1550 cal BP (or 400 cal AD), there are new dates for Reloncaví, Puerto Saavedra, Cañete-Lebu, Isla Mocha, Concepción, and Isla Santa María. In this context, the occupation of Isla Mocha and Isla Santa María is relevant. For the former, its earliest reoccupation is dated to 1940 ± 180 BP (Sánchez, 1997 [Gd 9197, 2036–1430 cal BP or 357 cal BC-520 cal AD]), while the latter's first occupation is dated to 1850 ± 30 BP (Massone et al., 2012 [Beta 310945, 1827–1618 cal BP or 123–332 cal AD]). This implies that the re-occupation of the coast was not necessarily followed by an immediate presence on these two islands. Nonetheless, this time the occupation was done by mainland groups and with an apparent continuity up to historical times. Meanwhile, in the cordillera, five localities (Calafquén, Galletué-Liucura, Central Ralco, Villarrica, Melipeuco) (García, 2009; Adán and Mera, 2011) have dates, which is a significant increase from the previous periods. This situation could indicate more extensive and intensive use of the territory, which would make the sites of this time span more visible. This would constitute a clear paleodemographic factor. However, an archaeo-demographic effect cannot be ruled out. In the valley, Purén-Lumaco contains almost all of the evidence. Since 2735 ± 55 BP (Dillehay, 2007 [AA 64648, 2928–2737 cal BP or 979–788 cal BC]), one can identify a continuous and solid trend of occupation. In a similar fashion to the cordillera, this situation could reflect more extensive and intensive use of the space. It also indicates that there could be more sites in the valley, such as, for example, Alero Quillen 1 and Quino 1 at the Galvarino-Lautaro locality (Valdés et al., 1985; Quiroz et al., 1997; Adán and Mera, 2011). In this case, there is a clear archaeo-demographic factor affecting our understanding of the Late Archaic period in the valley.

This period also witnessed the earliest presence of ceramics in Southern Chile. The use of TL dates is direct evidence of this phenomenon. The earliest TL dates by zone are: 135 ± 215 BC (565 BC-295 AD, Adán and Mera, 2011) in Central Ralco, 65 ± 200 AD (UCTL 1553, 335 BC-465 AD, Dillehay, 2007) in Purén-Lumaco, and 130 ± 160 AD (UCTL 1051, 190 BC-450 AD, Bustos and Vergara, 2001) in Concepción. Other localities with early TL dates are Galvarino-Lautaro, Isla Mocha, and Calafquén (Quiroz et al., 1997; Adán and Reyes, 2000; Adán and Mera, 2011). In addition, there are some ^{14}C dates that are also

related to the presence of early ceramics (Sánchez, 1997; Adán and Mera, 2011). They provide a date of 2190 ± 40 BP (Beta 273150, 2306–2017 cal BP or 357–68 cal BC) in Galletué-Liucura, 2110 ± 40 BP (Beta 253960, 2150–1930 cal BP or 201 cal BC-20 cal AD) in Villarrica, and 1940 ± 180 BP (Gd 9197, 2306–1430 cal BP or 357 cal BC-520 cal AD) in Isla Mocha. These localities with early ceramics presence are confined to the coast (Isla Mocha included), the valley, and the cordillera of the northern sector of Southern Chile, plus Calafquén, which lies just south of the boundary. It is not clear, for now, if the absence of early ceramics in the southern sector is a result of paleo-demographic or archaeo-demographic factors.

In contrast to the Middle Archaic period, not a single tradition or pattern has been proposed for the Late Archaic. This is a clear reflection of the still incomplete knowledge of, as well as the difficulties faced when addressing, the peculiar dynamics that this period entails. It thus remains an open question as to the connections, if any, between the later increase in the amount of dates and occupied localities, the re-occupation of the coast, and the arrival of ceramic technology to Southern Chile: Was there a population replacement, at least in the coast, during the Late Archaic?

4.6. Early Ceramic period: 401 AD – 1000 AD. 1550–950 cal BP

This period is represented by 17 ^{14}C dates and 49 TL dates (Table 7, Fig. 4). It is characterized by the consolidation of a ceramic tradition called the Pitrén Cultural Complex in Southern Chile (Menghin, 1959–60; Aldunate, 1989; Adán and Mera, 1997b). However, this complex is apparently not the only ceramic manifestation during this period. Pitrén is well represented in the valley from Angol to Los Lagos-Antilhue, in the cordillera from Central Ralco to Calafquén, and in the coast from Cañete-Lebu to Corral-Curiñanco, as well as Isla Mocha. In the coastal territory that runs from Concepción to Quidico-Yani, including Isla Santa Maria, a different tradition or traditions seem to have developed. Lenga Complex or Temprano Complex are among the names that have been given to these manifestations (Quiroz, 2010; Massone et al., 2012). To the north (for example, Chanco-Pelluhue), the ceramic evidence is not clear enough to determine whether it is a northern manifestation of the Pitrén Complex or a more local tradition (Sánchez and Gaete, 1994; Gaete and Sánchez, 1995, 2000). To the south of Corral-Curiñanco, Los Lagos-Antilhue, and Calafquén, it is also unclear if these populations were part of the Pitrén Complex or merely obtained the pieces from the latter. In any case, the definition and distribution of the Pitrén phenomenon are heavily biased toward its ceramic component, overemphasizing the diagnostic features, while little is known about its subsistence and social organization. It has been argued that these groups were organized in a hunter-gatherer economy, with some horticultural practices (Adán and Mera, 2011).

The ceramics' ubiquity and visibility make the sites from this period much more identifiable. These factors also explain the shift from ^{14}C to TL as the preferred dating method, as well as the number of dates and sites recorded for such a small time span, a much larger quantity in comparison to previous periods. Nonetheless, it also probably indicates that the territory was used more extensively, represented by an increase in localities identified along the coast and in the valley zone. This most likely suggests a rise in population density at the regional level.

During this period, the coast thus resumed its importance as the area with the most dates and sites. This outcome is part of an archaeo-demographic process. This does not negate the paleo-demographic trend mentioned above, but the absence of a clearer continuity between localities is mostly explained by the archaeologists' research focuses and interests. Regarding the valley, for the first time since the Paleoindian period, a wider distribution of localities is observable, extending about 225 km. At the same time, almost half of the dates come from Purén-Lumaco. As for the cordillera, there is reduction in the number of localities with dates, and more than half of these dates come from Calafquén. These two cases are examples of how intensive research at the locality level has been effective for generating dates and sites. This should thus encourage similar undertakings in other areas of the valley and cordillera to fill in the gaps in our knowledge of areas to the north and south of the identified localities.

Table 7
Date localities, number of dates, and number of sites with numerical dates for Early Ceramic period. (N = Northern, S = Southern, Ct = Coast, V = Valley, Ca = Cordillera).

Locality	Sector		Zone			Dates			Sites		
	N	S	Ct	V	Ca	Ct	V	Ca	Ct	V	Ca
Chanco-Pelluhue	X		X			4			3		
Concepción	X		X			3			3		
Isla Santa María	X		X			6			2		
Golfo de Arauco	X		X			1			1		
Quidico-Yani	X		X			2			2		
Cañete-Lebu	X		X			5			4		
Tranaquepe-Tirúa	X		X			2			2		
Isla Mocha	X		X			13			7		
Angol	X			X			1			1	
Purén-Lumaco	X			X			7			5	
Galvarino-Lautaro	X			X			1			1	
Temuco	X			X			3			3	
Central Ralco	X				X			2			2
Corral-Curiñanco		X	X			2			2		
Reloncaví		X	X			2			1		
Loncoche		X		X			1			1	
Valdivia		X		X			1			1	
Los Lagos-Antilhue		X		X			1			1	
Melipeuco		X			X			1			1
Calafquén		X			X			8			5
	13	7	10	7	3	40	15	11	25	13	8
Total	20		20			66			46		

4.7. Late Ceramic period: 1001 AD – 1550 AD. 950–400 cal BP

This period is represented by 65 ^{14}C dates, 70 TL dates, and 1 OH date (Table 8, Fig. 4). During this period, the El Vergel Complex has been identified in the coast and valley of the northern sector (Aldunate, 1989, 2006; Dillehay, 2007; Campbell, 2011). It is characterized by a much more sedentary lifestyle, significant reliance on cultivated resources (such as quinoa and maize) along with hunter-gatherer practices, the earliest manifestations of public architecture (mounds), and a social organization amenable to trans-egalitarian societies or simple chiefdoms. Meanwhile, for the northern sector cordillera and the entire southern sector, a continuity of the patterns already outlined for the Early Ceramic period is proposed.

The number of dates and localities for this period, especially in the northern sector, indicates a spatially intensive occupation. As can be expected, the coast contains most of this data, to the extent that all coastal localities show occupation during this period. This situation is the product of both paleodemographic and archaeo-demographic factors. It would be possible to say that the entire Southern Chilean coast showed occupation during this period. For this reason, the situation in the valley zone is rather disappointing, because only 4 localities have dates. On the other hand, the cordillera has its greatest number of occupied localities (7 of 8), reflecting a persistent and probably more intensive occupation. However, our understanding remains mostly restricted to the area between Central Ralco and Calafquén.

Table 8
Date localities, number of dates, and number of sites with numerical dates for the Late Ceramic period. (N = Northern, S = Southern, Ct = Coast, V = Valley, Ca = Cordillera).

Locality	Sector		Zone			Dates			Sites		
	N	S	Ct	V	Ca	Ct	V	Ca	Ct	V	Ca
Chanco-Pelluhue	X		X			7			5		
Concepción	X		X			5			5		
Coronel	X		X			1			1		
Isla Santa María	X		X			15			8		
Golfo de Arauco	X		X			4			4		
Quidico-Yani	X		X			5			1		
Cañete-Lebu	X		X			4			3		
Tranaquepe-Tirúa	X		X			3			3		
Isla Mocha	X		X			34			6		
Puerto Saavedra	X		X			2			1		
Angol	X			X			4			3	
Purén-Lumaco	X			X			6			5	
Temuco	X			X			6			5	
Central Ralco	X				X			2			1
Melipeuco	X				X			1			1
Colico-Caburgua	X				X			2			2
Villarrica	X				X			4			4
Curarrehue	X				X			2			2
Chanchan		X	X			4			4		
Corral-Curiñanco		X	X			6			4		
Reloncaví		X	X			4			3		
Quetalmahue		X	X			1			1		
Los Lagos-Antilhue		X		X			1			1	
Calafquén		X			X			11			7
Lago Chapo		X			X			1			1
	18	7	14	4	7	95	17	23	49	14	18
Total	25		25			135			81		

4.8. Historic period: 1551 AD – present. 400 cal BP – present

An evaluation of this period using only archaeological evidence (more specifically, only the numerical dates) would be deficient or, at the very least, biased (Table 9, Fig. 4). However, we believe that excluding this period from the current evaluation is an even more biased strategy. It is represented by 19 ^{14}C dates, 19 TL dates, and 2 OH dates.

According to ethnohistoric estimates, the population of Southern Chile at the time of the European arrival (1550 AD) was about one million (Bengoa, 2003). However 50 years later, the native population is estimated to have dropped to 100,000. From that moment onwards, several different local population dynamics make it difficult to discuss paleodemography at a regional scale. These include: the creation of a free-Indian country south of the Bio-Bio river by the end of the 16th century, the massive movement of people into the trans-andean territory from the 17th to 19th centuries, the Spaniards' re-incorporation of several tracts of land south of the Cruces river starting in the mid-17th century, and finally the total conquest of Southern Chile during the second half of the 19th century. In addition, the resolution of dating techniques and the span of the error ranges, which in several cases cover this entire period, are far from the ideal needed to address these population phenomena. One is nonetheless tempted to think that the decrease in the number of localities with dates compared to the previous period is a consequence of the complex population dynamics triggered by the Europeans' arrival. However, we are most inclined to think that it is an archaeo-demographic effect, given the scarcity of research devoted to this period.

Table 9
Date localities, number of dates, and number of sites with numerical dates for Historic period. (N = Northern, S = Southern, Ct = Coast, V = Valley, Ca = Cordillera).

Locality	Sector		Zone			Dates			Sites		
	N	S	Ct	V	Ca	Ct	V	Ca	Ct	V	Ca
Chanco-Pelluhue	X		X			2			2		
Coronel	X		X			1			1		
Isla Santa María	X		X			1			1		
Tranaquepe-Tirúa	X		X			1			1		
Isla Mocha	X		X			6			4		
Purén-Lumaco	X			X			7			4	
Pitrufquén	X			X			1			1	
Central Ralco	X				X			5			5
Colico-Caburgua	X				X			1			1
Villarrica	X				X			2			1
Curarrehue	X				X			4			4
Chanchan		X	X			1			1		
Reloncaví		X	X			1			1		
Los Lagos-Antilhue		X		X			1			1	
Maullín		X		X			1			1	
Calafquén		X			X			5			4
	11	5	7	4	5	13	10	17	11	7	15
Total	16		16			40			33		

5. Conclusions

In this section, we will summarize the paleodemographic and archaeo-demographic trends outlined above. For the coast, there is a sudden emergence and progressive increase of occupied localities starting in 7600 cal BP (or 5600 cal BC). This comes to a halt in the northern sector at around 3400 cal BP (or 1400 cal BC), after which an occupational hiatus of at least about 1050 years occurs. After this, a re-occupation starts around 2350 cal BP (or 350 cal BC). This is accompanied in 2050–1750 cal BP (or 100 BC-200 AD) by mainland groups' occupation of Isla Mocha and Isla Santa María, as well as the earliest presence of ceramics. After that point, a new incremental trend becomes clear in the number of occupied localities and continues up to historical times. As the coast has been by far the most investigated area, the evidence of the proposed occupational hiatus seems to represent a true paleodemographic outcome. At the same time, it is crucial that we determine a more accurate reservoir effect for the ^{14}C dates on shells in order to refine our understanding of this area.

In the valley, occupation appears to be very sporadic from 12,000 cal BP (or 10,000 cal BC) up to 3000 cal BP (1000 cal BC). This situation is most likely a result of archaeo-demographic variables. The main sources of chronological data for the valley are investigations that are extremely geographically focused (Purén-Lumaco) or geographically and chronologically focused (Maullín and Osorno). These 3 localities provide 67 of the 92 dates available for the valley. At the same time, these investigations indicate that even during periods poorly represented in the dates, there were people in the valley. Therefore, what is needed are research projects designed to locate further evidence of this. Without this data, most of our interpretations of paleodemography in the valley will be highly unsubstantiated and uncertain.

In the cordillera, the first signs of occupation appear around 12,000 cal BP (10,000 cal BC), followed by sporadic events between roughly 9500 cal BP (or 7500 cal BC) and 2200 cal BP (250 cal BC). After this, there is a consistent and permanent trend of dates and occupied localities up to historical times. That date also coincides with the earliest ceramics in the cordillera. In this case, we are not as confident regarding the presence of a hiatus, or several of them, which could simply reflect an archaeo-demographic gap in the research. Our depiction of the cordillera is biased towards Calafquén, as this locality provides 35 of the 72 dates available for the zone. It is clear that much more research in other localities is needed before we can say something more concrete about this area.

From a strictly chronological perspective, Calafquén is important since it is the only locality with dated occupations during each of the seven periods identified. This case clearly reflects the intense research that this area has been subjected to. For this very same reason, it demonstrates that it is possible to discover sites from periods that remain poorly represented, such as the Early Archaic. Calafquén is followed by Purén-Lumaco, which presents a continuity in dates from the Early Archaic up to historic times (six periods in total). This locality could become the basis for a better understanding of population dynamics in the valley, especially in relation to the Late Archaic, which accounts for most of its dates. Reloncaví also presents a continuity in dates, from the Middle Archaic up to historic times (five periods). Villarrica also has five periods, but experiences a gap during the Middle Archaic and again during the Early Ceramic. It has yet to be determined if these gaps reflect paleodemographic or archaeo-demographic effects. Six localities present occupation over four consecutive periods. They are: Concepción, Golfo de Arauco, and Cañete, all starting in the Middle Archaic; and Isla Santa María, Isla Mocha, and Central Ralco, all starting in the Late Archaic. However, the chronological continuity of the first three is complicated by the proposed coastal hiatus.

In a more regional sense, the settlement and mobility habits of cordillera and valley populations during the Paleoindian, Early Archaic and Middle Archaic periods probably play roles in the difficulty of finding sites for these periods. At the same time, the increase of dated localities starting in the later part of the Late Archaic likely denotes a certain degree of population increases, as well a shift to a much less mobile lifestyle. This situation becomes clearer during the Ceramic periods, especially in the Late Ceramic period.

To some extent, the main characters of this evaluation were the coast and the Late Archaic. As mentioned previously, since the late 1960s the coast has been the preferred location for a progressively larger share of research in the region. As a result, we can reconstruct rather accurately the paleodemographic processes that occurred in this zone. This is not the case for the cordillera or, by any means, the valley. In light of this, virtually any research carried out in these two areas will make a significant contribution to our understanding of Southern Chile's population dynamics.

As regards the Late Archaic, this period is very difficult to comprehend, as several different processes occurred during it. In a sense, it has an initial segment that can be considered a continuation of the Middle Archaic, and which includes the earliest occupation at Isla Mocha. There is then a second segment notable for the coastal hiatus and the intermittent occupation events in the cordillera, which are contemporaneous to the occupations in the valley. The third and final segment is marked by a re-occupation of the coast, the effective occupation of Isla Mocha and Isla Santa María, and the earliest appearance of ceramics in the northern sector's three zones, framed by a significant increase in dates for the coast, valley, and cordillera. An easy route for addressing the complexity of this period would be to segregate it into phases, or merge the first segment with the Middle Archaic and the third segment with the Early Ceramic period, treating the hiatus as a no-man's land. We believe that this is not the best approach. Rather, we should develop research that focuses on this period and addresses its different aspects. One of these is evaluating the links between Isla Mocha and the Northern Patagonian Channels. Another is the link between the first ceramics and new economic strategies related to farming.

Finally, this evaluation is built upon the research of many archaeologists. The comments about the lack of research in the valley and cordillera are not a critique of those who have worked in these zones, but rather are call to implement more projects there. In light of the archaeo-demographic trends, for these two zones to acquire a level of data comparable to the coast, at least 10–15 years of additional research should be necessary.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.quaint.2014.07.026.

References

Abarzúa, A.M., Villagrán, C., Moreno, P.I., 2004. Deglacial and postglacial climate history in east-central Isla Grande de Chiloé, Southern Chile (43°S). Quaternary Research 62, 49–59.

Abarzúa, A.M., Moreno, P.I., 2008. Changing fire regimes in the temperate rainforest region of Southern Chile over the last 16,000 years. Quaternary Research 69, 62–71.

Abarzúa, A.M., 2009. Respuestas ambientales a cambios climáticos y culturales en la Región de la Araucanía, Chile. Tesis Doctoral. Facultad de Ciencias Forestales, Universidad Austral de Chile, Valdivia, Chile.

Abarzúa, A., Pinchicura, A., Jarpa, L., Martel-Cea, A., Sterken, M., Vega, R., Pino, M., 2014. Environmental responses to climatic and cultural changes. In: Dillehay, T. (Ed.), The Teleoscopic Polity. Andean Patriarchy and Materiality. Springer, New York, pp. 123–141.

Adán, L., Mera, R., 1997a. Anexo N°1. La Tradición Cerámica Bícroma rojo sobre blanco en la región centro-sur: Los estilos Vergel y Valdivia. Propuesta Tipológica Morfológica-Decorativa de la Alfarería. Informe Proyecto Fondecyt 1950823. Archivo Nacional, Santiago, Chile.

Adán, L., Mera, R., 1997b. Acerca de la distribución espacial y temporal del Complejo Pitrén: una revaluación a partir del estudio sistemático de colecciones. Boletín de la Sociedad Chilena de Arqueología 24, 33–37.

Adán, L., Mera, R., 2011. Variabilidad Interna en el Alfarero Temprano del Centro-Sur de Chile: el Complejo Pitrén en el Valle Central del Cautín y el Sector Lacustre Andino. Chungara 43 (1), 3–23.

Adán, L., Reyes, V., 2000. Sitios Los Chilcos: Descripción y análisis de un nuevo cementerio Pitrén en la región del Calafquén. Boletín de la Sociedad Chilena de Arqueología 30, 34–45.

Aldunate, C., 1989. Estadio alfarero en el sur de Chile. In: Hidalgo, J., Schiappacasse, V., Niemeyer, H., Aldunate, C., Solimano, I. (Eds.), Culturas de Chile: Prehistoria. Desde sus orígenes hasta los albores de la Conquista. Editorial Andrés Bello, Santiago, pp. 329–348.

Aldunate, C., 2006. Una reevaluación del Complejo Cultural El Vergel. In: Actas del XVI Congreso Nacional de Arqueología Chilena (Tomé 2003). Museo de Historia Natural de Concepción and Escaparate Ediciones, Tomé, Concepción, Chile, pp. 331–336.

Archaeological Site Index to Radiocarbon Dates from Great Britain and Ireland, 2014 accessed on July 7, 2014. http://archaeologydataservice.ac.uk/archives/view/c14_cba/.

Armesto, J.J., Manuschevich, D., Mora, A., Smith-Ramirez, C., Rozzi, R., Abarzúa, A.M., Marquet, P.A., 2010. From the Holocene to the Anthropocene: a historical

framework for land cover change in southwestern South America in the past 15,000 years. Land Use Policy 27, 148–160.
Australian Archaeological Datasets, 2014 accessed on July 7, 2014. http://www.anwilliams.com/AW/Australian_Archaeological_Datasets.html.
Bengoa, J., 2003. Historia de los antiguos mapuches del sur (Catalonia, Santiago).
Bueno, L., Politis, G., Prates, L., Steele, J. (Eds.), 2013. A Late Pleistocene/early Holocene Archaeological ^{14}C Database for Central and South America: Palaeoenvironmental Contexts and Demographic Interpretations. Quaternary International, vol. 301.
Bustos, V., 1985. Investigaciones arqueológicas en Isla Quiriquina. Universidad de Concepción and Escuela de Grumetes, Concepción.
Bustos, V., Vergara, N., 2001. Evolución de las prácticas mortuorias en el litoral de la Octava Región. Chungara 33 (1), 73–78.
Bustos, V., Seguel, Z., Vergara, N., 1998. Los conchales antrópicos de ostras en la microárea Raqui –Tubul, extremo sur del Golfo de Arauco, VIII Región. Serie Antropología 1, 41–64.
Campbell, R., 2011. Socioeconomic Differentiation, Leadership, and Residential Patterning at an Araucanian Chiefly Center (Isla Mocha, AD 1000-1700). Ph.D. Dissertation. Department of Anthropology, University of Pittsburgh, Pittsburgh, USA.
Canadian Archaeological Radiocarbon Database [CARD], 2014 accessed on July 7, 2014. http://www.canadianarchaeology.ca/radiocarbon/card/.
Cisternas, M., 2005. Suelos enterrados revelan la prehistoria sísmica del centro-sur de Chile durante los últimos dos milenios. Revista de Geografía Norte Grande 33, 19–31.
Contreras, L., Quiroz, D., 2011. Cazadores y recolectores marítimos al sur del Golfo de Arauco (entre punta Lavapié y Tirúa). In: Massone, M., Sánchez, M., Quiroz, D., Contreras, L. (Eds.), Cazadores recolectores costeros en la Región del Bío-Bío. Museo de Historia Natural de Concepción and Escaparate Ediciones, Concepción, pp. 113–135.
Crombé, P., Van Strydonck, M., Sergant, J., Boudin, M., Bats, M. (Eds.), 2009. Chronology and Evolution within the Mesolithic of North-West Europe. Cambridge Scholars Publishing, Cambridge.
Dillehay, T. (Ed.), 1997. Monte Verde, a Late Pleistocene Settlement in Chile. The Archaeological Context and Interpretation, vol. 2. Smithsonian Institution Press, Washington, D.C.
Dillehay, T., 2007. Monuments, Empires, and Resistance. Cambridge University Press, Cambridge.
Dillehay, T. (Ed.), 2014. The Teleoscopic Polity. Andean Patriarchy and Materiality. Springer, New York.
Dillehay, T., Collins, M., 1988. Early cultural evidence from Monte Verde in Chile. Nature 332, 150–152.
Dillehay, T., Gordon, A., 1988. La actividad prehispánica de los incas y su influencia en la Araucanía. In: Dillehay, T., Netherly, P. (Eds.), La frontera del Estado Inca, British Archaeological Reports International Series, vol. 442. Oxford, pp. 215–234.
Dillehay, T., Pino, M., 1989. Stratigraphy and chronology. In: Dillehay, T. (Ed.), Monte Verde, a Late Pleistocene Settlement in Chile, Palaeoenvironment and Site Context, vol. 1. Smithsonian Institution Press, Washington, D.C, pp. 133–145.
Dillehay, T., Sauer, J., 2011. Excavación de la residencia fortificada de un encomendero español, la casa- fuerte de Santa Sylvia, Villa San Pedro, Pucón: Informe Técnico de 1992 – 1993, de Américo Gordon, vol. 53. Vanderbilt University Publications in Anthropology, Nashville.
Dillehay, T., Pino, M., Mott Davis, E., Valastro, S., Varela, V., Casamiquela, R., 1982. Monte verde: radiocarbon dates from an early-man site in South-Central Chile. Journal of Field Archaeology 9, 547–550.
Dillehay, T., Pino, M., Bonzani, R., Silva, C., Wallner, J., Lequesne, C., 2007. Cultivated wetlands and emerging complexity in South Central Chile and long distance effects of climate change. Antiquity 81, 949–960.
Dillehay, T., Ramírez, C., Pino, M., Collins, M.B., Rossen, J., Pino-Navarro, J.D., 2008a. Monte verde: seaweed, food, medicine, and the peopling of South America. Science 320, 784–786.
Dillehay, T., Ramírez, C., Pino, M., Collins, M.B., Rossen, J., Pino-Navarro, J.D., 2008b. Supporting Online Material for Dillehay et al. 2008a accessed on July 7, 2014. http://www.sciencemag.org/cgi/data/320/5877/784/DC1/1.
Flores, C., Lira, N., 2006. Aspectos comunes para sitios de cazadores recolectores costeros en los canales patagónicos septentrionales. Boletín de la Sociedad Chilena de Arqueología 39, 103–112.
Gaete, N., Sánchez, R., 1995. Síntesis arqueológica de la costa al sur del Maule, Provincia de Cauquenes, VII región. In: Hombre y Desierto 9/Actas del XIII Congreso Nacional de Arqueología Chilena (Antofagasta 1994), Tomo 1. Instituto de Investigaciones Antropológicas Universidad de Antofagasta, Antofagasta, Chile, pp. 117–125.
Gaete, N., Sánchez, R., 2000. Ocupación multicultural en la costa de la provincia de Cauquenes, VII región del Maule, Chile. In: Actas del Tercer Congreso Chileno de Antropología (Temuco 1998), vol. II. Colegio de Antropólogos de Chile and Universidad Católica de Temuco, Temuco, Chile, pp. 783–790.
Gaete, N., Navarro, X., 2004. Estrategias de vida de canoeros cazadores pescadores recolectores del seno de Reloncaví. Entre el bosque siempreverde y el mar interior. Región de Los Lagos, Chile. In: Civalero, M.T., Fernández, P.M., Guráieb, A.G. (Eds.), Contra viento y marea. Arqueología de Patagonia. Instituto Nacional de Antropología y Pensamiento Latinoamericano y Sociedad Argentina de Antropología, Buenos Aires, Argentina, pp. 217–235.
Gajardo, R., 1994. La vegetación natural de Chile: clasificación y distribución geográfica. Editorial Universitaria, Santiago, Chile.
Gajewski, K., Munoz, S., Peros, M., Viau, A., Morlan, R., Betts, M., 2011. The Canadian archaeological radiocarbon database (CARD): archaeological ^{14}C dates in North America and their paleoenvironmental context. Radiocarbon 53, 371–394.
García, C., 2005. Estrategias de movilidad de Cazadores Recolectores durante el período Arcaico en la región del Calafquén, sur de Chile. Memoria para optar al título de Arqueólogo, Departamento de Antropología, Facultad de Ciencias Sociales, Universidad de Chile, Santiago, Chile.
García, C., 2009. Cazadores recolectores en el área lacustre de la vertiente occidental Andina (39°S): cronología, contextos y procesos. In: Salemme, M., Santiago, F., Álvarez, M., Piana, E., Vázquez, M., Mansur, M.E. (Eds.), Arqueología de Patagonia: una mirada desde el último confín. Editorial Utopías, Ushuaia, Argentina, pp. 1011–1022.
Garrett, E., 2013. Biostratigraphic Constraints on Megathrust Earthquake Deformation History in South Central Chile. Ph. D. thesis. Durham University.
Gordon, A., 1978. Urna y canoa funeraria. Una sepultura doble excavada en Padre Las Casas, Provincia de Cautín, IX Región, Chile. Revista Chilena de Antropología 1, 61–80.
Gordon, A., 1985. Huimpil. Un Cementerio Agroalfarero Temprano en el Centro Sur de Chile, vol. 2. Hombre, Cultura Y Sociedad, pp. 19–70.
Informe Final Proyecto Fondecyt 1910161 Gordon, A., 1992–95. Excavación de la residencia fortificada de un encomendero español Casa Fuerte Santa Sylvia, Villa San Pedro, Pucón. Archivo Nacional, Santiago, Chile.
Hajek, E.R., Di Castri, F., 1975. Bioclimatografía de Chile. Dirección de Investigación, Vice-Rectoría Académica, Universidad Católica de Chile, Santiago accessed on July 7, 2014. http://www.ecolyma.cl/documentos/bioclimatografia_de_chile.pdf.
Hogg, A.G., Hua, Q., Blackwell, P., Niu, M., Buck, C., Guilderson, T., Heaton, T., Palmer, J., Reimer, P., Reimer, R., Turney, C., Zimmerman, S., 2013. SHCal13 Southern Hemisphere calibration, 0–50,000 years cal BP. Radiocarbon 55, 1889–1903.
Ilabaca, P., 1989. Evolución de la costa de Concepción: el caso de las bahías de Concepción y San Vicente. Biología Pesquera 18, 29–35.
Isla, F.I., Flory, J.Q., Martínez, C., Fernández, A., Jaque, E., 2012. The Evolution of the Bío Bío Delta and the coastal Plains of the arauco Gulf, Bío Bío region: the Holocene sea-level curve of Chile. Journal of Coastal Research 28 (1), 102–111.
Lara, A., Solari, M.A., Prieto, M., Peña, M., 2012. Reconstrucción de la cobertura de la vegetación y uso del suelo hacia 1550 y sus cambios a 2007 en la ecorregión de los bosques valdivianos lluviosos de Chile (35° – 43° 30′S). Bosque 33 (1), 13–23.
Latorre, C., Moreno, P., Vargas, G., Maldonado, A., Villa-Martínez, R., Armesto, J., Villagrán, C., Pino, M., Núñez, L., Grosjean, M., 2007. Late Quaternary environments and palaeoclimate. In: Moreno, T., Gibbons, W. (Eds.), The Geology of Chile. London Geological Society Press, London, pp. 309–328.
Luebert, F., Pliscoff, P., 2006. Sinopsis bioclimática y vegetacional de Chile. Editorial Universitaria, Santiago, Chile.
Maldonado, A., González, L., Jackson, D., Uribe, M., Abarzúa, A., de Porras, M., Reyes, O., Adán, L., Urbina, S., Méndez, C., Campbell, R., 2012. Desde Atacama hasta la Patagonia: Paleoclima y ocupaciones humanas durante el Holoceno. In: Paper presented at the XIX Congreso Nacional de Arqueología Chilena, Arica.
Massone, M., Sánchez, M., Quiroz, D., Contreras, L. (Eds.), 2011. Cazadores recolectores costeros en la Región del Bío-Bío. Museo de Historia Natural de Concepción and Escaparate Ediciones, Concepción.
Massone, M., Gaytán, E., Sánchez, M., Contreras, L., Silva, C., Jácome, C., 2012. El sitio arqueológico SM 39, un espacio de uso funerario de especial significación en la Isla Santa María, entre los siglos I y XIV dC. Informes Fondo de Apoyo a la Investigación Patrimonial 14, 47–81.
McCulloch, R., Bentley, M., Purves, R., Hulton, N., Sugden, D., Clapperton, C., 2000. Climatic inferences from glacial and palaeoecological evidence at the last glacial termination, southern South America. Journal of Quaternary Research 15 (4), 409–417.
Menghin, O., 1959–60. Estudios de prehistoria araucana. Acta Praehistorica III–IV, 49–120.
Méndez, C., 2013. Terminal Pleistocene/early Holocene ^{14}C dates form archaeological sites in Chile: critical chronological issues for the initial peopling of the region. Quaternary International 301, 60–73.
Mera, R., García, C., 2004. Alero Marifilo-1. Ocupación holoceno temprana en la costa del lago Calafquén (X Región, Chile). In: Civalero, M.T., Fernández, P.M., Guráieb, A.G. (Eds.), Contra viento y marea. Arqueología de Patagonia. Instituto Nacional de Antropología y Pensamiento Latinoamericano y Sociedad Argentina de Antropología, Buenos Aires, Argentina, pp. 249–262.
Navarro, X., 1979. Arqueología de un yacimiento precordillerano en el sur de Chile (Pucón, IX Región). Tesina para optar al Bachillerato en Ciencias Sociales. Departamento de Estudios Históricos y Arqueológicos, Universidad Austral de Chile, Valdivia, Chile.
Navarro, X., 1995. Arqueología de la costa valdiviana: evidencias de ca 5000 años antes del presente. Medio Ambiente 12 (2), 24–34.
Navarro, X., Pino, M., 1999. Estrategias adaptativas en ambientes costeros del bosque templado lluvioso de la zona mapuche. Una reflexión desde el precerámico. In: Belardi, J., Fernández, P., Goñi, R., Guraieb, A., De Nigris, M. (Eds.), Soplando en el viento… Actas de las III Jornadas de Arqueología de la Patagonia (Bariloche 1996). Universidad Nacional de Comahue, Neuquén, Argentina, pp. 65–82.
Navarro, X., Dillehay, T., Adán, L., 2010. Experiencias adaptativas tempranas de vida alfarera en el sector lacustre cordillerano de Villarrica. La ocupación del sitio Pucón 6 (IX Region). Revista Cazadores-Recolectores del Cono Sur 4, 59–76.

Ocampo, C., Rivas, P., 2004. Poblamiento temprano de los extremos geográficos de los canales patagónicos: Chiloé e Isla Navarino. In: Chungara 36 (suplemento especial)/Actas del XV Congreso Nacional de Arqueología Chilena (Arica 2000), Tomo I. Universidad de Tarapacá, Arica, Chile, pp. 317–331.
Peel, M.C., Finlayson, B.L., McMahon, T.A., 2007. Updated world map of the Köppen-Geiger climate classification. Hydrology and Earth System Sciences Discussions 4 (2), 439–473.
Pino, M., Chávez-Hoffmeister, M., Navarro-Harris, X., Labarca, R., 2013. The late pleistocene pilauco site, osorno, south-central Chile. Quaternary International 299, 3–12.
Quiroz, D., 2001. Cazadores recolectores marítimos en el litoral araucano durante el Holoceno. Tesis para optar al grado de Magíster en Arqueología. Departamento de Antropología, Universidad de Chile, Santiago, Chile.
Quiroz, D., 2010. Ocupaciones El Vergel en las costas septentrionales de La Araucanía: una secuencia cronológica por termo-luminiscencia. In: Actas del XVII Congreso Nacional de Arqueología (Valdivia 2006), Tomo 1. Sociedad Chilena de Arqueología, Universidad Austral de Chile, and Ediciones Kultrún, Valdivia, Chile, pp. 441–450.
Quiroz, D., Sánchez, M., 2004. Poblamientos iniciales en la costa septentrional de la Araucanía (6.500–2.000 a.p.). In: Chungara 36 (suplemento especial)/Actas del XV Congreso Nacional de Arqueología Chilena (Arica 2000), Tomo I. Universidad de Tarapacá, Arica, Chile, pp. 289–302.
Quiroz, D., Vásquez, M., Sánchez, M., 1997. Quino-1, un sitio alfarero temprano en la región centro-sur: noticias y comentarios para un fechado. Boletín de la Sociedad Chilena de Arqueología 24, 49–52.
Quiroz, D., Vásquez, M., Sánchez, M., 2000. Los pescadores arcaicos en el centro sur de Chile: el caso de Isla Mocha. In: Contribución Arqueológica 5/Actas del XIV Congreso Nacional de Arqueología Chilena, Tomo 2. Museo Regional de Atacama, Copiapó, Chile, pp. 741–761.
Reimer, P., Bard, E., Bayliss, A., Warren Beck, J., Blackwell, P., Bronk Ramsey, C., Grootes, P., Guilderson, T., Haflidason, H., Hajdas, I., Hatté, C., Heaton, T., Hoffmann, D., Hogg, A., Hughen, K., Felix Kaiser, K., Kromer, B., Manning, S., Niu, M., Reimer, R., Richards, D., Marian Scott, E., Southon, J., Staff, R., Turney, C., van der Plicht, J., 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 Years cal BP. Radiocarbon 55 (4), 1869–1887.
Roa, C., Silva, C., Campbell, R., 2014. El aporte de la Isla Mocha al conocimiento sobre el aprovechamiento de plantas con valor alimenticio en el Sur de Chile (1000–1700 d.C.). In: Actas del XIX Congreso Nacional de Arqueología Chilena (Arica 2012). Universidad de Tarapacá, Arica in press.
Sánchez, M., 1997. El periodo alfarero en la Isla Mocha. In: Quiroz, D., Sánchez, M. (Eds.), La isla de las palabras rotas. Biblioteca Nacional de Chile and Centro de Investigación Diego Barros Arana, Santiago, Chile, pp. 103–131.
Sánchez, M., Quiroz, D., Massone, M., 2004. Domesticación de plantas y animales en la Araucanía: datos, metodologías y problemas. In: Chungara 36 (Suplemento Especial)/Actas del XV Congreso Nacional de Arqueología Chilena (Arica 2000), Tomo I. Universidad de Tarapacá, Arica, Chile, pp. 365–372.
Sánchez, R., Gaete, N., 1994. Santos del Mar Túmulo: un asentamiento alfarero en la costa de la provincia de Cauquenes (VIII Regió). Boletín del Museo Regional de la Araucanía 5, 79–89.
Seguel, Z., 1973. Une Sépulture “verticale” dans l'amas de coquilles de Tubul I, province de Arauco – Chili. In: L'Homme, hier et aujourd'hui. Recueil d'études en hommage à André Leroi-Gourhan, Cujas, Paris, France, pp. 601–607.
Seguel, Z., 1998. El conchal “Bellavista I” y el poblamiento temprano en el sector litoral de la bahía de Concepción. Serie Antropología 1, 25–40.
Seguel, Z., 2003. Compendio de notas sobre las investigaciones arqueológicas, en las bahías de Concepción y Arauco. VIII región. Chile. Universidad Metropolitana de Ciencias de la Educación, Santiago, Chile.
Silva, C., 2010. El Complejo El Vergel y su vergel: vegetales domésticos prehispanos en la costa septentrional araucana. In: Actas del XVII Congreso Nacional de Arqueología (Valdivia 2006), Tomo 1. Sociedad Chilena de Arqueología, Universidad Austral de Chile, and Ediciones Kultrún, Valdivia, Chile, pp. 1279–1289.
Silva, C., 2014. Archaeobotanical remains. In: Dillehay, T. (Ed.), The Teleoscopic Polity, Andean Patriarchy and Materiality. Springer, New York, pp. 221–236.
Stern, C., Moreno, H., López-Escobar, L., Clavero, J., Lara, L., Naranjo, J., Parada, M., Skewes, M., 2007. Late Quaternary environments and palaeoclimate. In: Moreno, T., Gibbons, W. (Eds.), The Geology of Chile. Geological Society Press, London, pp. 149–180.
Stuiver, M., Braziunas, T., 1993. Modeling atmospheric ^{14}C influences and ^{14}C ages of marine samples back to 10,000 BC. Radiocarbon 35, 137–189.
Stuiver, M., Reimer, P., Reimer, R., 2014. CALIB 7.0 [WWW program and documentation]. accessed on July 7, 2014. http://intcal.qub.ac.uk/calib/calib.html.
Tamers, M., 1973. Instituto Venezolano de Investigaciones Cientificas Natural Radiocarbon Measurements VII. Radiocarbon 15 (2), 307–320.
The Paleoindian Database of the Americas [PIDBA], 2014 accessed on July 7, 2014. http://pidba.utk.edu/dating.htm.
Valdés, C., Sánchez, M., Inostroza, J., Sanzana, P., Navarro, X., 1985. Excavaciones arqueológicas en el Alero Quillén 1, Provincia Cautín, Chile. In: Boletín del Museo Arqueológico de La Serena 18/Actas del IX Congreso Nacional de Arqueología Chilena (La Serena 1982). Dirección de Bibliotecas, Archivos y Museos and Sociedad Chilena de Arqueología, La Serena, Chile, pp. 399–435.
Vandenberghe, J., 2012. Late Holocene Climate Variability in South-Central Chile: a Lacustrine Record of Southern Westerly Wind Dynamics. M.Sc. thesis. Ghent University, Ghent, Belgium.
Van Meurs, M., Gordon, A., 1989. Monkul-1, un conchal precerámico en el centro-sur de Chile. Chungara 23, 19–36.
Van Meurs, M., Gordon, A., 1993. Monkul-1, un sitio de estuario en la IX Región. In: Boletín del Museo Regional de la Araucanía 4/Actas del XII Congreso Nacional de Arqueología Chilena (Temuco 1991), Tomo I. Museo Regional de la Araucanía, Temuco, Chile, pp. 173–180.
Vásquez, M., 1997. El período arcaico en la Isla Mocha. In: Quiroz, D., Sánchez, M. (Eds.), La isla de las palabras rotas. Biblioteca Nacional de Chile and Centro de Investigación Diego Barros Arana, Santiago, Chile, pp. 215–235.
Velásquez, H., Adán, L., 2004. Marifilo I: evidencias arqueofaunísticas para entender las relaciones hombre y bosques templados en los sistemas lacustres cordilleranos Centro Sur de Chile. In: Civalero, M.T., Fernández, P.M., Guráieb, A.G. (Eds.), Contra viento y marea. Arqueología de Patagonia. Instituto Nacional de Antropología y Pensamiento Latinoamericano y Sociedad Argentina de Antropología, Buenos Aires, Argentina, pp. 507–519.
Villagrán, C., 1991. Historia de los bosques templados del sur de Chile durante el Tardiglacial y Postglacial. Revista Chilena de Historia Natural 64, 447–460.
Watt, S., 2010. Records of Volcanism and Controls on Volcanic Processes in Southern Chile. Ph.D. thesis. Worcester College and the Department of Earth Sciences, University of Oxford, Oxford, UK.
Wilmshurst, J., Hunt, T., Lipo, C., Anderson, A., 2010. High-precision radiocarbon dating shows recent and rapid initial human colonization of East Polynesia. Proceedings of the National Academy of Sciences USA 108 (5), 1815–1820.