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Climate change, availability of territory, and Late Pleistocene human exploration of Ultima Esperanza, South Chile

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ABSTRACT

At the time of the first human exploration of Ultima Esperanza, Chile, swift climatic and environmental changes were taking place. The retreat of the Pleistocene glaciation and the formation of an ice-dammed proglacial lake east of the Cordillera created adequate conditions for human colonization. Volcanic activity, climatic oscillations, and concomitant floristic changes defined the environment encountered by the first hunter–gatherers arriving to Ultima Esperanza. The oldest archaeological evidence was deposited sometime between 10,930 and 10,410 BP and point to ephemeral occupations. The evidence from Ultima Esperanza is compared with other areas where early human presence was detected in Fuego-Patagonia. The hypothesis that the early human occupations at Cerro Benitez-Lago Sofía resulted from logistical exploitation from Pali Aike is introduced.

1. Introduction

The dispersal of humans throughout the world can be understood in terms of biogeographical corridors and barriers. The mapping and dating of critical resources and archaeological remains provides a history of human success and failure at different places in the planet (Gamble, 2013). Practically none of the regions successively incorporated by humans was immediately saturated with people, which is especially true in the more remote southern extremes of America where population was very low at the end of the Pleistocene (Borrero, 1999). In discussing the early evidence, we refer to Fuego-Patagonia, which is a geographical term introduced by Vaino Auer (1960) to treat Patagonia and Tierra del Fuego as a unit.

The earliest evidence for human presence in Fuego-Patagonia is concentrated in four southern regions, the central plateau in Santa Cruz (Miotti, 1998; Paunero, 2000), the Pali Aike Lava Field (Bird, 1988), Tierra del Fuego (Massone, 2004) and Ultima Esperanza (Nami, 1987; Prieto, 1991; Martin et al., 2014) (Fig. 1). These early occupations display similar sets of tools, hearths, and faunal remains. An important bias is that all the early archaeological sites are recorded from caves. Efforts to localize open-air sites relevant for the early peopling of the region are just beginning (Massone, 2004; Martin and San Román, 2010; Prieto and Labarca, 2011), but it is clear that they will be required to have a fuller view of early human settlement and activities.

At least two of the mentioned regions, the central plateau and Pali Aike, display evidence of relatively intense occupations, and thus can be considered population nodes or staging areas (sensu Anderson and Gillam, 2001) during the early process of colonization. It is our hypothesis that these are places with long-term occupations from which other regions were peopled. The evidence recovered at Ultima Esperanza and Tierra del Fuego is quantitatively less abundant. In this paper, we will discuss the first exploration of Ultima Esperanza, Chile, reviewing the available archaeological, paleontological and paleoecological evidence on the existence and access of land suitable for human installation. The central plateau and Pali Aike will be discussed and a general comparison with the case of Tierra del Fuego will be made.

2. Ultima Esperanza

The information for Ultima Esperanza is concentrated at the Cerro Benitez-Lago Sofía area (CBLS), and is limited to two sites. Cueva del Medio (CM) and Cueva Lago Sofía 1 (CLS1) (Nami, 1987, 1989-1990; Prieto, 1991; Jackson and Prieto, 2005; Martin et al., 2014) (Fig. 2). The tool assemblages recovered at these sites share a bifacial lithic technology with the rest of the oldest sites in Fuego-

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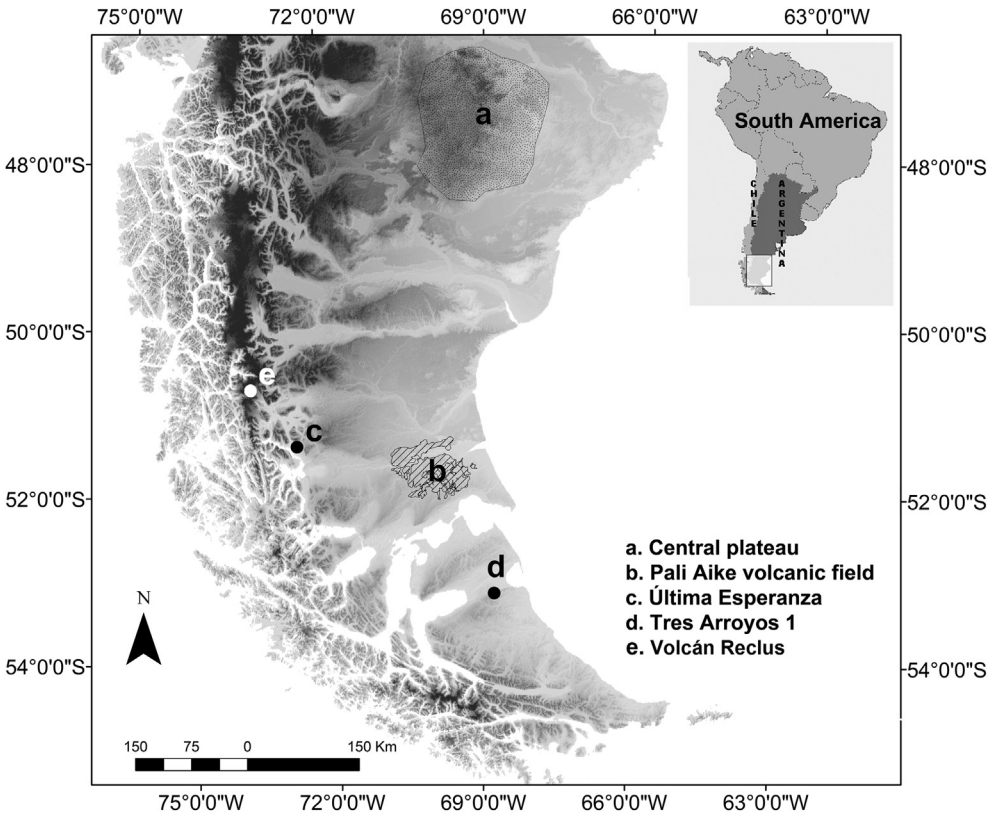

Fig. 1. Location of the regions with the oldest evidence in Southern Patagonia.

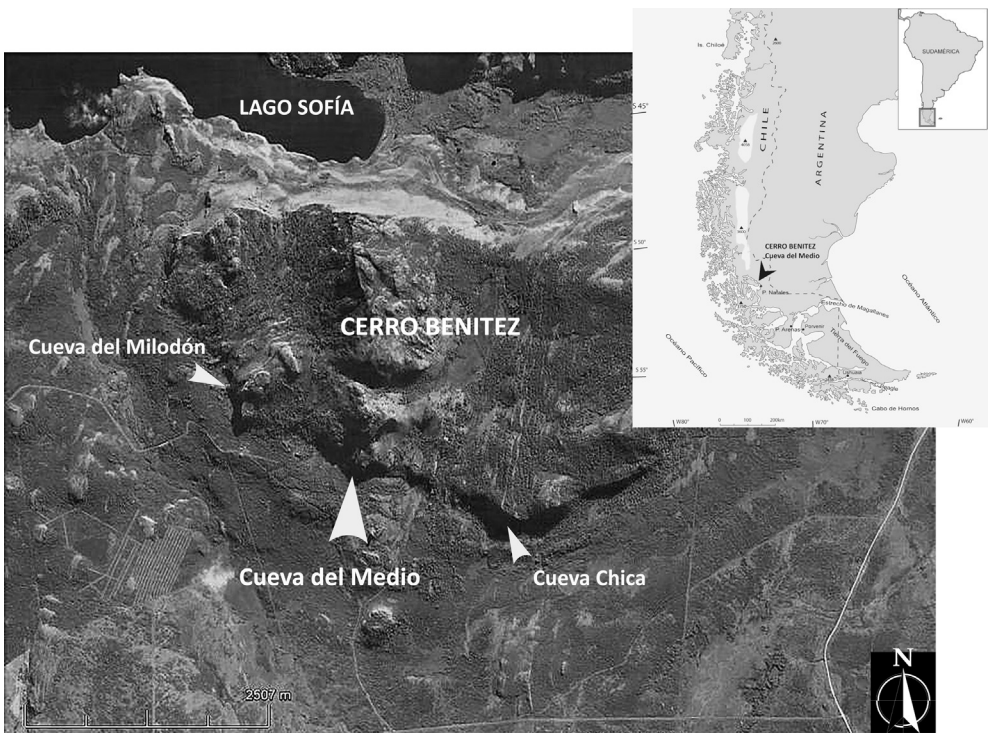

Fig. 2. Ultima Esperanza. Location of sites at Cerro Benitez.

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Patagonia (Nami, 2003). A bone technology is also well represented at these sites (Jackson, 1990; Nami, 2010; Scheinsohn, 2010).

CM and CLS1 are separated by about 4 km, so that they are within foraging radii of each other. Many partially contemporaneous paleobiological sites, like Cueva Chica, Cueva Lago Sofía 4, Cueva del Milodón and many others are also located within those radii. Carnivore – i.e. *Panthera*- and herbivore (*Mylodon*) dens were located at these paleobiological sites, but the remains of other extinct mammals were also found. Only one of these sites, Cueva del Milodón, contain minimal evidence of human activities, in the form of cut marks on *Hippidion* bones (Martin, 2013: 263). In contrast, the findings at Cueva del Medio and Cueva Lago Sofía 1 include hearths, lithic and bone tools, and butchered bones of both extinct and modern fauna all in good stratigraphic position (Nami, 1987, 1994a: 159; Prieto, 1991; Nami, 2010; Martin et al., 2014). The faunal lists are dominated by camelids (*Lama* sp.) and horse (*Hippidion saldiasi*), but other species are also present, *Mylodon*, *Panthera onca mesembrina* and *Smilodon*, not necessarily the result of human deposition (Martin, 2013). Particularly ambiguous is the case of ground sloths whose association with humans appears doubtful (Borrero and Martin, 2012). AMS radiocarbon dating indicates that the human occupations at Cueva del Medio occurred between 10,930 and 10,410 BP, and at Cueva Lago Sofía 1 between 10,780 and 10,140 BP (Nami and Nakamura, 1995; Massone and Prieto, 2004; Steele and Politis, 2009; Martin et al., 2014). If we consider standard radiocarbon dates, the chronological range is wider and older (Table 1).

3. Paleoclimate and paleoecology

The geography of Fuego-Patagonia at the end of the Pleistocene was very different from today. The most important differences are related with Tierra del Fuego which at that time was part of the continent. It was during the early Holocene that it was cut off by the rising sea, and that the formation of the Strait of Magellan took place (McCulloch et al., 1997).

The continental ice cap also was a formidable barrier separating the eastern Patagonian steppes from the southern Pacific coasts, a situation that only slightly changed with the opening of corridors between what today are called the North and South Ice Caps around 12,800 BP (Turner et al., 2005: 369), and the retreat of the glaciers from Ultima Esperanza (Sagredo et al., 2011; García et al., 2014). More specifically for CBLS, the retreat of the glaciers started well before 15,000 BP (Sagredo et al., 2011), creating a landscape of proglacial lakes and peat bogs.

Other minor barriers probably existed, but apparently were not significant for the peopling process. The landscape was seasonally fragmented by few rivers with high post-glacial discharges, the Santa Cruz and Gallegos rivers, but when ice choked in winter they should not have been an obstacle for human circulation (Borrero, 2012). Increasing evidence of very cold environments was identified at Cueva del Medio and other sites in Ultima Esperanza (Martin et al., 2014). In general terms, this evidence is synchronic with the Antarctic Cold Reversal (Sugden et al., 2005; McCulloch et al., 2005).

Discussions concerning the existence of a proglacial paleolake in the CBLS region are well published, and there are different interpretations about its extent and heights (Stern et al., 2011; Solari et al., 2012; García et al., 2014). The proglacial lake was formed after 14,520 ± 140 BP, "the closest minimum date of ice recession in the region as determined from the Vega Benitez core" (Stern et al., 2011: 12) (Fig. 3). New dates obtained at Cueva Chica are confirmatory, as the area near the cave was not only free of ice by ca. 14,870 BP, but also was viable for large mammals inhabiting the cave (Martin et al., 2013). Stern et al. (2011) propose that the lake was lowered to ~120 m, "to connect these lake shore caves to the mainland". The chronological evidence from Cueva Chica suggest that the opening of a terrestrial connection between CBLS and the lands in the east occurred before suggested by Stern and collaborators. Volcanic activity was important and at least two major volcanic eruptions of the Reclús volcano took place near the end of the Pleistocene, the R1 eruption at 12,660 BP and minor eruptions after R1 (Stern, 2008). These eruptions poured out tonnes of ashes and tephra which were recorded at several archaeological and paleobiological sites (Massone, 1991; Jackson, 2007; Stern, 2008). Their short term impact surely included the disruption of the local ecology.

Pollen records indicate that cold-resistant herbs dominated until ca. 9954 BP (Moreno et al., 2012: 20), with an increase in local fires and a process of terrestrialization recorded at Pantano Dumestre. The Early Holocene was the time of a rapid spread of *Nothofagus* forests as attested at Pantano Dumestre and Lago Eberhard in correlation with a warm event. Moreno and collaborators interpreted these results as indicating substantial warming and a decline in precipitation brought by weaker SW winds throughout Patagonia.

Low temperatures and strong winds are considered factors limiting the expansion of the forest in Ultima Esperanza until the early Holocene. It was during this warmer trend that the deposition of charcoal microparticles increased, probably indicating a less humid environment with more available fuel (Moreno et al., 2012).

4. Exploration

Exploration refers to the initial radiation of humans into empty land (Borrero, 1994–1995), a process in which less resistance routes are usually used and most of the settling-in places are located at areas that are rich in resources. The main theories about the colonization of Fuego-Patagonia suggest that people was slowly moving south through the eastern steppes or near the Atlantic coast, today partially submerged (Borrero, 1999; Dillehay, 2000; Miotti, 2010), although a dispersion along the foot of the Andes was also suggested (Martinic, 1993). The chronological information derived from standard radiocarbon dates indicates that the central plateau was explored probably ca. 11,580 BP or before (Paunero, 2000, 2003), and Pali Aike ca. 11,000 BP or before. If only AMS dates are used, then the older ages are 11,100 and 10,600 respectively (Table 1). This information suggests that older standard dates must be replicated with modern dating techniques. The existence of archaeological sites of similar age, older than 10,000 radiocarbon

Table 1
Range of uncalibrated radiocarbon dates for early human occupations in Fuego-Patagonia. In all cases the AMS range is shorter than using all the dates.

Site	AMS (range) BP	AMS + standard (range) BP	Source
Cueva del Medio	10,860–10,410	10,930–9595	Nami and Nakamura (1995) and Martin et al. (2014)
Cueva Lago Sofía 1	10.780–10,140	11,570–10,140	Prieto (1991) and Massone and Prieto (2004)
Fell Cave	10,600–10.295	11,000–10,080	Martin (2013) and Martin (2012)
TA1	10,685–9960	11,880–9960	Massone (2004) and Martin et al. (2009)
Central plateau	11,100–10,400	11,580–9230	Miotti et al. (2003), Paunero (2009) and Steele and Politis (2009)

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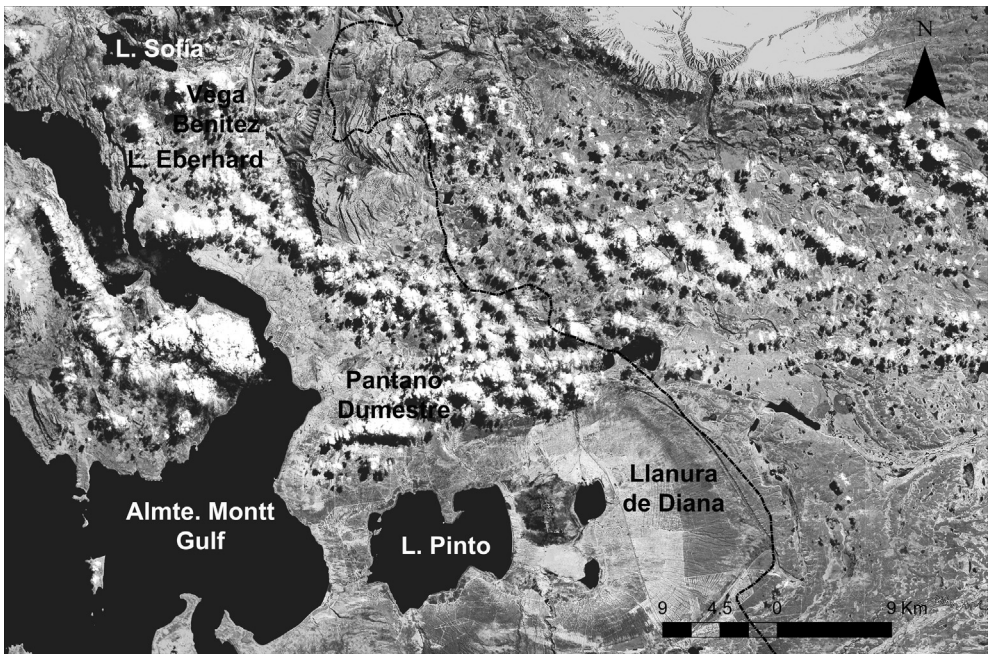

Fig. 3. Ultima Esperanza. Location of paleoclimatic records (Stern et al., 2011).

years, in Ultima Esperanza at the western reaches of Fuego-Patagonia lead to the question of the conditions under which that region was incorporated within the human range.

It is difficult to tell when the archaeological evidence refers to the initial exploration or the colonization of a region. Some of the criteria used to recognize early exploration sites are of course related with the chronology of the first occupations and the conditions for accessibility and habitability offered by the region (i.e. Rockman and Steele, 2003). Equally important is how much knowledge of the local resources is demonstrated in the earlier occupations and the intensity and redundancy of use of places.

The older evidence from CBLS spanning the period 10,860–10,140 BP, and the low intensity of the occupations, particularly at Cueva Lago Sofía 1, testify to ephemeral occupations that we believe are related with exploration. The whole human Late Pleistocene record is limited to short occupations at two sites, CM and CLS1. Moreover, there is no evidence of occupational continuity in the area post 10,140 BP. The discontinuity of the occupation of CM and CLS1 is longer than 5000 years. This situation invites to consider what changed in Ultima Esperanza. Not only people were absent since 10,000 BP, but also megamammals. Brief periods of occupation were to be expected during the exploration of a region, but not to the point of creating archaeological invisibility. Considering that the human knowledge of the region and its resources is limited, use of sub-optimal locations is expected for the initial exploration of any region. Cueva del Medio and Cueva del Milodón are the most visible and obvious places for installation, but they are not necessarily optimal. They are very large, open and cold places exposed to the southern and western winds. The case of CLS1 is different in that it is a much smaller cave. However, the evidence of human occupation of this site is minimal.

Franco studied the criteria to recognize the lithic technological evidence interpreting an exploration stage. She suggests that tools should not be broken, as they should be expediently made on local rocks, which are those found within a radius of 40 km around the site (Meltzer, 1989). Long-cutting edges should be dominant and the few cases of exotic rocks are to be understood in the context of personal gear (Civalero and Franco, 2003; Franco, 2003). Importantly, she concluded that versatility is an adequate property for explorers, particularly bifacial tools with high transportability. These expectations are generally met in the early Patagonian assemblages, including those at Ultima Esperanza (Borrero and Franco, 1997). What this information appears to reflect is the relatively incomplete knowledge of the local geography and its resources at that time.

The 37 lithics recovered in the lower levels of Cueva Lago Sofía 1 are made of local raw materials. The tools include at least one polyhedric core that was reused as an expedient tool (Jackson and Prieto 2005: 117), three side-scrapers, one bifacial knive, two retouched flakes and 29 pieces of debitage, two of which were used. Nineteen of those rejects are derived from the recovered core. The raw materials are all local, basically lutites (70%) and tuffs (30%), both abundant near the cave (Jackson and Prieto, 2005:118). Bone flakers and an awl were also found (Jackson, 1990).

There are only partial descriptions of lithic tools recovered at Cueva del Medio (Nami, 1987; Huidobro, 2014). In several publications Nami noted the finding of two Fell Cave projectile points, together with one polyhedral core, one end-scraper, two side-scrapers, one raclette, one knife, one marginally retouched tool, 38 flakes and bone flakers at his Fell I component (Nami, 1987, 1989–1990, 1998, 2010). Recent work by Martin produced another Fell Cave projectile point among other lithic tools (Martin et al., 2014). Lithics are less abundant in Nami's Fell III component, including three fragments of projectile points, one end-scraper, one side-scraper, a bifacial tool and debitage (Nami, 1994a). Most of the raw materials used for tools with one exception are local. Effectively, Nami (1987) mentions the presence of chalcedony which is not available in the immediate vicinity. The abundance of chalcedony at Sierra Baguales ~90 km north (Borrazzo, 2008) and its presence in Pali Aike ca. 150 km East (Charlin, 2009; Charlin and Pallo, 2013) should be mentioned. In both areas chalcedony was used during later periods. Nami and Casé (1988) inform that the local raw materials used at Cueva del Medio – rhyolites, dacites and devitrified tuffs – are present as pebbles and cobbles derived from the conglomerate on which the cave was formed. They are present as veins on the walls of the cave

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and also at glacial deposits nearby. A black tuff was the most used raw material (Nami, 1987, 1994a). What emerges from this synthesis is that the small region of CBLS offers limited but important evidence of Late Pleistocene occupations, which are followed by a relatively long period of absence of people. Of course, it is not clear if this absence is real or a result of a sampling problem. If the pattern is real, then abandonment may have to do with the original conditions under which CBLS was used, perhaps as part of short-term seasonal circuits after which the sites were not revisited for centuries. Certainly, taking into account the available models of winter stress for southern Patagonia, seasonal use is to be expected for the CBLS region (Pallo, 2012), a condition exacerbated by the presence of the Cordillera Oriental (Prieto and Labarca, 2011). It is possible that at ~52°S, resources were more spatially segregated in comparison with northern locations, requiring large hunting ranges.

5. Habitats, routes and corridors

The location of Ultima Esperanza differs significantly from that of other western Patagonian basins which constitute biogeographic dead-ends bounded by the continental ice-cap. Effectively, the Andean ice-cap was the western limit for the expansion of human populations and other species across hundreds of km between 45° and 52° S. Ultima Esperanza was certainly covered by ice at the end of the Pleistocene, but it was free of ice before human arrival to southern Patagonia. Perhaps for that reason the chronology of human occupation at Ultima Esperanza is older than in the rest of the western Patagonian basins (Borrero, 2004). The evidence from Ultima Esperanza indicates that people was able to disperse to the west earlier than in the rest of Patagonia. When discussing routes of access to CBLS, both the Pali Aike Lava Field, located ~150 km east, and the Central Plateau, ~500 km northeast, appears as the better alternatives for the origin of dispersal. The earlier occupations at CBLS are comparatively synchronic with those of both eastern localities (Table 1).

When human populations were beginning to extend their range into South Patagonia the cold conditions of the Antarctic Cold Reversal were prevalent. However, no specific cold adaptations were identified among humans (Borrero, 2012). According to the available chronologies, this people first populated the central plateau and Pali Aike at about the same time. There is no easy way to tell how interconnected were the people living in the central plateau and Pali Aike, but both topography and ecological settings indicate that corridors probably existed, so that it is possible that some kind of metapopulation was in place across the eastern steppes. The main obstacle in between is the Santa Cruz river, probably not a problem for circulation during winter. Importantly, the study of the process of manufacture of Fell Cave projectile points at different localities in Pampa and Patagonia showed that people who lived far away probably shared technical and social knowledge (Flegenheimer and Cattáneo, 2013).

The process of exploration of the southern and western lands probably was an extension of home ranges following the low topography of Southern Patagonia. There are not many alternative routes to reach Ultima Esperanza, which was not an isolated region but was only geographically marginal. There are no robust alternatives to explain the peopling of Ultima Esperanza from the North. The Pacific coastal connection with northern continental Chile is difficult and discontinuous, probably dotted with calving glaciers during the end of the Pleistocene. Very few productive lands existed at the end of the Pleistocene near the Pacific with most of the channels and islands covered by ice (McCulloch et al., 2000; Prieto and Labarca, 2011). The oldest radiocarbon dates for human presence in the maze of channels that today separates Ultima Esperanza from the Puerto Montt area is around 5500 BP (San Román, 2014). The distance between CBLS and the continent North of Chiloé Island is over 1100 km in a straight line. Immediately North of this area is the Monte Verde site, dated to ca. 12,500 BP (Dillehay, 1997), but available paleogeographic information suggests that the connectivity was greater with the east rather than with the south (Borrero, 2005). There is no evidence of dispersal down the western archipelagos during the Pleistocene.

The eastern steppes appear as a more parsimonious origin for the people arriving to CBLS. Not only does all the evidence indicate that the older occupations are found in those steppes, but there is also topographical continuity (corridors) that facilitated dispersal. Archaeological evidence at CBLS unambiguously points toward a terrestrial way of life. Some trees were present before 10,000 BP, as anthracological studies from Cueva del Medio determined the use of *Nothofagus pumilio* as fuel (Nami, 1994a). However, the full expansion of the forest was a slightly later phenomenon (Moreno et al., 2012).

Several authors discuss river basins as adequate dispersal "routes" for colonizers (Anderson and Gillam, 2000; Kelly, 2003; Miotti, 2010; Nami, 2013: 17). The Chico and Gallegos basins were convenient corridors connecting Pali Aike with the CBLS region (Carballo Marina, 2007), particularly the Gallegos basin, as its headwaters are within 30 km of the location of CBLS. The Late Pleistocene history of this river is not well known, but before human arrival there was a glacier piedmont which "drained the Ultima Esperanza basin toward Río Gallegos, on the Atlantic coast through a meltwater channel (Sagredo et al., 2011: 95). Importantly, the Gallegos River constitutes one of the few Holocene sources of fresh water in a water deficient territory (Mayr et al., 2007).

Between Pali Aike and CBLS, there is a minor barrier, a relatively flat, swampy territory at ~200–250 masl, extensively covered by *Nothofagus* forests, which is known as the Llanuras de Diana (Martinic, 2001). It is located within an old morainic amphiteather where the Anibal Pinto and other lakes are placed (Zamora and Dollenz, 1985: 67; Sagredo et al., 2011: 94). However, the conditions were probably different at the end of the Pleistocene when the forest was not there. Certainly, the absence of trees made the Llanuras relatively easy to traverse. When the advance of *Nothofagus* forests from their Pleistocene refugia occurred, the Llanuras de Diana became a barrier for humans. The closed evergreen forests and the swampy soils were the main causes. This area was a very effective barrier for European colonizers in the 19th Century, and was avoided by the local Aonikenk natives (Moyano, 1931: 144). Other routes to reach CBLS are found north of the Llanuras, at Sierra del Cazador or the Vizcachas valley which are closer to the Coyle and Santa Cruz basins, but are longer and geographically more complicated.

6. Discussion

Long-term occupations are expected at the highest ranked patches of any region (Bird and O'Connell, 2006). The central plateau is characterized by heterogeneous but abundant availability of high quality lithic sources (Cattáneo, 2006; Hermo, 2009) and adequate biotic resources and rockshelters (Miotti, 1998). Pali Aike is a place where rock sources are not as widespread and good quality as in the central plateau but are still abundant (Charlin, 2009). The availability of rockshelters, on the other hand, was extremely high. The evidence at Pali Aike indicates an important occupational node that was settled and inhabited by several generations (Bird, 1988). A record of relatively continuous human occupations exists in that region. At the central plateau the situation is similar, in that the intensity of human occupation measured in number of sites or number of radiocarbon dated occupations is

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higher for the period 11,100–10,400 BP (Miotti, 2008; Salemme and Miotti, 2008; Paunero, 2009). More importantly, the evidence of the central plateau also shows continuous human occupation into the Early Holocene. At that time, people appear to be expanding into other previously unoccupied environments (Borrero, 1999). Civalero and Aschero refer to, "different pulses of exploration from the Central plateau" toward the West, represented at Cerro Casa de Piedra (Civalero and Aschero, 2003: 145). Logistical occupations in the vicinity of the central plateau were also inferred for the period 10,845–10,477 BP at site La Gruta, located in the southern extreme of the plateau at, "a time at which radiation was actively taken place." (Franco et al., 2012: 161).

Occupations at Pali Aike, particularly at Fell Cave, were also intense for the period 10,600–10,295 BP. Hunting large body mammals requires, at some point, enlargement of hunting ranges. Because human group size basically results from adjustments to resources, even small changes in the distribution of raw materials, refuge and fauna may trigger band fission (Kelly, 2011, 2013). It is our hypothesis that the peopling of Pali Aike was the result of successive processes of band fission and subsequent changes in hunting ranges that started in the north.

In contrast, the evidence at CBLS and Tierra del Fuego display no signs of occupational continuity. In both cases the record it is restricted to ephemeral Late Pleistocene occupations followed by long occupational gaps. The environmental history indicates geographically constrained conditions for human displacement and installation. The limited evidence found in stratigraphy at Ultima Esperanza indicates scattered occupations without any vertical component. Even when the existence of a "pile" of *Hippidion* bones was recovered at Cueva del Medio, they were only a few bones (Nami, 1994b, 2014), and there are no important accumulations resulting from successive archaeological occupations.

6.1. Tierra del Fuego

It is important to know if CBLS and Tierra del Fuego were only seasonally used outposts, or places explored and abandoned during the Late Pleistocene. The regional rhythms governing the use of those regions were probably the result of decisions taken at population nodes placed in the steppes, such as Pali Aike or other unknown places. The conditions under which Tierra del Fuego was populated were recently examined by McCulloch and Morello (2009) who described two periods during which land bridges connected the continent and Tierra del Fuego. The first existed around 13,100 BP for a short time, the second between approximately 10,315 and 8265–7490 BP, with a duration of ca. 1500 years. Tres Arroyos 1, the only Late Pleistocene site of the island was occupied between 10,855 and 10,130 BP, after the first period but before the second, as defined by McCulloch and Morello (2009). Accordingly, Tres Arroyos 1 was occupied at a time during which no land bridge existed, which is the reason why that particular occupation cannot be easily explained as a result of logistical forays from the continent (Borrero, 1994–1995: 15). Although the distance between Fell cave and Tres Arroyos 1 is only 170 km, it is difficult to accept that there was much human traffic between the continent and the island at that time. The presence of a wide meltwater river in the land bridge should have been an impediment to negotiate and there is nothing to suggest that it was even moderately rich in biotic resources (McCulloch and Morello, 2009). The early inhabitants of Tres Arroyos 1 prepared five hearths and discarded some 819 lithic tools – most of them debitage – and four manuports (Jackson, 2002), which were probably the result of different short visits (Massone, 2004).

Then, assuming a terrestrial mode of displacement, some antecedents for the occupation at Tres Arroyos 1 must exist in the island of Tierra del Fuego. At least three observations can be offered, 1) if occupations at Tres Aroyos 1 were the result of logistic movements, they involved a population node located on the island; 2) the earliest occupations at the continent should be minimally around 13,000 BP in order to be able to take advantage of the first window of opportunity to reach Tierra del Fuego, and 3) conditions for cultural divergence – or population extirpation – created by the formation of the Strait of Magellan were in place.

6.2. From Pali Aike to Ultima Esperanza: attraction and connectivity

Important in the comparative analysis between Pali Aike and Ultima Esperanza is the fact that there was no Late Pleistocene ice cover at Pali Aike, since the Andean glaciers never reached the Atlantic (Rabassa et al., 2011). For that reason, Pali Aike was ecologically well suited for human arrival even before the retreat of the Late Pleistocene Andean glaciers. From a cultural point of view, a major difference is that evidence at Fell Cave speaks of relatively intense early occupations and continuity into the Holocene (Emperaire et al., 1963; Bird, 1988). Lithic studies showed that only a segment of the manufacturing sequence for Fell Cave projectile points is represented at the Fell Cave site (Flegenheimer and Cattáneo, 2013), implying the existence of functionally distinct sites nearby. Also, most of the 19 or more Fell Cave projectile points recovered at the site were heavily resharpened and recycled (Politis, 1991; Nami, 1998), which is a measure of the intensity of occupation of the region in a context of high mobility. Early Holocene occupations that attest to regional continuity are recorded at Fell itself and Pali Aike, Don Ariel and Cueva de los Chingues (Bird, 1988; Nami, 1999; Martin, 2013).

We do not know the precise ecological differences between Pali Aike and Ultima Esperanza, but there are contrasts in geographical, climatological, and ecological conditions. The distance between the Atlantic and Pacific coasts at 52° S is about 250 km, with a gradient in precipitation from 200 mm/year in the east to thousands mm/year in the west (Lenaerts et al., 2014). Volcanic activity existed in both regions, but in CBLS it is restricted to relatively discontinuous deposition of tephra (Stern, 2008). Volcanic activity at Pali Aike dramatically affected the landscape, dominated by three successive lava flows (D'Orazio et al., 2000). On the other hand, the relatively minor volcanic activity at Ultima Esperanza probably affected directly or indirectly the local ecology encountered by the first humans, while the intense volcanic activity at PA occurred well before the arrival of humans.

One question is how attractive was the CBLS environment for humans. This region is characterized by extended lowlands, which are constituted mainly by swamps and bogs, particularly toward the west and south of CBLS. Much of this land was the bottom of proglacial lakes during the Late Pleistocene, and was not productive until sometime after the discharge of the proglacial lake, ca. 10,000 BP. The timing of the local ecological succession is still unknown, but it is possible that relatively unproductive land was abundant near the early sites at CBLS, thus constraining both animal movements and the early human occupations. The first evidence for megamammals living at CBLS, near 15,000 BP provides a minimal date for ecesis (Martin et al., 2013). The early faunal assemblages recovered at Cueva Chica, Cueva del Milodon, Cueva Escondida and other sites at CBLS testify to animal occupations of the extreme western continental land. The presence of abundant fauna has to be at least part of the attraction, especially the presence of camelids and horses, the prey of early inhabitants of Fuego-Patagonia. The chronological information for camelids is well published (Nami and Nakamura, 1995; Massone and Prieto, 2004; Martin, 2013; Martin et al., 2013). The available information for *Hippidion saldiasi* indicates a restricted chronological range between 10,860 and 10,310

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Table 2
Radiocarbon dates for *Hippidion saldiasi* from the CBLS area.

Site	Sample	^{14}C (BP)	Lab	Source
Cueva Nordenskjöld	Tibia (splinter)	13,990 ± 150	AA-100230	Unpublished
Cueva del Milodon	Phalange III	11,900 ± 60	Beta-371877	Unpublished
Cueva del Medio	Astragalus	10,860 ± 110	AA 100235	Martin et al. (2014)
Cueva Escondida	Lunar	13,890 ± 60	Beta-310944	Unpublished
Cueva del Medio	Phalange I	10,680 ± 40	Beta-344428	Martin et al. (2014)
Cueva del Medio	Tibia	10,860 ± 160	NUTA-2331	Nami and Nakamura (1995)
Cueva del Medio	Vertebra	10,710 ± 100	NUTA-1811	Nami and Nakamura (1995)
Cueva Lago Sofía 1	Incisivo	10,310 ± 160	OxA-9504	Massone and Prieto (2004) and Steele and Politis (2009)
Cueva Lago Sofía 1	3rd tarsal	10,780 ± 60	OxA-9319	Massone and Prieto (2004) and Steele and Politis (2009)
Cueva del Milodón	Phalange I	11,480 ± 60		Alberdi and Prado (2004)

BP, but our research extended it to 13,990 BP (Table 2), clearly showing the local availability of both key resources before the arrival of humans.

It is our hypothesis that there was a connection between the early human occupations recorded at Pali Aike and CBLS. Basic evolutionary issues like the changing interaction between carnivores, herbivores, and humans are beginning to be known for these regions, which show many similarities (Martin, 2013; Prevosti and Martin, 2013). However, for the moment it is difficult to go beyond the basic fact that the recorded large vertebrate mammals and the basic lithic tools are similar. *Smilodon* and *Macrauchenia* are not recorded at Pali Aike. For that reason, it is worth asking if the animal resources were homogeneously distributed in the intermediate zone between Pali Aike and CBLS. The evidence for rich faunal assemblages in Pali Aike goes back to before the Last Glacial Maximum (Martin et al., 2004; Borrero and Martin, 2008, unpublished information), while the oldest evidence for CBLS is dated around 15,000 BP (Martin et al., 2013).

The known spatial distribution of Late Pleistocene fossil remains in southern Patagonia is discontinuous with two concentrations of fossil localities. The first concentration can be found between Tres Arroyos 1 in Tierra del Fuego, the eastern site at 68°47′ W, and Las Buitreras at 70° 10′ 28″ W. One important cluster of paleobiological and archaeological sites with megamammals within this concentration extends between Cueva Cóndor in the east at 69° 25′ W (Barberena et al., 2007), Fell Cave located at 70°03′23″ and Las Buitreras (Fig. 4). Within the polygon determined by these four sites there are seven sites with extinct mammals. An extensive zone without any record of extinct faunas lies between the Pali Aike locality and CBLS. This region was intensively searched, but no early or late paleontological or archaeological materials were found.

The second concentration of mammal fossil remains is narrowly restricted to CBLS and immediate surroundings. Fifteen sites containing Late Pleistocene extinct mammals are recorded there and Cueva del Milodón (72° 37′ 13″) is the western Late Pleistocene bone assemblage (Fig. 4). The only claim for the presence of Late Pleistocene megamammal bones west of Cerro Benitez corresponds to a *Mylodon* pelvis found some 10 km west of Cueva del Milodón, and radiocarbon dated 12,125 ± 85 BP (Stern et al., 2011). At Cerro Castillo, some 30 km northeast of Cerro Benitez, a Mylodontinae dermal bone was recovered in the lower undated levels (San Román and Morello, 2003). On the basis of the older pre Late Glacial

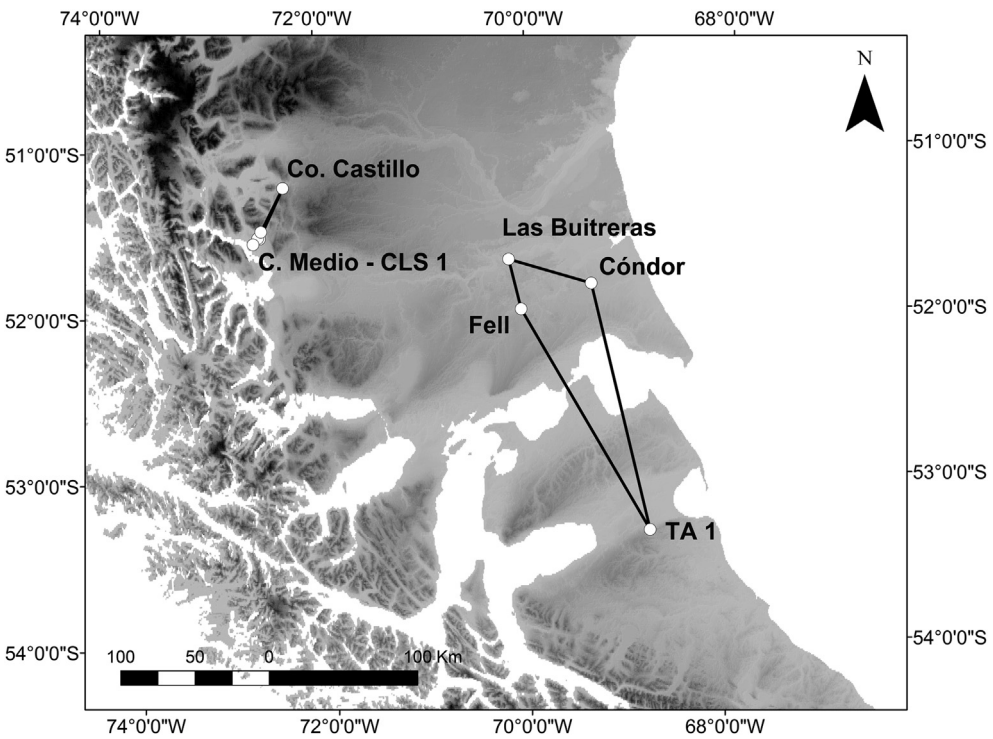

Fig. 4. Late Pleistocene faunal accumulations in Southern Patagonia and Tierra del Fuego.

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Maximum dates at Pali Aike, the existence of corridors and given that it constitutes the only alternative repository of Late Pleistocene megamammals in an intensively researched area, it is our hypothesis that Pali Aike was the source for the fauna that began to arrive to CBLS after the retreat of the ice, sometime before 15,000 BP.

In order to understand the process of human colonization, it is important to know if there was any continuity in the distribution of resources, as leap-frogging (sensu Binford, 1982) within the same patch is a relatively fast mode of human movement – usually leaving behind unoccupied space- but it is much slower when changing patches. However, the availability of megamammals in the intermediate zone remains an open question and the possibility of spatial segregation of fauna exists.

If environmental or climatic reasons produced a decline in megafauna at any of the patches, then search costs of the surviving individuals increased, prompting broadening of the diet and human mobility. If that was the situation in the eastern patches, then CBLS could have been comparatively very attractive, a place with a concentration of resources. The velocity of human incorporation of new land could be high, responding to the degree of similarity between new and old territories that assures no major transfer costs about prey behavior and other resources. Slow expansion of home ranges and a process of fission are the basic mechanisms behind this process and even exploratory movements never required long-term separation from the original population node (Anderson et al., 2013: 196). The ~150 km separating Pali Aike from CBLS appears to be a great distance, but in other regions, like Uruguay, there is evidence of Late Pleistocene people moving distances up to 140–170 km to acquire lithic raw materials (Suárez, 2011: 208), suggesting that this distance is within the reach of early colonists confronting empty land.

The occupation of CBLS can be the result of exploratory mobility by successive extensions of hunting ranges, perhaps few individuals searching for alternative places for hunting, or new territories. The occupation of other western margins was also explained as the result of people expanding their ranges during the early Holocene (Civalero and Aschero, 2003). In a region with water deficits (Mayr et al., 2007), Ultima Esperanza was an attractive territory. Generally speaking, the western territories before the expansion of the forests were good hunting alternatives, perhaps what Karl Butzer called a “high biomass of k-selected herbivores” (Butzer, 1991: 140). There was high faunal diversity at CBLS, and the available resources were attractive enough to sustain punctuated occupations as recorded at CM and CLS1. We consider the occupations at CBLS as marginal as they indicate discontinuous use of the land, probably from a distant population core (Borrero, 2004: 56).

It is difficult to sustain that hunter–gatherers stopped moving when they arrived to CBLS (Prieto and Labarca, 2011), as hunter–gatherer adaptations are generally mobile. To move around was an imposition for new colonists who needed to learn the distribution of unknown resources and the local geography (Meltzer, 2009: 235). In more strict terms, the evidence recovered at CBLS and nearby can only be explained as a result of very ephemeral use of the region by highly mobile hunter–gatherers. Analysis of the archaeological evidence explains those occupations more economically as a result of excursions, probably related to nodes located someplace else.

7. Conclusions

Summing up, connections between the inhabitants of Pali Aike and Tierra del Fuego probably existed, but they were indirect and relatively old. There is no record of human presence in the north of Tierra del Fuego after the early occupation recorded at Tres Arroyos 1 until the middle of the Holocene. Starting ca. 8000 BP the terrestrial connection with the continent was definitely interrupted with the formation of the Strait of Magellan.

On the other hand, there is high connectivity between Pali Aike and the western margins of Patagonia, particularly CBLS (Borrero and Manzi, 2007: 170). Altitudes around 100–200 masl indicate a relatively flat topography which was not disrupted by any barrier, as the Llanuras de Diana were probably easier to navigate at the end of the Pleistocene. On that basis we propose the hypothesis that the source for the earliest ephemeral incursions into CBLS can be found at Pali Aike.

The early populations of Fuego-Patagonia were certainly prepared to deal with environmental heterogeneity. Some innovations can be expected as a result of moving into new land, but most would not amount to more than variations on a common theme. Given that basically the same prey was being exploited, then few investments in technology were required. Castiñeira et al. (2011: 350) in their morphometric analysis of a collection of Fell Cave projectile points from Uruguay found that particular design is adequate for the colonization of new lands where risks are expected. Accordingly, Maggard and Dillehay (2011) considered that people possessing those points can be ascribed to ‘transient explorers’ (sensu Beaton, 1991). CBLS may simply be a region that was discontinuously used in time and space, perhaps for sporadic large game hunting forays. Dispersing into new land can also be considered a way of spreading risk, a process that requires abilities to move, to process information and to select places according with intuitive cost-benefit analyses. As remarked by Beaton (1991: 215), exposure to relative isolation can also lead to extinction, a possibility to be considered in discussing the archaeology of CBLS.

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