

# Compendium of the Review about the Huemul Distribution in Patagonia: Past and Present

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## 1. Process of occupying habitat areas by wild cervids

Habitats allowing positive population growth are classified as source areas. Cervids and other ungulates introduced or re-introduced to source areas frequently expand their range along additional source areas. Once the animal density increases, dispersers will eventually also inhabit marginal areas, and even sink areas, where losses are only replaced with additional incoming dispersers (Pulliam, 1988). In a similar manner, the initial populations established in source areas are all-year residents. Possibly due to increasing population density, some dispersers in seasonal latitudes will move altitudinally to establish new summer ranges, yet return to their original winter area, and thereby re-joining that resident population. This was shown to have occurred with red deer (*Cervus elaphus*) recolonizing the Swiss National Park (Haller, 2002), and exotic red deer introduced to Patagonia in areas formerly used by huemul (Flueck and Smith-Flueck, 2011). There might exist some special cases where a winter range is inhabitable during summer, such that there are no resident animals and all of them participate in the migration (e.g. Mysterud et al., 2011). This might be more related to wet/dry seasons rather than seasonal altitudinal migrations in cold-temperate regions. It takes generations to evolve migratory behavior as a cultural trait (Putman and Flueck, 2011; Festa-Bianchet, 2018; Jesmer et al., 2018). The young of migrating mothers follows them to migrate to winter ranges, and back to summer ranges the following spring (Jakopak et al., 2019). However, a mother dying on the winter range commonly results in the young remaining there as a resident (Flueck, 1989; Thirgood, 1995; Via et al., 1995; Avital and Jablonka, 2000; McClure et al., 2005). Recolonization generally occurs by moving to new winter ranges, and after arriving to such an area, its initial use is as residents (Haller, 2002; Flueck and Smith-Flueck, 2011), and only after several generations does migratory behavior become established to use surrounding summer ranges (Festa-Bianchet, 2018). Traditional migratory patterns even lead to bypassing better areas and to remain in inferior habitat, even by traversing several mountain ranges (Moser, 1962; Flueck, 1989).

Consequently, during the last glaciation huemul occurred in grasslands to the east of the Andes mountains, and once glaciers started to retreat, they began to occupy the Andes range and eventually passed to the western side (Flueck and Smith-Flueck, 2011). Many areas of the Andes were inhabited and used within a migratory pattern, which later has been eliminated through anthropogenic impacts (see below). These processes resulted in most extant huemul remaining as year-round resident populations in summer ranges with various consequences as shown in the accompanying paper.

## 2. Historical spatial habitat use by huemul

Before the first explorers arrived and initiated the first documentation of features in Patagonia, the situation of huemul had already been modified. For one, early humans (indigenous and colonists) and their hunting dogs affected the huemul distribution. In addition, the unusual lack of anti-human behavior of huemul (see below) intensified the effect by resulting in local extinctions. Most importantly, the first descriptions of huemul by several early naturalists already noted this phenomenon (Gay, 1847; Philippi, 1892; Steffen, 1895; Onelli, 1905; Gigoux, 1929).

### 2.1. Lack of anti-human behavior

In terms of fearlessness, Osgood (1923) was able to throw rocks at huemul a few meters away; indigenous people killed them with just rocks, clubs or lasso (Onelli, 1905; Housse, 1953; Díaz and Smith-Flueck, 2000; Tonko, 2008); and in open grasslands, a team member could approach a huemul and kill it with just a knife, while first allowing the head explorer to take a time-consuming hyalotype photo (Onelli, 1904). Prichard (1902b) described how after shooting a huemul standing in a group, the other members still came closer, so that eventually he could harvest a whole group. This fearlessness was corroborated during the first-ever capturing of six huemul in Argentina: the time between spotting the animal and placing a capture dart ranged from 32 to 73 minutes, and still allowed to place the dart from distances ranging only from 10 to 23 m. The huemul simply ignored the people preparing themselves for darting (Flueck and Smith-Flueck, 2018). Although huemul apparently can reduce their tolerance towards humans, the process was certainly too slow in the past, when the aim was to harvest huemul (Prichard, 1902b; Goss, 1983).

### 2.2. Historical efficiency of hunting huemul

Past densities in areas easily accessed by humans can also be deduced from the reported hunting efficiency. For instance, Juan Ladrillero reported in 1558: ‘and then we went up to the place known as the Deer Point, where in just one hour two of our men shot fifteen of them with the arquebus’ – and this being weaponry less accurate than bow and arrow (Díaz and Smith-Flueck, 2000). Prichard (1902a) summarized that he could have very easily shot ten huemul in a day, based on his whole team living from huemul for many weeks during work. Equestrian precolonial humans rarely hunted huemul in the forests as horses and boladores were useless there, however, they killed huemul out in the open foothills, lowlands or open valleys (Falkner, 1774; de la Cruz, 1836; Prichard, 1902a; von Colditz, 1925; Gigoux, 1929; Grosse, 1949; Housse, 1953; Liebermann, 1962; Iglesias, 1965; Kolliker Frers, 1969). Boladores are devices with weights on the ends of interconnected cords, used to capture animals by entangling their legs. Once the use of feral and controlled livestock became common, huemul - driven down by snow to lower forests, valley bottom and further out to open flats, were then much persecuted by gauchos or native people and their dogs (Gay, 1847; Prichard, 1910; von Colditz, 1925; Gai, 1936; Housse, 1953; Kolliker Frers, 1969; Miller et al., 1973; Torrejon, 2001). Every native hunter in Patagonia had at least a dozen dogs, to accompany them on hunting trips by horseback (Onelli, 1904; von Colditz, 1925).

### 2.3. Anthropophobia by huemul and other cervids

Under natural conditions, cervids are exposed to numerous predators, mainly felids, canids, ursids, raptors and humans. Large predators of felids, canids and humans commonly elicit an anti-predator responses, by the deer becoming alerted and if needed, by fleeing. Under special conditions like captive breeding, cervids may become predator-naïve, or when an exotic predator has been introduced. Commonly, a basic level of anti-predator behavior is always present, like red deer (*Cervus elaphus*) introduced to Patagonia, being able to adapt to the new predator puma (*Felis concolor*) (Flueck and Smith-Flueck, 1993). Another example is a bedded newborn Black-tailed deer fawn (*Odocoileus hemionus columbianus*) which increases the pulse and respiratory rate when first approached by a human, and when mobile later on, retains a distance even when the tamed mother feeds off the hand of a person. Thus, general anti-predator behavior does not have to be learned, and anthropophobia is typically exhibited even during an animal's first encounter with a human (Stringham and Rogers, 2017).

Studying wild Odocoileines, deer alerted shortly after a human started to approach, with approach distances ranging from 70 to 1000 m (Lingle and Wilson, 2001). Similarly, different ways of approaching by a human resulted in the deer fleeing at a minimal distance of 60-90m, depending on the approach tactic (Stankowich and Coss, 2006; Stankowich, 2008).

In contrast, huemul are naive regarding humans, in an unique way among cervids. In actuality, one or more people frequently can get very close to huemul, including in areas where the animals likely never had seen a human. Moreover, huemul will walk towards humans to very close distances: such cases are documented repeatedly with photos and videos. For instance, finding a group of 4 huemul in a remote part of a Chilean National Park, a video of 5 minutes shows how this group approaches and a female eventually sniffs the leg of the person, and then moves on slowly (Flueck, unpubl). Very young fawns also walked directly up to people (Flueck, unpubl.). It corroborates a similar experience by Prichard (1902a) when a huemul walked away after having sniffed his leg, or the gaucho putting to death a huemul using a knife, photographed by Onelli (1904). This lack of anti-human behavioral response explains the historical efficiency of hunting huemul, thus preventing adaptive behavioral changes, and resulting in their local extermination.

### 2.4. Historical use of huemul products

The ease of hunting huemul was accompanied by the many useful products obtained. Instructively, early descriptions at contact with pedestrian hunter-gatherers referred to some as 'huemules', reflecting their clothes made from huemul skins (Steward, 1946; Torrejon, 2001). For one sole area it was estimated that two thousand huemul were killed per year, mainly to feed dogs, pigs, chickens, while skins were made into clothing and shelters for people and their domestic animals, or used for commercial trading (Giai, 1936; Liebermann, 1962; Iglesias, 1965; Kolliker Frers, 1969). Claraz (1864) stated that huemul hides had already been traded for over 50 years (i.e. 1785) through Carmen de Patagones via Buenos Aires to Europe (Cabrera and Yepes, 1940), through Valdivia (Philippi, 1873), while Behm (1880) mentioned the export site of Punta Arenas in Chile for hides, and in addition for male heads in velvet. Considered useful for its various products, the huemul was listed as early as 1883 as one of the commercially important species traded and utilized by humans (Simmonds, 1883). Then, to provide better protections, Chile proposed in 1902 to charge an export tax for huemul skin hides (Ramirez Morales, 1991).

When the Chilean Presidente José Joaquín Prieto decided in 1832 to place the huemul symbol in their National Flag, huemul had already become so unknown that the first Flag depicted huemul as a horse, based on the first description by Abbot Molina in 1782, naming it *Equus bisulcus* (now: *Hippocamelus bisulcus* Molina 1782). However, most relevant is the declaration of 1832 made by President Prieto: that huemul was already most rare, and how its good skin had been their valued material to make the corslets and war boots for their troops of soldiers (Donoso et al. 2017).

### 2.5. Historical comments about the concurrent problematic status of huemul

The ease of hunting huemul and the high interest in its products resulted in local extinctions in many sites. Therefore, it is not surprising that historically huemul was not only considered as having already disappeared or as being very rare (Vidaurre, 1782; Molina, 1809; Gay, 1847; Sclater, 1873; Philippi, 1857, 1892; Sclater, 1873; Prichard, 1910; Wolffsohn, 1910; von Colditz, 1925; Hauman, 1926; Latcham, 1935; Gai, 1936; Magne de la Croix, 1937; De Agostini, 1941; Ringuelet, 1946; Housse, 1953; Pefaur et al., 1968; Kolliker Frers, 1969; Miller et al., 1973), but was also considered to be close to extinction (Onelli, 1905; von Colditz, 1925; Dawilov, 1926; Gigoux, 1929; Grosse, 1949; Kolliker Frers, 1969). Moreover, as colonization had already advanced in other sites, and with it the disappearance of huemul, hunters in one such region were honored with a feather in their hats if still able to kill a huemul (Prichard, 1902a).

### 2.6. Historical reports about sites still containing huemul

Although locally exterminated in many areas early on, some historical accounts still mentioned huemul populations - with a few even considered numerous, between the Andean foothills and the Patagonian mesas, and even reaching all the way eastward to the Atlantic coast (Günther, 1875; Behm, 1880; Prichard, 1902a,b; Church, 1903; Hatcher, 1903; Onelli, 1905; Osgood, 1923; von Colditz, 1925; Gai, 1936; Santos Gollan, 1946; Housse, 1953; Liebermann, 1962; Kolliker Frers, 1969; Conway 2005). Reports from the 16-19th centuries mentioned huemul near ports of San Julian and Desire (e.g. Pigafetta 1521 and van Noort 1598, both cited in Eastman, 1915; Pennant, 1793; MacDouall, 1833; Roulin 1835). With time, naturalists found an even more reduced distribution, but still with some descriptions of huemul far from the Andean forest, including in the so-called 'Patagonian pampa' (Claraz, 1864; Musters, 1871; Burmeister, 1873; Moreno, 1898, 1899; Prichard, 1902a,b; Hatcher, 1903; Onelli, 1905; Steffen, 1897, 1900, 1910; Wolffsohn, 1910; Osgood, 1923; von Colditz, 1925; Gigoux, 1929). In these same reports, huemul were commonly found occurring in great numbers together with guanaco.

Moreover, indigenous people were reported to like and to be cooking huemul meat, hunted in steppe areas together with guanaco and ostrich (*Rhea pennata*) (Bürger, 1924; Aschero, 2010; Machon and Juarez, 2013). Even documented with photos is a huemul hunted by the governor of Chubut in 1904, at a site 270 km east of the continental divide (Anon., 1904).

Many of these historical reports of huemul distribution resulted from expeditions aimed at describing the landscape, hydrology and biology, such that there is much corroborating evidence in form of resulting huemul specimens deposited in numerous museum collections all over the world: Italy, France, Switzerland, Austria, Germany, Czechoslovakia, England, USA to name a few. Also corroborating the historic distribution are numerous shed antlers or huemul remains found in archeological sites (Onelli, 1905; Reichlen, 1959; Laming-Emperaire et al., 1972; Johnson, 1976; Silveira, 1979; Cardich and Miotti, 1983; Massone, 1984; Goni, 1988; Serret, 1990; Diaz, 1993; Re et al., 2005; Díaz et al., 2007; Carballo Marina et al., 2008; Paillan and Tello, 2012; Teta and Rodríguez, 2020).

Nonetheless, it is utmost important to recognize that the pre-Columbian anthropogenic impact on the huemul distribution was substantial, and resulted in corresponding initial reports of already severely modified circumstances. Thus, others have concluded that huemul and guanaco were already nearly extinct by the time of the first Spanish arrival, but still occurred in Coquimbo (Chile, at 30°S) as late as 400 years ago (Fig. 4b in the accompanying paper): this is 680 km further north of the extant and isolated northern-most population (Bahre, 1979; Saavedra and Simonetti, 1991; Moreno et al., 1994; Ale, 2014).

### 2.7. Paleobiogeography

The pre-Columbian distribution of huemul resulted likely from *Odocoileus* founders (Morejohn and Dailey, 2004), which dispersed through the Panama isthmus. Species which successfully passed this equatorial filter were generalists and predominantly savanna-adapted (Webb, 1978), and considering paleoclimatic conditions, *Hippocamelus* colonized southwards through continuous savanna habitat east of the Andes (Hoffstetter, 1963; Hershkovitz, 1969; Frailey et al., 1980; Markgraf and Kenny, 1997). The early presence of *Hippocamelus* species in South American plains, and its absence from Andean fossil records imply that the genus did not evolve in the Andes. The most probable scenario suggests that *Hippocamelus* first evolved elsewhere as suggested by lowland fossils (Paula Couto, 1953, 1979; Rusconi, 1967) as mentioned above. Glaciations kept *Hippocamelus* repeatedly away from the Andes, with fossils known from northeastern Brazil (8°9'S, 36°22'W), and from the rangeland plains of southeastern Brazil, Uruguay and Argentina (Castellanos, 1944; Magalhaes et al., 1992; Eisenberg, 2000; da Silva et al., 2006; Guérin and Faure, 2009; Anonymous, 2021). Hershkovitz (1972) thus recognized *Hippocamelus* as pastoral and only secondarily adapted to sylvan habitats.

During glaciations, the Andes were covered with ice even near the equator (Clapperton, 1993; Coltorti et al., 2007), and continuous sheets 1600–1800 m thick covered the Andes from about 33–56°S during the last glacial maximum (Flint and Fidalgo, 1969). Glaciers south of 42°S dipped into the Pacific and reached hundreds of kilometers into eastern Patagonia. There, only non-forested habitat existed, with Patagonia-like rangelands reaching far into Brazil, and much of South America was covered by savanna and rangelands (Marshall, 1988; Clapperton, 1993; Rasmussen, 1994; Markgraf and Kenny, 1997; Tatura et al., 2002; Rabassa and Coronato, 2009). Moreover, the sea level was 120–150 m lower than currently and the Atlantic coastline located >300 km east of the present coastline, which almost doubled the area of eastern, flat paleorangelands (Rabassa et al., 2011). Huemul thus persisted repeatedly in only non-forested habitats, which is the typical environment for the extant congeneric taruca (*H. antisensis*) (Flueck and Smith-Flueck, 2012a).

During glaciations, *Hippocamelus* persisted in eastern non-forested lowlands, and as mixed feeders, huemul are known to consume notable amounts of grass (Smith-Flueck, 2003; Prothero and Foss, 2007). Extant huemul ate 16% grass (Sierralta, 2003), while taruca had ~60% of grass in its diet (15 species, Gazzolo, 2006). Furthermore, besides Gramineae, Patagonian rangelands contain many shrubs, they maintain important green-grass production throughout winter, and deer are known to heavily use seed heads, further corroborating past distributions of huemul in non-forested habitat. Even smaller-sized cervids thrive exclusively in non-forested rangelands, like Pampas deer (*Ozotoceros bezoarticus*) or roe deer (*Capreolus capreolus*) (Pérez et al., 2008), and many *Odocoileus*, including *Odocoileus*, are versatile in foraging and successfully utilize rangelands, steppes and deserts besides closed forests (Putman and Flueck, 2011). Similarly, huemul also exhibit flexible feeding behavior, utilizing some 200 plant species (from modern studies), and many more if considering past distributions and exotic food received in zoos like in Buenos Aires (Flueck and Smith-Flueck, 2012b).

Once eastern Patagonia became free of ice, huemul were able to reach Andean habitat and, when deglaciation allowed, eventually cross the Andes through corridors which

had opened (Moreno et al., 1994). Faunal exchanges from the east occurred across low Andean passes, explaining the presence of huemul in late Pleistocene as far north-west as 30°S by the Pacific coast (Bahre, 1979; Saavedra and Simonetti, 1991; Moreno et al., 1994; Ale, 2014). With the last glacial retreat, forests spread from few western refuges, and eventually covered the southern Andes again, reaching their current extent only 2,000–3,000 years ago (Markgraf and Kenny, 1997; Rabassa and Coronato, 2009; Armesto et al., 2010).

The only congeneric, taruca - considered osteologically indistinguishable and possibly a mere subspecies by some (Wagner, 1855; Philippi, 1857; Dabbene, 1911; Krieg, 1925; reviewed in Diaz, 1995), currently utilize non-forested rangelands with high affinity to Patagonia (Fernández and Busso, 1997). However, taruca also have been displaced because of anthropogenic pressures, e.g. from *Prosopis* forests by the Pacific coast (Dabbene, 1911; Horkheimer, 1960; Sinclair, 2009). Although now mainly found above treeline, some populations are still found, even exclusively, in *Polylepis* and yungas forests, also due to continued hunting pressure (Aldenderfer, 1998; Tarifa and Yensen, 2001).

Paleobiogeography indicates that the ability to utilize non-forested rangelands was essential for the persistence of huemul (Hershkovitz, 1972; Webb, 1978), making the claim unrealistic that huemul are strictly a forest-dependent species.

### 3. Historical seasonal habitat use

#### 3.1. Resident behavior of huemul

Not only were huemul described as year-round resident populations in valleys and on winter ranges, but also as having been there frequently together with guanaco, and even with numbers equivalent to guanaco (Cox, 1863; Claraz, 1864; Prichard, 1902a; Steffen, 1910; Krieg, 1940; de Agostini, 1945; Grosse, 1949).

Examples of current resident behavior at low elevations stems from a large island with mountains reaching 1830 m.a.s.l., and forests reaching the coast. All sightings and signs occurred between sea level and 200 m elevation, and on 0–15 % slopes: no huemul signs were recorded above the tree or shrub lines (Moreira-Arce et al., 2021)

#### 3.2. Migratory behavior of huemul

In some cases, huemul grazed together with cattle or mules on high-elevation summer ranges, and then went down with the domestic animals when these were driven by gauchos from summer areas to low winter range lands (Philippi, 1892). Others have described huemul to descend to valleys and/or out into the grasslands during winter where they formed large groups of over 100 huemul (Moreno, 1898; Gay, 1847; Claraz, 1864; Sclater, 1875; Lydekker, 1898; Prichard, 1902a,b; Wolffsohn, 1910; Steffen, 1910; Neveu-Lemaire and Grandidier, 1911; von Colditz, 1925; Dawilov, 1926; Gigoux, 1929; Gai, 1936; Krieg, 1940; Grosse, 1949; Housse, 1953; Lieberman, 1962; Kolliker Frers, 1969; Ibar Bruce, 1973; Goss, 1983; Serret, 1990). Moreover, given that antlers are shed in late winter and have nothing to do with hunting, any antler findings can serve as an additional indicator of winter habitat use, by resident or migratory animals. As such, old shed antlers have been collected in historical winter ranges like temperate grasslands. For example, when first settling the large Rio Manso valley, a colonist reported finding old shed antlers while initially plowing riparian areas (Flueck and Smith-Flueck, 2012b). Then interestingly, prehistoric remains have been found in Patagonian grasslands and near the Atlantic Ocean (Ibar Bruce, 1973; Cardich and Miotti, 1983; Serret, 1990; Guineo et al., 2008; Fernandez et al., 2016), including a human-modified antler recently (Cruz et al., 2010). Hence, from very early on it was recognized that continued human pressure resulted in huemul remaining in high and inaccessible areas (Pennant, 1793; Gay, 1847; Philippi, 1892; Wolffsohn, 1910; Cabrera and Yepes, 1940; Ibar Bruce, 1973), which was interpreted as being refugee areas (Krieg, 1940; Housse, 1953; Liebermann, 1962; Kolliker Frers, 1969). Current habitat use by huemul in the Park Shoonem is certainly only a frac-

tion of the area reported to have been used historically (Moreno, 1898; Onelli, 1905; Steffen, 1910).

#### 4. List of references for historical spacial data

The main paper provides a map showing the locations of historical presence of huemul, based on hunting, shed antlers, and archeological samples (n = 54, Figure 4). The following list of citations formed the basis of these locations:

Agassiz, L. 1872. The 1871-1872 Hassler expedition. Occurrence dataset, version 162.229. doi.org/10.15468/p5rupv, accessed Oct 2020 In: (Ed. Morris PJ) Museum of Comparative Zoology. Harvard University, Cambridge, USA.

Ale, A. 2014. A social economic formation of hunter-gatherers in the semiarid northern Chile: a revaluation of San Pedro Viejo of Pichasca site. *La Zaranda de Ideas* 11:67-88.

Anchorena, A. 1902. Descripción gráfica de la Patagonia y valles andinos. Compania Sudamericana de Billetes de Banco, Buenos Aires.

Anonymous, 1904. Excursión del gobernador del Chubut. *Caras y Caretas* (Buenos Aires) 7(300):58.

Bahre CJ. 1979. Destruction of the Natural Vegetation of North-Central Chile. University of California Publications in Geography, Vol 23, Berkeley, USA. 117 pp.

Behm, E. 1880. Reise im südwestlichen Patagonien von J.T. Rogers und E. Ibar, 1877, nebst den Tagebüchern von A. de Viedma 1782 und J.H. Gardiner 1867. *Petermanns Geographischen Mitteilungen* 26(2):47-64.

Burmeister, C.V. 1893. Nuevos datos sobre el territorio Patagonico de Santa Cruz. *Revista del Museo de la Plata* 4:227-256 and 338-352.

Burmeister, C.V. 1901. Memoria sobre el territorio de Santa Cruz. Imprenta La Nación, Ministerio de Agricultura de la Republica Argentina.

Carballo Marina, F., Manzi, L.M., Campan, P.A., Belardi, J.B., Tiberi, P., Manero, A., Saenz, J.L. 2008. Distribución del registro arqueológico en la cuenca del rio Gallegos (Santa Cruz): linea de base y aporte a la preservación del patrimonio. Pages 175-225 In: (Eds. Borrero LA and Franco N) *Arqueologia del Extremo sur del Continente Americano*. Editorial Dunken, Buenos Aires.

Cardich, A., Miotti, L. 1983. Recursos Faunisticos en la Economia de los Cazadores-Recolectores de Los Toldos (Provincia de Santa Cruz). *Relaciones de la Sociedad Argentina de Antropologia* 16:145-157.

Diaz, N.I. 1993. Changes in the range distribution of *Hippocamelus bisulcus* in Patagonia. *Z. Säugetierkunde* 58:344-351.

Díaz, N.I. 2000. The huemul (*Hippocamelus bisulcus* Molina, 1782): a historical perspective. Pages 1-31 In: (Eds. Díaz, N.I. and J. Smith-Flueck) *The Patagonian huemul, a mysterious deer on the brink of extinction*. L.O.L.A., Buenos Aires.

Díaz, N.I., Prieto, A., Bahamonde, G. 2007. Guanacos tímidos, huemules confiados: el límite occidental de los cazadores terrestres australes. *Magallania*, (Chile) 35(1):133-138.

Eastman, C.R. 1915. Beginnings of American natural history. *The America Museum Journal* 15(7):349-355.

Goni, R.A. 1988. Arqueología de momentos tardíos en el Parque Nacional Perito Moreno (Santa Cruz, Argentina). Pages 140-151 In: *Precirculados del IX Congreso Nacional de Arqueología Argentina*. Universidad de Buenos Aires, Buenos Aires.

Goni, R.A., Belardi, J.B., Re, A., Nuevo Delaunay, A., Molinari, R.L., Ferraro, L. 2007. Los grabados de la meseta del lago Strobel (Patagonia argentina) desde una perspectiva regional. Pages 427-438 In: *Actas del Primer Simposio Nacional de Arte Rupestre* (Cusco, noviembre de 2004). Institut Francais d'Etudes Andines, Peru.

Hatcher, J.B. 1903. Reports of the Princeton University expeditions to Patagonia, 1896-1899. Vol. I: Narrative of the Expeditions. Geography of Southern Patagonia. E. Schweizerbart'sche Verlagshandlung, Stuttgart. 314 pp.

Johnson, L. 1976. Informe sobre una prospección arqueológica en magallanes. *Ans. Inst. Pat.*, Punta Arenas (Chile) 7:87-94.

Lacroix, F. 1841. Historia de la Patagonia, Tierra de Fuego, e Islas Malvinas. Imprenta del Liberal Barcelones, Barcelona, Spain

Laming-Emperaire, A., Lavallée, D., Humbert, R. 1972. Le site de Marazzi en Terre de Feu. *Objets et Mondes* 12(2):225-244.

Lista, R. 1881. La Tierra del Fuego y sus habitantes. *Boletín del Instituto Geográfico Argentino* 2:109-114.

MacDouall, J. 1833. Narratives of a voyage to Patagonia and Terra del Fuego. Renshaw and Rush, London. 320 pp.

Mansur, M.E., Piqué, R. 2009. Between the Forest and the Sea: Hunter-Gatherer Occupations in the Subantarctic Forests in Tierra del Fuego, Argentina. *Arctic Anthropology* 46:144-157.

Massone, M. 1984. Los paraderos tehuelches y proto-tehuelches en la costa del Estrecho de Magallanes. *Anales del Instituto de la Patagonia* 15:27-42.

Moreno, F.P. 1898. Apuntes preliminares sobre una excursión a los territorios del Neuquén, Río Negro, Chubut y Santa Cruz. *Rev. Museo de La Plata* 8(1): 200-459.

Moreno PI, Villagran C, Marquet PA, and Marshall LG. 1994. Quaternary paleobiogeography of northern and central Chile. *Revista Chilena de Historia Natural* 67:487-502.



Onelli, C. 1905. El huemul. Su patria: su vida. Revista del Jardin Zoológico de Buenos Aires Epoca II. Vol. 1(4): 370-374.

Paillan, J.T., Tello, G.E. 2012. Los recursos naturales y culturales, 28 de Noviembre, Guer Aaike. Santa Cruz: su importancia turistica y patrimonial. ICT-UNPA-35-2012. Pg. 1-15.

Paula Couto, C. 1953. Paleontologia Brasileira (Mamíferos). Instituto Nacional do Livro. Rio de Janeiro, Brasil. Pg. 1-516.

Paula Couto, C. 1979. Tratado de paleomastozoologia. Academia Brasileira de Ciencias, Rio de Janeiro, Brasil. Pg. 1-590.

Prichard, H.H. 1902. Through the heart of Patagonia. D. Appleton and Co., New York. 346 pp.

Prichard, H.H. 1902. Field notes upon some of the larger mammals of Patagonia made between September 1900 and June 1901. Proc. Zool. Soc. London 1, 272-277.

Re, A., Delaunay, A.N., Ferraro, L. 2005. Grabados en la meseta del lago Strobel (provincia de Santa Cruz, Argentina), el sitio laguna del Faldeo Verde. Relaciones de la Sociedad Argentina de Antropología XXX. 30:245-256.

Reichlen, H. 1959. Huemul in Fell's Cave, Chile: Specimen MNHN-2M-MO-1988-211. Museum National d'Histoire Naturelle, Paris (France) <http://coldb.mnhn.fr/catalognumber/mnhnizm/mo-1988-211>

Rosas, Y.M., Peri, P.L., Herrera, A.H., Pastore, H., Pastur, G.M. 2017. Modeling of potential habitat suitability of *Hippocamelus bisulcus*: effectiveness of a protected areas network in Southern Patagonia. Ecological Processes 6(28):DOI 10.1186/s13717-017-0096-2.

Rusconi, C. 1967. Animales Extinguidos de Mendoza y de la Argentina. Mendoza: Imprenta Oficial, Argentina. Pg. 1-489.

Saavedra B., and Simonetti J.A. 1991. Archaeological evidence of Pudu pudu (Cervidae) in central Chile. Zeits. Saeugetierkunde 56:252-253.

Serret, A. 1990. Observaciones preliminares de huemul, *Hippocamelus bisulcus*, en el lago Nansen del Parque Nacional Perito Moreno, Provincia Santa Cruz. Fundacion Vida Silvestre Argentina:23.

Siewert, C. 1896. Un viaje a Patagonia. Boletin del Instituto Geografico Argentino 17(7,8,9):363-391.

Silveira, M.J. 1979. Analisis e Interpretacion de los Restos Faunisticos de la Cueva Grande del Arroyo Feo. Relaciones de la Sociedad Argentina de Antropologia 13:229-253.

Skottsberg, C. 1911. The wilds of Patagonia. Edward Arnold, London. Pg. 1-336.

Steffen, H. 1900. Reisen in den Patagonischen Anden. Verhandlungen der Gesellschaft für Erdkunde zu Berlin 27(4): 194-220.

Teta, P., Rodríguez, D. 2020. Mammalogy National Collection (MACNMa). Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia' (MACN): Occurrence dataset [doi.org/10.15468/ukdxqp](https://doi.org/10.15468/ukdxqp)

Waterhouse, G.R. 1839. Mammalia. In: the Zoology of the Voyage of H.M.S. Beagle, Under the Command of Captain Fitzroy, During the years 1832-1836. Smith, Elder and Co., London.

Weber, A. 1903. Chiloe: su estado actual, su colonizacion, su porvenir. Imprenta Mejia, Santiago, Chile. 194 pp.

## General References used for Supplementary File S1

- Aldenderfer MS. 1998. *Montane Foragers: Asana and the South-Central Andean Archaic*. University of Iowa Press: Iowa.
- Ale, A. 2014. A social economic formation of hunter-gatherers in the semiarid northern Chile: a revaluation of San Pedro Viejo of Pichasca site. *La Zaranda de Ideas* 11:67-88.
- Anonymous. 1904. Excursión del gobernador del Chubut. *Caras y Caretas* (Buenos Aires) 7(300):58.
- Anonymous. 2021. Descubren los restos fósiles de seis ciervos prehistóricos. Agencia CTyS-UNLaM/DICYT, [www.dicyt.com](http://www.dicyt.com), 7 Oct.
- Armesto JJ, Manuschevich D, Mora A, Smith-Ramireza C, Rozzi R, Abarzúa AM, and Marquet PA. 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.
- Aschero CA. 2010. Las escenas de caza en Cueva de las Manos: Una perspectiva regional (Santa Cruz, Argentina) In: *IFRAO Congress – Symposium: Pleistocene art of the Americas* (Pre-Acts)
- Avital E, Jablonka E. 2000. *Animal traditions*. Cambridge Univ. Press, Cambridge, UK. 446 pp.
- Bahre CJ. 1979. *Destruction of the Natural Vegetation of North-Central Chile*. University of California Publications in Geography, Vol 23, Berkeley, USA. 117 pp.
- Behm E. 1880. Reise im südwestlichen Patagonien von J.T. Rogers und E. Ibar, 1877, nebst den Tagebüchern von A. de Viedma 1782 und J.H. Gardiner 1867. *Petermanns Geographischen Mitteilungen* 26(2):47-64.
- Bürger O. 1924. *Aus der Wildnis des Huemuls. Erlebnisse und Abenteuer unter den Kolonisten und Indianern Chiles*. Verlag Deutsche Buchwerkstätten, Dresden. 191 pp.
- Burmeister H. 1873. The huemul. *Nature* 9(214): 82.
- Cabrera A, and Yepes J. 1940. *Mamíferos sudamericanos*. (1st). Compañía Argentina de Editores, Buenos Aires. 370 pp.
- Carballo Marina F, Manzi LM, Campan PA, Belardi JB, Tiberi P, Manero A, Saenz JL. 2008. Distribución del registro arqueológico en la cuenca del río Gallegos (Santa Cruz): línea de base y aporte a la preservación del patrimonio. Pages 175-225 In: (Eds. Borrero LA and Franco N) *Arqueología del Extremo sur del Continente Americano*. Editorial Dunken, Buenos Aires.
- Cardich A, and Miotti L. 1983. Recursos Faunísticos en la Economía de los Cazadores-Recolectores de Los Toldos (Provincia de Santa Cruz). *Relaciones de la Sociedad Argentina de Antropología* 16:269–273.

Castellanos A. 1944. Paleontología estratigráfica de los sedimentos neógenos de la Provincia de Córdoba. *Publicaciones del Instituto de Fisiografía y Geología* 23: 1-47.

Church GE. 1903. A traveller in Patagonia. *Nature* 67, 321–322.

Clapperton CM. 1993. Nature of environmental changes in South America at the Last Glacial Maximum. *Palaeogeography, Paleoclimatology, Palaeoecology* 101: 189-208.

Claraz MG. 1864. Sur l'Equus bisulcus, de Molina. *Revue et Magasin de Zoologie Pure et Appliquee* 241-248.

Coltorti M, Abbazzi L, Ferretti MP, Iacumin P, Paredes Rios F, Pellegrini M, Pieruccini P, Rustioni M, Tito G, and Rook L. 2007. Last Glacial mammals in South America: a new scenario from the Tarija Basin (Bolivia). *Naturwissenschaften* 94: 288-299.

Conway W. 2005. *Act III in Patagonia: people and wildlife*. Island Press, Washington DC, USA. 344 pp.

Cox GE. 1863. *Viaje a las regiones septentrionales de la Patagonia. 1862-1863*. Imprenta Nacional, Santiago, Chile. Pg. 1-266.

Cruz I, Munoz AS, and Caracotche M. 2010. A huemul (*Hippocamelus bisulcus*) antler artefact in archaeological deposits of the Atlantic coast. Implications for human mobility and species distribution. *Magallania* 38, 287–294.

Dawilov. 1926. *Coihue*. Gmo. van Woerden & Cia, Buenos Aires. Pg. 1-103.

da Silva FM, da Silva Alves R, Franca Barreto AM, Bezerra de Sá F, and Borges Lins e Silva AC. 2006. A megafauna pleistocénica do estado de Pernambuco. *Estudos Geológicos (Brazil)* 16: 55-66.

Dabbene R. 1911. Sobre la existencia del huemul de Bolivia y Perú, *Odocoileus (Hippocamelus) antisensis* (Orb.) y del avestruz petiso, *Rhea darwini* Gould en el N.W. de la República Argentina. *Anales del Museo Nacional Buenos Aires, Serie 3* 14: 293-307.

de Agostini AM. 1941. *Andes Patagónicos: Viajes de exploración a la cordillera Patagónica Austral*. Talleres Gráficos Guillermo Kraft Ltda: Buenos Aires

de Agostini AM. 1945. *Andes Patagónicos: viajes de exploración a la cordillera Patagónica Austral*. (Vol. 1), Buenos Aires. Pg. 1-409.

de la Cruz L. 1836. Descripción de la naturaleza de los terrenos que se comprenden en los Andes, poseídos por los Peguenches; y los demás espacios hasta el río de Chadileubu. Pages 1-67 In: (Ed. de Angelis P) *Colección de obras y documentos relativos a la historia antigua y moderna de las provincias del Río de la Plata; ilustrados con notas y disertaciones*. Imprenta del Estado, Buenos Aires.

Diaz NI. 1993. Changes in the range distribution of *Hippocamelus bisulcus* in Patagonia. *Z. Säugetierkunde* 58:344-351.

- Díaz NI. 1995. Antecedentes sobre la historia natural de la taruca (*Hippocamelus antisensis*) y su rol en la economía Andina. *Chungara* 27: 45-55.
- Díaz NI, and Smith-Flueck J. 2000. *The Patagonian huemul. A mysterious deer on the brink of extinction*. Buenos Aires: Literature of Latin America.
- Díaz NI, Prieto A, and Bahamonde G. 2007. Guanacos tímidos, huemules confiados: el límite occidental de los cazadores terrestres australes. *Magallania*, (Chile) 35(1):133-138.
- Donoso D, Iriarte A, Segura B, and Tirado M. 2017. Antecedentes de Huemul (Capítulo 1). Pages 13-61 In: (Eds. Iriarte A, Donoso DS, Segura B, and Tirado M) *El Huemul de Aysén y otros rincones*. Ediciones Secretaría Regional Ministerial de Agricultura de la Región de Aysén y Flora & Fauna Chile Ltd, Aysen, Chile.
- Eastman CR 1915. Beginnings of American natural history. *The America Museum Journal* 15, 349–355.
- Eisenberg JF. 2000. The contemporary Cervidae of Central and South America. Pages 189-202 in: *Antelopes, deer, and relatives*, Vrba ES and Schaller GB (eds). Yale University Press: New York.
- Falkner T. 1774. *A description of Patagonia and the adjoining parts of South America: containing an account of the soil, produce, the religion, government, and some particulars relating to Falkland Islands*. Hereford, London, 1-144.
- Fernández OA, and Busso CA. 1997. Arid and semi-arid rangelands: two thirds of Argentina. Pages 41-60 in: *Proceedings from an International Workshop in Iceland. Rala Report no. 200*, Arnalds O and Archer S (eds). Agricultural Research Institute: Reykjavik.
- Fernandez PM, Cruz I, Bautista Belardi J, de Nigris M, and Muñoz S. 2016. La explotación del huemul (*Hippocamelus bisulcus*, Molina 1782) en la Patagonia a lo largo del holoceno. *Magallania* 44(1):187-209.
- Festa-Bianchet M. 2018. Learning to migrate. *Science* 361(6406):972-973.
- Flint RF, and Fidalgo F. 1969. Glacial Drift in the Eastern Argentine Andes between Latitude 41° 10' S. and Latitude 43° 10' S. *Bulletin of the Geological Society of America* 80:1043-1052.
- Flueck WT. 1989. *The effect of selenium on reproduction of black-tailed deer (Odocoileus hemionus columbianus) in Shasta County, California*. University of California, Davis, USA.
- Flueck WT, and Smith-Flueck JM. 2011. Recent advances in the nutritional ecology of the Patagonian huemul: implications for recovery. *Animal Production Science* 51(4):311-326.
- Flueck WT, and Smith-Flueck JM. 1993. Über das in Argentinien angesiedelte Rotwild (*Cervus elaphus* L., 1758): Verbreitung und Tendenzen. *Zeitschrift für Jagdwissenschaft* 39(3):153-160.

- Flueck WT, and Smith-Flueck JM. 2012a. Huemul heresies: beliefs in search of supporting data. 1. Historical and zooarcheological considerations. *Animal Production Science* 52: 685-693.
- Flueck WT, and Smith-Flueck JM. 2012b. Huemul heresies: beliefs in search of supporting data. 2. Biological and ecological considerations. *Animal Production Science* 52(8):694-706.
- Flueck WT, and Smith-Flueck JM. 2018. Radio marking the first group of endangered Patagonian huemul deer in Argentina. *J Neotrop Mammal* 25(2):461-465.
- Frailey D, Campbell KE, and Wolff RG. 1980. Additions to the knowledge of *Hippocamelus*, *Ctenomys*, and *Myocastor* from the middle Pleistocene of the Tarija basin, Bolivia. *Occasional Papers of the Museum of Natural History, University of Kansas* 85: 1-14.
- Gay C. 1847. *Historia Fisica y Politica de Chile: Zoologia*. Museo de Historia Natural de Santiago, Santiago, Chile. 495 pp.
- Gazzolo C. 2006. Botanical composition of taruka (*Hippocamelus antisensis*) diet during rainy season in Huascarán national park, Peru. In: *Advances in deer biology*, Bartos L, Dusek A, Kotrba R, and Bartosova J (eds). Research Institute of Animal Production: Praha; 216.
- Giai AG. 1936. Huemul, inofensivo venado de las soledades cordilleranas de la Patagonia. *La Chacra* (Arg.) 6(70):99-101.
- Gigoux EE. 1929. El huemul. *Revista Chilena de Historia Natural* 23: 573–82.
- Goni RA. 1988. Arqueología de momentos tardíos en el Parque Nacional Perito Moreno (Santa Cruz, Argentina). Pages 140-151 In: *Precirculados del IX Congreso Nacional de Arqueología Argentina*. Universidad de Buenos Aires, Buenos Aires.
- Goss RJ. 1983. *Deer Antlers: Regeneration, Function and Evolution*. Academic Press, New York, USA.
- Grosse A. 1949. El huemul - ciervo de los Andes y emblema del escudo Chileno. *Condor (Revista Chileno Alemana)* 12(22):10-12.
- Guérin C, and Faure M. 2009. The Cervidae (Mammalia, Artiodactyla) of the Upper Pleistocene/Lower Holocene deposits of the Serra da Capivara National Park Region (Piauí, Brazil). *Geobios* 42: 169-195.
- Guineo O, Guineo Garay R, and Garay G. 2008. *Conociendo al huemul de Torres del Paine*. La Prensa Austral, Punta Arenas, Chile. 94 pp.
- Günther A. 1875. Comments about Sclater and *Cervus chilensis*. Pages 44-46 In: *Proceedings of the Scientific Meetings of the Zoological Society of London*. Messrs. Longmans, Green, Reader, and Dyer, London.
- Haller H. 2002. Der Rothirsch im Schweizerischen Nationalpark und dessen Umgebung. Eine alpine Population von *Cervus elaphus* zeitlich und räumlich dokumentiert. *Nationalpark-Forschung Schweiz* 91:1-144.

Hatcher JB. 1903. *Reports of the Princeton University expeditions to Patagonia, 1896–1899. Vol. I: Narrative of the Expeditions. Geography of Southern Patagonia*. Stuttgart, Germany: E. Schweizerbart'sche Verlagshandlung.

Hauman L. 1926. Étude phytogéographique de la Patagonie. *Bulletin de la Société Royale de Botanique de Belgique* 58(2):105-179.

Hershkovitz P. 1969. The recent mammals of the Neotropical region: A zoogeographic and ecological review. *The Quarterly Review of Biology* 44: 1-70.

Hershkovitz P. 1972. The recent mammals of the neotropical region: a zoogeographic and ecological review. Pages 311-431 in: *Evolution, mammals, and southern continents*, Keast A, Erk FC, and Glass B (eds). State Univ. New York Press: Albany, New York.

Hoffstetter R. 1963. La faune pleistocene de Tarija (Bolivie). Note preliminaire. *Bulletin Muséum National d'Histoire Naturelle* 35: 194-203.

Horkheimer H. 1960. *Nahrung und Nahrungsgewinnung im vorspanischen Peru*. Colloquim Verlag: Berlin.

Housse PR. 1953. *Animales salvajes de Chile en su clasificación moderna: su vida y sus costumbres*. Ediciones de la Universidad de Chile, Santiago, Chile. 189 pp.

Ibar Bruce J. 1973. *Aisen, hombres y naturaleza*. Imprenta de la Armada, Valparaiso, Chile. Pg. 1-164.

Iglesias RE. 1965. El huemul. *La Montaña* (Arg.) (7):26-28.

Jakopak RP, LaSharr TN, Dwinnell SPH, Fralick GL, Monteith KL. 2019. Rapid acquisition of memory in a complex landscape by a mule deer. *Ecology* 100(12):e02854. 10.1002/ecy.2854.

Jesmer BR, Merkle JA, Goheen JR, Aikens EO, Beck JL, Courtemanch AB, Hurley MA, McWhirter DE, Miyasaki HM, Monteith KL, and Kauffman MJ. 2018. Is ungulate migration culturally transmitted? Evidence of social learning from translocated animals. *Science* 361(6406):1023-1025.

Johnson L. 1976. Informe sobre una prospección arqueológica en magallanes. *Anales Inst. Patagonico, Punta Arenas* (Chile) 7:87-94.

Kolliker Frers A. 1969. Das Waidwerk und die autochthonen Cerviden in Argentinien. Pages 25–31 in: *Parque Diana*. Vogel CA, editor. München, Germany: Stefan Schwarz Verlag.

Krieg H. 1940. *Als Zoologe in Steppen und Wäldern Patagoniens*. Bayerischer Landwirtschaftsverlag, Muenchen, Germany. 197 pp.

- Krieg H. 1925. Biologische Reisestudien in Südamerika. V. Die chilenischen Hirsche. *Zeitschrift für Morphologie und Ökologie der Tiere* 4: 585-597.
- Laming-Emperaire A, Lavallée D, and Humbert R. 1972. Le site de Marazzi en Terre de Feu. *Objets et Mondes* 12(2):225-244.
- Latcham RE. 1935. Expedicion científica Macqueen al Aysen. *Boletin del Museo Nacional* (Chile) 14: 7-31.
- Liebermann J. 1962. Sobre la historia natural del huemul. *Anales de la Academia Argentina de Geografia* 6:157-168.
- Lingle S and Wilson WF. 2001. Detection and avoidance of predators in white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*). *Ethology* 107:125-147.
- Lydekker R. 1898. *The deer of all lands : a history of the family Cervidae, living and extinct*. R. Ward, London. Pg. 1-329.
- MacDouall J. 1833. *Narratives of a voyage to Patagonia and Terra del Fuego*. Renshaw and Rush, London. 320 pp.
- Magalhaes, RM, MG Mello, and Bergqvist LP. 1992. Os cervidas pleistocenicos da regio nordeste Brasileira. *Anais da Academia Brasileira de Ciencias* 64: 149-154.
- Magne de la Croix P. 1937. El huemul. *Caras y Caretas* (Buenos Aires) 40, 117.
- Markgraf V, and Kenny R. 1997. Character of rapid vegetation and climate change during the late-Glacial in southernmost South America. Pages 81-90 in: *Past and Future Rapid Environmental Changes: Spatial and Evolutionary Responses to terrestrial Biota*, Huntley B (ed). Springer-Verlag: Berlin.
- Marshall LG. 1988. Land Mammals and the Great American Interchange. *American Scientist* 76: 380-388.
- Massone M. 1984. Los paraderos tehuelches y proto-tehuelches en la costa del Estrecho de Magallanes. *Anales del Instituto de la Patagonia* 15:27-42.
- Machon JF, and Juarez FN. 2013. *Patagonia 1892 : diario del explorador suizo Dr. Francisco Machón*. Editorial Dunken, Buenos Aires.
- McClure MF, Bissonette JA, and Conover MR. 2005. Migratory strategies, fawn recruitment, and winter habitat use by urban and rural mule deer (*Odocoileus hemionus*). *Eur J Wildl Res* 51:170-177.
- Miller S, Rottman J, and Taber RD. 1973. Dwindling and endangered ungulates of Chile: vicugna, lama, Hippocamelus, and Pudu. *Transactions of North American Wildlife and Natural Resource Conference* 38:55-67.
- Molina JI. 1809. *The geographical, natural, and civil history of Chili*. Vol. 1. Longman, Hurst,



Rees, and Orme: London.

Moreira-Arce D, Pefiaranda DA, López R, Stipicic GJ, Hidalgo-Hermoso E, and Simonetti JA. 2021. Observations of a coastal population of huemul, *Hippocamelus bisulcus* (Artiodactyla: Cervidae) in Riesco Island, Magallanes Region, Chile: a conservation opportunity. *Mammalia* 85(4):291-295.

Morejohn GV, and Dailey DC. 2004. The identity and postcranial osteology of *Odocoileus lucasi* (Hay) 1927. *Sierra College Natural History Museum Bulletin* 1: 1-54.

Moreno FP. 1898. Apuntes preliminares sobre una excursion a los territorios del Neuquen, Rio Negro, Chubut y Santa Cruz. *Revista del Museo de La Plata* 8(1):200-459.

Moreno FP. 1899. Explorations in Patagonia. *Geogr J* 14: 241-69.

Moreno PI, Villagran C, Marquet PA, and Marshall LG. 1994. Quaternary paleobiogeography of northern and central Chile. *Revista Chilena de Historia Natural* 67:487-502.

Moser CA. 1962. *The bighorn sheep of Colorado: a review of Colorado's bighorn sheep studies*. Technical Publication No. 10. The Colorado Game and Fish Department, Denver, Colorado, USA. Pg. 1-49.

Musters RN. 1871. A year in Patagonia. *J Royal Geogr Soc London* 41:59-77.

Myserud A, Loe LE, Zimmermann B, Bischof R, Veiberg V, and Meisingset E. 2011. Partial migration in expanding red deer populations at northern latitudes – a role for density dependence? *Oikos* 120:1817-1825.

Neveu-Lemaire M, and Grandidier G. 1911. *Notes sur les mammifères des hauts plateaux de l'Amérique du Sud*. Imprimerie nationale, Paris. Pg. 1-127.

Onelli C. 1904. *Trepando los Andes*. Compania Sud-Americana de Billetes de Banco, Buenos Aires. 297 pp.

Onelli C. 1905. El huemul. Su patria: su vida. *Revista del Jardin Zoológico de Buenos Aires* Epoca II. Vol. I.(4):370-374.

Osgood WH. 1923: in Patterson BD. 1983. The journal of Wilfred Osgood: The Marshall Field Chilean Expedition of 1922-23. *Field Museum of Natural History Bulletin* 54(2): 8-11; 28-33.

Paillan JT, and Tello GE. 2012. Los recursos naturales y culturales, 28 de Noviembre, Guer Aaike. Santa Cruz: su importancia turistica y patrimonial. *ICT-UNPA-35-2012*. Pg. 1-15.

Pefaur J, Hermosilla W, DiCatri F, Gonzalez R, and Salinas F. 1968. Estudio preliminar de mamíferos silvestres chilenos: su distribución, valor económico e importancia zoonótica. *Revista de la Sociedad de Medicina Veterinaria (Chile)* 18: 3-15.

Pennant T. 1793. *History of quadrupeds*. (3rd). B & J White, London.

Perez AE, and Batres DA. 2008. Los otros cazadores. Explotación de cérvidos en la Localidad Arqueológica Meliquina, Parque Nacional Lanin, República Argentina. Pages 89-107 in: *Zooarqueología hoy. Encuentros Hispano-Argentinos*, Díez JC (ed). Universidad de Burgos: Burgos.

Philippi RA. 1857. Über den Guemul von Molina. *Archiv für Naturgeschichte* 23:135-136.

Philippi RA. 1873. Zoología: Sinonimia del huemul. *Anales de la Universidad de Chile* 717-722.

Philippi RA. 1892. El guemul de Chile. *Anal. Museo Nac. Chile, Primera Seccion Zoologica* 2:1-9.

Prichard HH. 1902a. *Through the heart of Patagonia*. New York: D. Appleton and Co.; 346 pp.

Prichard HH. 1902b. Field notes upon some of the larger mammals of Patagonia made between September 1900 and June 1901. *Proceedings of the Zoological Society of London* 1, 272-277.

Prichard HH. 1910. *Hunting camps in wood and wilderness*. London: William Heinemann; 274 pp.

Prothero DR, and Foss SE. 2007. *The Evolution of Artiodactyls*. JHU Press: Baltimore.

Pulliam HR. 1988. Sources, sinks, and population regulation. *Am. Naturalist* 132:652-661.

Putman R, and Flueck WT. 2011. Intraspecific variation in biology and ecology of deer: magnitude and causation. *Animal Production Science* 51(4):277-291.

Rabassa J, and Coronato A. 2009. Glaciations in Patagonia and Tierra del Fuego during the Ensenadan Stage/Age (Early Pleistocene–earliest Middle Pleistocene). *Quaternary International* 210: 18-36.

Rabassa J, Coronato A, and Martínez O. 2011. Late Cenozoic glaciations in Patagonia and Tierra del Fuego: an updated review. *Biological Journal of the Linnean Society* 103: 316-335.

Ramirez Morales F. 1991. Apuntes para una historia ecológica de Chile. *Cuadernos de Historia* 11:149-196.

Rasmussen, PC. 1994. Geographic variation in morphology and allozymes of south american imperial shags. *The Auk* 111(1):143-161.

Re A, Delaunay AN, and Ferraro L. 2005. Grabados en la meseta del lago Strobel (provincia de Santa Cruz, Argentina), el sitio laguna del Faldeo Verde. *Relaciones de la Sociedad Argentina de Antropología* XXX. 30:245-256.

Reichlen H. 1959. Huemul in Fell's Cave, Chile: Specimen MNHN-2M-MO-1988-211. *Museum National d'Histoire Naturelle, Paris (France)* <http://coldb.mnhn.fr/catalognumber/mnhnizm/mo-1988-211>

- Ringuelet RA. 1946. Serie Técnica y Didáctica Nr. 2: Temas de Ciencia Naturales. ProBiotA (2003). División Zoología Vertebrados, Museo de La Plata: Argentina.
- Roulin M. 1835. Mémoire pour servir a l'histoire du tapir: et description d'une espece nouvelle (le tapir pinchaque) appartenant aux hautes régions de la Cordillere des Andes. *Mémoires des Savans étrangers* 6:5-112.
- Saavedra B., and Simonetti J.A. 1991. Archaeological evidence of Pudu pudu (Cervidae) in central Chile. *Z. Saeugetierkunde* 56:252-253.
- Santos Gollan J. 1946. *Contribución al conocimiento de los mamíferos del Parque Nacional de Nahuel Huapi*. Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Argentina. Pg. 1-66.
- Slater PL. 1873. Remarks on *Cervus chilensis* and *Cervus antisiensis*. *Journal of Natural History Series* 4 11(63):213-214.
- Slater PL. 1875. On *Cervus chilensis*. *Proc. Zool. Soc., Lond.* Feb. 2:44-47.
- Serret A. 1990. Observaciones preliminares de huemul, *Hippocamelus bisulcus*, en el lago Nansen del Parque Nacional Perito Moreno, Provincia Santa Cruz. Fundacion Vida Silvestre Argentina, Buenos Aires, 23 pp.
- Sierralta D. 2003. La microhistología de fecas para el estudio de dieta del huemul. In: *Huemul Ecology Research for Conservation Planning*. Darwin Initiative (ed). Cochrane: Chile; CD ROM.
- Silveira MJ. 1979. Analisis e Interpretacion de los Restos Faunisticos de la Cueva Grande del Arroyo Feo. *Relaciones de la Sociedad Argentina de Antropologia* 13:229-253.
- Simmonds PL. 1883. *A dictionary of useful animals and their products*. E. & F.N. Spon, London. 136 pp.
- Sinclair C. 2009. Daily life among the fishermen of the fog. Page 41-48 in: *Fishermen of the fog: The Changos and their ancestors*. Museo Chileno de Arte Precolombino, Santiago, Chile.
- Smith-Flueck JM. 2003. The ecology of huemul (*Hippocamelus bisulcus*) in Andean Patagonia of Argentina and considerations about its conservation. Doctoral Dissertation, Universidad Nacional Comahue: Argentina.
- Stankowich T. 2008. Tail-Flicking, Tail-Flagging, and Tail Position in Ungulates with Special Reference to Black-Tailed Deer. *Ethology* 114:875-885.
- Stankowich T and Coss RG. 2006. Effects of predator behavior and proximity on risk assessment by Columbian black-tailed deer. *Behavioral Ecology* 17(2):246-254.
- Steffen H. 1895. Die Erforschung de Rio Puelo. *Petermanns Geographischen Mitteilungen* 41(8):190-193.

- Steffen H. 1897. Die chilenische Aisen Expedition. *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* 24:461-474.
- Steffen H. 1900. Reisen in den Patagonischen Anden. *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* 27(4):194-220.
- Steffen H. 1910. Viajes de exploracion: estudio en la Patagonia occidental 1892-1902. *Anales de la Universidad de Chile* 2(50):1-419.
- Steward JH. 1946. *Handbook of South American Indians. Volume 1. The marginal tribes.* (Smithsonian Institution: Washington, D.C.)
- Stringham SF and Rogers LL. 2017. Fear of Humans by Bears and Other Animals (Anthropophobia): How Much is Natural? *Journal of Behavior* 2(2):1009.
- Tarifa T, and Yensen E. 2001. Mammals of Bolivian Polylepis woodlands. *Revista Boliviana de Ecología y Conservación Ambiental* 9: 29-44.
- Tatura A, del Valle R, Bianchi M, Outes V, Villarosa G, Niegodzisz J, and Debaene G. 2002. Late Pleistocene palaeolakes in the Andean and Extra-Andean Patagonia at mid-latitudes of South America. *Quaternary International* 89: 135-150.
- Teta P, and Rodríguez D. 2020. Mammalogy National Collection (MACNMa). Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia' (MACN): Occurrence dataset doi.org/10.15468/ukdxqp
- Thirgood SJ. 1995. The effect of sex, season and habitat availability on patterns of habitat use in fallow deer. *J. Zool., Lond.* 235:645-659.
- Tonko J. 2008. Kawesqar travel narratives. *Onomazein* 18(2):11-47.
- Torrejon F. 2001. Variables geohistoricos en la evolucion del sistema economico Pehuenche durante el periodo colonial. *Revista Universum* (Chile) 16:219-236.
- Via S, Gomulkiewicz R, DeJong G, Scheiner CD, Schlichting SM, and Van Tienderen PH. 1995. Adaptive phenotypic plasticity: consensus and controversy. *TREE* 10(5):212-217.
- Vidaurre FG. 1782. *Des Herrn Abts Vidaure kurzgefasste, geographische, natürliche und bürgerliche Geschichte des Königreichs Chile.* Carl Ernst Bohn: Hamburg.
- von Colditz R. 1925. *Im Reiche des Kondor.* Paul Parey, Berlin, Germany. 415 pp.
- Wagner JU. 1855. *Die Säugthiere in Abbildungen nach der Natur.* L.D. Weigel, Leipzig, Germany.

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Webb SD. 1978. A history of savanna vertebrates in the New World. Part II: South America and the Great Interchange. *Annual Review of Ecology, Evolution, and Systematics* 9: 393-426.

Wolffsohn JW. 1910. Notas sobre el huemul. *Revista Chilena de Historia Natural* 14:227-34.