# THE PATAGONIAN HUEMUL

## A Mysterious Deer on the Brink of Extinction

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# The huemul (*Hippocamelus bisulcus* Molina, 1782): A historical perspective

# 1

## INTRODUCTION

Patagonia is located in the southern tip of the South American continent, a huge territory of more than 900,000 square kilometers. This roughly triangular region stretches from the Río Colorado in Argentina and Valdivia in Chile south to Tierra del Fuego. The Patagonian landscape offers abrupt contrasts: mesetas and terraces to the east, characterized by steppe shrubs and bunchgrass vegetation, and the Andes to the west, covered by lakes of glacial origin, courses of water, and thick forests. The exploration of this region by Europeans dates from the 16th century. Early chronicles indicate that the former indigenous peoples hunted the huemul for the meat and hides. In the past, this Andean deer appears to have been abundant. However, with increasing settlement at the end of the 19th century and the introduction of ovine and bovine husbandry, the natural landscape of Patagonia commenced to suffer a profound modification with the subsequent impact on the native flora and fauna. At present, the huemul has vanished from much of its original range.

The purpose to unfold some data of interest on this deer compels us to retrace the way through the course of time. This report is based on narratives of exploring parties and travelers of ancient times, natural historians and other available literature on ethnography, ethnohistory and archaeology. Thus, the reconstruction of the huemul history has been placed within a broad context. Based on these data, I intend to provide a wide perspective on the huemul in its environment and its relationship with humans in the past.

## EARLY DAYS

The earliest description of the huemul was made in 1782 by the Jesuit clergyman Giovanni Ignazio Molina (1740-1829), a pioneer of the zoological history of Chile. He described it from hearsay information as a kind of horse under the name of *Equus bisulcus* in his *"Saggio sulla storia naturale del Chili"*. Molina did not embrace any particular branch of science and many of the descriptions of Chilean mammals are vague or inaccurate, although his contribution to South American mammalogy was exceptional. The French naturalist Claudio Gay made the earliest mention of the antlers in his *"Historia Física y Política de Chile"*. In 1834 the Chilean government resolved to depict the huemul on the coat of arms, along with the Andean condor, and this decision destined him to become a significant piece of the national patrimony. It was Juan Ladrillero[1] exploring the Estrecho de Magallanes in 1557-58 who first reported sightings of these deer in Chile, as he commented "...and then we went up to the place

known as the Deer Point, where in just an hour two of our harquebusiers shot fifteen of them...". This observation corresponds to the surroundings of what is now Última Esperanza, Magallanes province. It is not until 1591 that these deer are observed for the first time in Puerto Deseado, Argentina, when Thomas Cavendish[2] sailed along the coast of South America and entered the Estrecho de Magallanes.

The position of the huemul within the Class Mammalia is the following: Order Artiodactyla, Suborder Ruminantia, Infraorder Pecora, Superfamily Cervidae, Family Cervidae, Subfamily Odocoileinae, Tribe Odocoileini, Genus *Hippocamelus*, Species *bisulcus*. The evolutionary history of Cervidae is still rather obscure though is currently being studied by modern genetic techniques. Antlered forms first appeared in North America in the Early Pliocene and it is presumed that the deer entered South America in the Late Pliocene. The South American forms are represented by only one subfamily (Odocoileinae) and six genera. *Hippocamelus* would have a comparatively recent origin since the earliest evidence are remains found in deposits of Pleistocene Age in Argentina, Chile, Bolivia, Ecuador and Uruguay.[3] There are two extant species for this genus: *bisulcus* (Molina, 1782) and *antisensis* (d'Orbigny, 1834), the latter commonly named "taruca". Both species are allopatric. The taruca is found in the Andean highlands from Perú south into western Bolivia, northwestern Argentina, and northern Chile. These species have a close general resemblance but the huemul is slightly larger and the point of bifurcation of the branches is slightly further up from the burr.

Former confusions on its true nature generated an unusually complicated synonymic history.[4] The generic name *Hippocamelus* is a combination of the Greek terms ιππος + καμηλος. The first one (*hippos*) means "horse" or "mare" and the second (*camelus* in Latin) means "camel". *Bisulcus* is a Latin word that means "having two furrows; cloven", but it is not referred to the forked antlers, but to the hoofs. This term passed to the Spanish language and formerly it was applied to the artiodactyls. According to the dictionary of the Royal Spanish Academy "*bisulco, -a*" means "two-hoofed". It was used as a common name in the Official Report "La Sierra de Curamalal (Currumalan)" presented by Eduardo L. Holmberg (1884) to the Governor of Buenos Aires, Dr. Dardo Rocha. It says, "Regarding the bisulcos we brought a Stag hunted by Mr. Guillermo Casey near the Sierra where we have encountered many pairs, also in the field, as well as herds of about 50 or 60 Guanacos". Other authors thought the huemul was akin to a South American camelid, a type of llama. In 1816 Leuckart *(Dissertatiuncula Inauguralis de Equo bisulco Molina:23)* made it the basis for the new genus *Hippocamelus*: camel similar to a horse and, meaningfully, substituted the specific name *dubius* (= doubtful). The huemul was also designated *Auchenia huamel* Smith, 1827 *(Griffith's Animal Kingdom, 5:764)*, *Cervus (Cervecuus) andicus* Lesson, 1842 *(Nouveau Tableau du Règne Animal:173)*, *Cervus chilensis* Gay and Gervais, 1846 *(Annals des Sciences Naturelles:91)*, *Capreolus leucotis* Gray, 1849 *(Proceedings of the Zoological Society of London:64)*. It was wrongly placed in different genera such as *Furcifer*, *Huamela*, *Xenelaphus*, *Creagroceros*, *Cariacus* and *Mazama.* It was too late when doubts on its true nature cleared away. By application of the Law of Priority of the International Code of Zoological Nomenclature the name *Hippocamelus bisulcus* (Molina, 1782) is today maintained.

The huemul holds many indigenous names.[5] José T. Medina noted in his study on Chilean vocabulary of the flora and fauna that the word *huemul* -quoting Father Luis de Valdivia- has an Araucanian origin, *huamul*, "although Rodolfo Lenz believes that *huemul* is also an indigenous primitive form". In the Alakaluf language of the canoe people of western Patagonia the term *yekchal* was recorded for its two varieties. For the northern Alakaluf it was recorded on the Isla Wellington by Joseph Emperaire (*jektsal*, "cerf"), Christos Clairis (*jeqcal*, "huemul") and Oscar Aguilera (*yekcál*, "huemul"). In 1688-89 the corsair Jean de la Guilbaudière recorded the term *jegel* ("un cerf") on the northern coast of the Estrecho de Magallanes for the central Alakaluf dialect. Junius Bird collected this term on the western

part of the Estrecho de Magallanes from the Alakaluf that spoke the northern and central dialects. He wrote it *yuk-chal*, *ek-chal*, *yik-chal* ("deer", "ciervo"). Of particular note is the belief of the linguist Pedro Viegas Barros that in the Alakaluf tongue of the Isla Wellington the name of the cattle, *yeqcalayeq* (= *yekchalayek*), derives from its name. Apparently, these Indians only knew two ungulates: the huemul and the guanaco (*Lama guanicoe*). On the northern coast of the Estrecho de Magallanes two navigators collected a word that was likely used to designate the huemul: *cossini* (Oliver van Noort[6]), "a name of a quadruped", and *halchun* (Richard W. Coppinger[7]), "deer". The phonetics of the latter term is **qhalcon ~*qhason*. The indigenous names recorded for the three Tehuelche subgroups of eastern Patagonia are as follows: *sunam* in Gununa'Kena (Northern Tehuelche), *soonom* in Teushen (Northern meridional Tehuelche) and *soonem* or š*oonem* in Aónikenk (Southern meridional Tehuelche). The Tehuelche name is not a related term to the three tongues but a linguistic loan: Teushen is closely related to Aónikenk but Gununa'Kena is remotely allied with Teushen and Aónikenk. Furthermore, the term s*unam* (Gununa'Kena) passed to the Argentine Araucanian as *šunám* to designate a type of deer.[8] The Pehuenche, the piñon-eaters of the high cordillera of southern Mendoza and Neuquén provinces, named the huemul *schenam* as registered by the Swiss voyager Georges Claraz[9]. He also recorded the term *cisnal* or *cisnam* for this deer among the Creoles at Carmen de Patagones, Río Negro province.

*H. bisulcus* has a stocky build and relatively short legs. It swims with ease and when pursued it readily enters the water to escape. Body measurements for adult males average 900 mm at shoulder height and 1,630 mm for total body length. Adult females average 810 mm at shoulder height and 1,510 mm for body length. The average ear length is 170 mm, that of the tail 130 mm. Body weight is 60-90 kg. The male differs from the doe in larger size and stouter neck. Some individuals, often adult males, have a dark Y-shaped facial pattern that extends along the muzzle and above eye-level. The pelage is dense and brittle, and the general color is dark brown. The hair length is 30-70 mm. Each hair has three subterminal rings: the basal two thirds are ashy, then pass gradually into light brown, with a subapical yellowish ring and a blackish tip. The hairs are wavy and flattened in the curves, and the air trapped among the cells of the inner layer confer low-temperature tolerance[10]. The winter coat is paler, often with a gray or yellow cast, and when the second annual shedding occurs in spring, it shows gray spots that give a peculiar appearance. The coat is shed in big clumps much like the mountain goat (*Oreamnos americanus*) and upon appearance may give the impression of a sick animal to the inexperienced observer[11]. The anal and inguinal areas and the lower surface of the tail are white; the inner surface of the ears and the areas around the eyes are whitish. Only the males bear a bifurcated set of antlers about 200-250 mm in length (from burr to tip of hind beam). Occasionally three or four supernumerary tines may occur, although the explorer and naturalist Hesketh H. Prichard reported heads with as many as eight points. Male fawns grow the first set of antlers at about 18 months of age. Antler growth and velvet shedding are completed by December.

Both sexes of this species have lower canine teeth that do not protrude beyond the lip. Tarsal glands are present but metatarsal glands are absent. The diet consists primarily of herbaceous plants but also woody browse, especially during autumn-winter. Activity is mainly diurnal, and they move over home ranges of about 300-700 ha. Behavior patterns are not well known. Solitary individuals are common, but an adult male may associate throughout much of the year with an adult female, and occasionally with several adult females (see chapter 3, this volume). Rutting takes place in March-May, and birth occurs in November-December after a gestation period of 6-7 months. Females usually give birth to a single unspotted fawn.

This Andean deer has keen senses of sight, smell and hearing. It has been known for its curiosity and confidence, and apparently it changes its behavioral pattern depending on human harassment: mis-

trustful and careful or tame and trustful, according to the little or no prior contact with people.[12] Early the 20th century, in the woods close to the Galician colony 16 de Octubre in the Chubut province, Argentina, the huemuls were wilder, and the hunter that could hunt one would win a feather for his cap.[13] In contrast, in Ultima Esperanza, Chile, and in the vicinity of Lago Argentino, Argentina, the local landowners got them accustomed to approaching their houses to feed them, particularly in winter, when the food was scarcer. When they were not yet subjected to pursuit as relentlessly as in the following years, these deer used to come down from the mountains and roam about with the livestock and not on a few occasions did they go into the stock yards.[14] Prichard[15] made reference to their lack of wariness as observed on the western bank of the Río Los Antiguos, Santa Cruz (Argentina). On one occasion three does got so close to him that a huemul even sniffed his boots before proceeding to follow him as he moved away. On their voyages into Patagonia's vast wilderness in the early 20th century, Prichard[16] as well as Carl Skottsberg, John B. Hatcher and Robert and Katherine Barrett confirmed how readily these deer could be shot at very close range. Prichard's account of the animal's behavior tallies with the observation of the zoologists Max Biraben and his wife, María I. H. Scott. They believed that the naïveté and lack of wariness of this animal "would account for its habit of freezing in certain instances: when pursued by dogs or when caught by man. In such circumstances it stands motionless and at the mercy of the chasers. The animal's behavior is the same even if the chasers do it no harm. He will let himself die on the site, which could be in the middle of a stream, even after he is completely out of danger".[17]

In the early 1900s, observations of huemul behavior in southern Argentina revealed that when fleeing, the offspring go first followed by the does and finally the males. The running gait is agile but aimless, and once caught it does not fight back nor does it use its antlers to attack. When taken young, it is tamed and tolerates the captivity better than the adults. There are only a few records of the semi-captivity of this animal. One such attempt was made by Santiago Radboone,[18] a hunter for the Buenos Aires Zoo, Argentina. He used to have some huemuls on his small property close to the Lago San Martín (Santa Cruz) that even had had several offspring. The naturalist Andrés G. Giai[19] noted that some Neuquén residents bottle fed the offspring and then set them free. In the Zoo Station of Isla Victoria in Nahuel Huapi National Park, Neuquén, some huemuls were kept for several years, but in other instances the animals died during the 30 minute transfer to the island due to capture stress.

An attempt to keep this animal in captivity is traced back to 1932 when Adolfo Dago Holmberg was director of the Buenos Aires Zoo.[20] Lacking knowledge on this species at that time and concern about the population decline, Holmberg proposed to keep some deer in the Zoo. Clemente Onelli had made a similar attempt when he held the same position as Holmberg, but on this occasion the animals captured died on their way to the Zoo. In the summer of 1933, Holmberg planned an exploration in the surroundings of Lago Argentino, Santa Cruz, which was not successful as not a single animal was found. In view of the difficulties, he decided to commend the task to Radboone who succeeded in capturing some animals. Nevertheless, after crossing the Patagonian plateau to the Atlantic coast for shipment, the animals began to die and only one survived until a few hours before arriving at Buenos Aires.[21] There have also been some attempts in Chile to hold them in captivity. In 1941 a buck was taken to the Santiago Zoo but it refused to eat and died 15 days thereafter.[22] In 1972 a huemul died in the Chillan Zoo, 10 days after capture.[23] The following year two bucks and two does were kept in captivity on the Isla Dawson in the Estrecho de Magallanes to determine the biological aspects of the species. One of the bucks arrived dead and the rest died between six and ten months thereafter. The post-mortem report showed that this species is extremely susceptible to the coccidiosis of the domestic sheep and revealed many physical and parasitological disorders.[24] Attempts at live capture have not been very

successful in the past. However, capture, transportation, chemical immobilizacion techniques and captivity of hoofed animals have improved greatly in the last years.

## HISTORICAL RANGE

The huemul is a medium-sized deer of rugged terrain and steep mountain slopes. It is principally found in forest and dense shrub cover areas (see chapter 3, this volume). Seasonal altitudinal movements have been reported, with summer ranges being generally higher than winter ranges. The species is endemic to southern Argentina and Chile. Formerly the huemul ranged along the Andes from about 34° S in Chile and 36° 50' S in Argentina to 54° S. Early reports mention it occurring on some Pacific coast islands such as Wellington, Riesco and Englefield and in certain areas it extended its range to the Atlantic coast[25] (see Annex, this volume). Although there are no historical accounts for other islands, it is possible that the huemul inhabited some of them at one time considering that this animal swims with ease. Its presence on Tierra del Fuego is poorly documented. G. R. Waterhouse[26], who reported the mammals collected by Charles Darwin, registered on his voyage of 1834 the existence of a "deer", and the Argentine explorer Ramón Lista[27] noted the occurrence of the huemul in his 1881 publication. Up to the present, *Hippocamelus* sp. has been absent in the archaeological record of the island. As things stand, I am not able to say with certainty whether or not the huemul was ever present on Tierra del Fuego.

The historical range of the huemul shown in Fig. 1 is based on historical accounts and assumed habitat conditions existing before the arrival of European man. The bulk of the distributional data has been obtained from travelers accounts, early chroniclers, scientific expeditions for field observation, and natural history observers.[28] Most of the evidence of voyagers come from the Andean region and the Magallanic channels due to their interest in exploring and establishing themselves in both areas. This resulted in an abundance of data for both areas while vast regions of the territory remained unexplored for a long time. Furthermore, early travelers found only two natural ports on the Atlantic coast to offer shelter to shipping: Puerto Deseado and Bahía San Julián (Santa Cruz); hence most historical references correspond solely to both coastal localities.

Writing in 1873 on the huemul Philip L. Sclater[29] stated, "It may be objected that the name chilensis is inappropriate as the animal is more particularly Patagonian than Chilean". Archaeological findings and historical evidence have shed new light on this point. As early as the voyage of Thomas Cavendish[30] in 1591 to the South Seas, deer were found near Puerto Deseado, Santa Cruz. Furthermore, a manuscript housed in the British Museum labeled "Add. M. 17603", presumably from the 18th century, describes the Atlantic coast of Patagonia and refers to the presence of deer in this area. Also in Cabo Blanco, near Puerto Deseado, the Beagle's crew hunted deer during the voyages of 1832 and 1833[31]. The question that remains is why the deer were not recorded by more travelers near Puerto Deseado in historic times. There are two factors that may account for this. It should be considered that these trips rarely had a naturalistic purpose and that the final destination was generally the Estrecho de Magallanes. Moreover, there is evidence of changes in the volume of the Río Deseado and thus the landscape of the surrounding areas would be modified. Research on the Deseado formation attest to a deposit of temporary and intermittent stream typical of arid or semiarid regions.[32] Deer were also recorded on the Atlantic coast at Bahía Camarones (Chubut), and in the area from Río Santa Cruz to the Estrecho de Magallanes (Santa Cruz). The last record to signal their presence on coastal areas was made by Francisco P. Moreno[33] towards the end of the 19th century.

During hydrographical studies carried out in 1900 in the plains of Santa Cruz (approx. 47ºS, 69º-70ºW), Argentina, Carlos Burmeister found two small groups of huemuls (6 and 12 individuals each). He described the zone as a broken tableland where the predominant vegetation was represented by calafate (*Berberis* sp.), molle (*Schinus o'donelli*) and mata negra (*Verbena tridens*). At an earlier time, in 1884, when some explorers traveled in the Río Negro province, these deer were observed near the hills south of Río Chubut, far from the forested region.[34] Another interesting record was published in 1905 by the Buenos Aires Zoo.[35] By that time, in the banks along the Río Senguerr, Chubut, this species was found as far as Choique Nilahue ("Where the Ostrich Lives") situated near the junction with the Río Genoa. Furthermore, in the hilly area between the Río Chubut and Senguerr, Chubut, as far as 25 or 30 km from the coast, it was still possible to find various individuals. In the steppe of Magallanes province, Chile, the huemul was registered in historical times at Segunda Angostura, Laguna Blanca, San Gregorio, on the eastern coast of the Estrecho de Magallanes, and in the area between Punta Dungeness and Chabunco. With reference to the presence of the huemul far from the forested terrain, Clemente Onelli[36] indicated in 1905 that this species flanked the rivers to frequent the pampas.

Excavations at archaeological sites have yielded important information on this species (Fig. 2). The presence of huemul remains does not necessarily mean that it inhabited the surrounding areas, although the importance of the taxon present still remains. The available data from Argentina and Chile come from a number of sites located in the forest and ecotone areas: Alero IV del Tromen[37], Alero Las Mellizas[38], Alero Los Cipreses[39], Cementerio Río Limay[40], Alero del Chamán[41], Cerro Casa de Piedra[42], Alero Dirección Obligatoria[43], Las Guanacas[44], Alero Fontana[45], Dos Herraduras[46], Cabo Negro-Bahía Laredo[47], Punta Santa Ana-Bahía Buena[48], Punta Baja[49], Cueva Lago Sofía[50], e isla Englefield[51]. Furthermore, remains of huemul have been found at sites located in the steppe: Arroyo Feo[52], Entrada Baker[53], Cueva Fell[54] and San Gregorio[55]. Other sites have produced finds of Cervidae: Cuyín Manzano[56] and Cueva del Medio[57]. *Hippocamelus* sp. appears late in the archaeological record of arid Patagonia. This is probably due to two factors[58]: i) a late Holocene range expansion of the species to an arid environment, ii) incomplete sampling at the steppe sites. As of the present state of knowledge, important points remain unanswered: i) What kind of ecological events do the archaeological sites represent?, ii) What dietary regimes were available?, iii) How might environmental dynamics have influenced population densities and adaptations for reproduction?

If this species once inhabited the Argentine plains, and reached Uruguay in the Quaternary era as pointed out by Lucas Kraglievich[59], it could have reached Chile through accessible passes in relatively recent times. When referring to the area comprised between Lago Buenos Aires and Argentino (Santa Cruz), T. Hungerford Holdich suggested that the presence of these deer in the Chilean forest was evidence that they had found their way through Andean passes. Historic accounts for Argentina provide evidence that huemul abounded in the surroundings of four lakes: Tromen, Buenos Aires, San Martín and Argentino (early the 20th century a herd of over 100 individuals was reported near Lago Argentino). The number of animals observed in these areas contrasts markedly with the rest, where generally only two or four individuals were found. When, in 1871, Enrique M. Simpson started an expedition 6,5 km south of Estuario Quitralco, Chile, with the intention of finding a pass across the cordillera, the numerous deer observed in a valley made him suspect that they had come from Argentina where they were abundant. The presence of this species in the area was confirmed at archaeological sites in the Río Ibáñez valley[60], northern coast of Lago General Carrera-Buenos Aires. Field data gathered in studies carried out recently in Aisen (44º-49ºS), Chile, show that the geographic distribution is in most cases closely correlated to the eastern springs of the cordillera.[61]

If we take into account the localities where the huemul abounded in the past, we find that two of

the largest lakes (Buenos Aires and Argentino) in the Santa Cruz province, Argentina, are connected to major rivers draining west-east to the Atlantic Ocean, and that the Lago San Martín, Argentina, lies close to the Río Chico basin. Based on a review of historical information, it can be assumed that these deer originally inhabited the plains and that, considering their vulnerability, ecological changes, predators, human settlements or all of these together, the deer were compelled to migrate towards the mountains following the hydrographic basins of the major rivers. Something very similar could have occurred in northern Patagonia where the higher human density could have prevented a more fluid dispersal of the species to Chile across the cordillera. In the surroundings of the Río Limay, Neuquén, bone remains at excavations revealed the importance of this species as a food resource. Alternatively, we may suppose that this species still occupies the niche to which it is best adapted. However, the situation of the huemul is at present extremely precarious while the studies on habitat requirements and behavioral ecology are scarce.

One can support the hypothesis that in the past the huemul lived in Patagonia gradually migrating eastwards to the Atlantic coast. The alternative hypothesis holds the misidentification of the species as probable. Since the southern border of distribution of the pampas deer (*Ozotoceros bezoarticus*) is the northern Río Negro province[62] and a misidentification with the pudu (*Pudu puda*) is highly improbable, there are two alternatives to be considered:

i. Originally, the huemul lived in Patagonia and then retreated to the remote, undisturbed Andean areas. It is important to emphasize that the last records for the Atlantic coastal localities date from the end of the 19th century when the human activities increased. Analysis of a 10,000-year accumulation of owl pellets in Cueva Traful in southern Neuquén province in Argentina enabled O. P. Pearson and A. K. Pearson[63] and later O. P. Pearson[64] to show that an important faunal change occurred during the 20th century. Furthermore, T. Veblen and D. Lorenz reported prominent changes in vegetation during this period in the forest-steppe boundary in northern Patagonia.

ii. This species lived in the Andean forested habitats and occasionally reached the Atlantic coast. Environmental changes in the habitat may have initiated a migration of individual animals through corridors across inhospitable land. Pollen profiles covering the late and post-glacial era in Patagonia contain major vegetation changes that coincide with climatic fluctuations.

Available data are not enough to support either of the alternatives, although neither of them can be dismissed until more systematic studies are performed.

## HUNTING TECHNIQUES

Huemul hunting seemed to be difficult, not because of the deer aggressiveness but because of the harsh weather of the regions it inhabits. These areas are characterized by strong winds, rain and snow. When the first colonists settled towards the beginning of the 20th century in the surroundings of the Lago San Martín, Santa Cruz, herds of up to 50 individuals used to roam undisturbed until they started to disappear. As back as 1936 it was still possible to find many antlers in the vicinity, and even on the islands of this lake. Near Lago O'Higgins area, Chile, around 1,200 huemuls have been hunted in the 1920s and the hides were used to protect domestic animals.[65]

In the past, these deer have been hunted for subsistence purpose by the native Indians. The role

of the huemul as a food resource among the Patagonian hunters is not yet clear in the archaeological record. The abundance of guanaco at excavations contrasts markedly with that of huemul. This led to the assumption that these deer were a complementary form of sustenance. A recent study on the meat of diverse skeletal units of a male huemul has showed that it is lean[66]. The huemul was not an important prey in terms of fat and this fact together with the low population density[67], low predictability and smaller size compared with the guanaco[68] may have been part of the reasons for its low exploitation.

Summer was not the best time for huemul hunting because they were found above tree-line. Pursuing them became easier in winter when they came down to lower elevations for food. Historical observations are scanty and fragmentary. An early chronicle to serve as a reference was the account of Antonio de Córdoba. In 1785, this Spanish navigator and geographer touched the coasts of the Estrecho de Magallanes and became acquainted with deer hunting. He observed that apparently the hunting groups did not penetrate far into the woods to hunt the deer but awaited them on the banks of the lakes and rivers when they went to seek water. The presence of numerous dogs suggested to him that they were used in detecting the deer tracks, adding that it was not very difficult to capture them. The natives used bows and arrows or killed them "with poles or stones". A testimony on the groups frequenting the waters around the Isla Dawson is made by the German ethnologist Martin Gusinde, who –quoting Thomas Bridges- states: "These natives go as far as the Canal Barbara, and frequently visit the Patagonian coast where they killed wild cattle and deer. Deer abound in the western and densely-wooded districts of Patagonia, but are not found on any of the islands south of it".[69] When Gusinde further reports on the hunting, quoting Junius Bird, he says, "Deer are found on Chiloé, Wellington and Isla Riesco and Península Taitao and back in some of the bays and fjords. Pursuit is arduous, and only where the topography favored the hunters were any taken". This is corroborated by Francisco P. Moreno[70] as he noted, "The Indians inhabiting the Pacific channels south of Calen Inlet hunt the huemul in some valleys at the end of the numerous fjords".

Dogs helped in deer hunting among some Patagonian groups. In 1831, Robert Fitz Roy was in command of the *Beagle* to complete the explorations of Patagonia and Tierra del Fuego commenced by Cap. King during 1826-30. When the *Beagle* approached the large marine embayments of Hoyas Otway and Skyring, Magallanes, Fitz Roy encountered about 100 Indians whom he named Huemules due to the great number of skins they had of this animal. The Huemules lacked horses and had few canoes but they used very big dogs for deer hunting[71]. The French arqueologist Joseph Emperaire referred to deer hunting among the Indians of the archipielagos in "*Les nomades de la Mer*". When the prey was detected - he explained- the dogs swarmed over it. The terrified animal rushed uphill until some rocky promontory barred its way. Once captured, the killing technique was simple: they slew the animal with clubs or stones. But when the huemul worked their way downhill in winter to the lakes or rivers, they would probably take to the water in a desperate attempt to escape. In these instances the natives attempted to strike at it with harpoons from the canoe. In addition, Oscar Aguilera reports on a similar hunting method for the Alakaluf of the Isla Wellington, "To catch a huemul they also use dogs to drive the animal to a cliff and corner it, or it is pursued to the sea where the hunters wait for it with harpoons". Generally, the saw-tooth spear was used, or lacking this, a harpoon with a single or double bark and a point tied to the handle by a short thong[72]. Projectile points were also effective for deer hunting[73]: an example of this method is a huemul vertebra pierced by a triangular projectile point found in a cave situated in the steppe near Río Picún-Leufú valley, Neuquén[74].

The Swedish botanist Carl Skottsberg[75] made reference to the hunting in his account of the voyage to western Patagonia and Tierra del Fuego in 1907-09 to study the botany of the region. Skottsberg explains that when the natives of the area north of Canal Messier and the Golfo de Penas returned in

September from the winter seal hunt, they headed for the Río Baker to track huemuls. While women watched the boats, men scattered into the territory armed with bows and arrows and boleadoras which consisted of two round stones covered with leather and joined by a thong. On the voyages throughout Patagonia in the early years of the 20th century, the huemul was hunted by Prichard, who commented on the fine flavor and tenderness of the venison, even superior to that of guanaco and European deer. It is probable that the first woman to hunt a huemul was lady Florence Dixie[76]. Born in Douglas, England, she traveled with her husband Sir Alexander Beaumont Dixie in 1878 to Punta Arenas, Chile. The hunting in Torres del Paine, Magallanes, proved to be so pathetic due to the animal's defenseless behavior, that it deterred her from hunting such an unexciting game species.

The Patagonian hunters were accustomed to scorch or slightly roast the meat of the animals hunted and some drank raw the blood of freshly killed guanaco, the *Rhea* (local name ñandú) and the huemul[77]. In recent years, the Pehuenche Félix Manquel[78] (he died in 1983) recalled huemul hunting and the preparation of venison in the days when he, as a child, lived near Mamul Malal, Neuquén, "... Having a lasso handy you can tie him up, on foot or on a horse. But then he will try to go back uphill and will not walk. So you have to kill him or drag him, if he balks. We used to do that, in stormy days, when herds of huemuls came down from the Andes, we chose the fattest one to eat. We tied him up and dragged him home, to the hut. The head of huemuls, as well as the heads of guanacos and horses, we cooked by burying it in the ground under the fire. The next day we took it out cooked, and ate it with sauce. The skins came off easily, the meat stayed white and we ate everything, brains, tongue, eyes…".

Data on the presence of the huemul in southern Mendoza are meager[79]. The Indians lived in this province on diverse animal species and vegetables that changed with seasonal availability. According to the chronicler Diego de Rosales, among the preferred animal species were guanaco (*Lama guanicoe*), armadillos (Dasypodidae), vizcacha (*Lagidium*), ñandú (*Rhea americana*), hares (*Dolichotis*) and deer.[80] No references were found on the use of huemul's bezoar, a concretion found in the stomach and intestines of some animals and used by the Indians to treat certain diseases because of their attributed healing properties.

## PREPARATION AND USE OF SKINS

The animal skins have always been a basic element for the indigenous peoples, whether it be for their domestic economy or barter trade. Some indigenous groups that developed a canoe-based way of life to exploit marine food also used hides to construct the boats. There are numerous references of the use of skins for shelter, clothing and containers. One such account was authored by Fitz Roy. When he refers to the aborigines of the surroundings of the Hoya Otway, he says that "guanaco, as well as seal and otter-skins, are in their possession, therefore they probably barter with the Patagonians. They also have the skins and horns of a deer, which, as I understood them, inhabits their country. They catch small animals with snares, made of whale-bone, just like hare-snares". Chacon y Pery's accounts describing the explorations of commandant Richard Mayne in the channels during 1867-1869 attest to the use of skins. According to him, guanaco was abundant in the area between the Strait's eastern inlet and the Cabo Froward, Magallanes. On the contrary, he found deer abundant in the western section of the Strait since the Indians employed huemul skins more than those of seals. Fitz Roy mentioned the use of the skins in the same region to make quivers. In 1829 he encountered in the Hoya Otway a group of Indians in a canoe who resembled the Fueguian tribes for their weapons, except for the use of quivers made of deer-skins. Preserved huemul skins found at Cueva de las Manos[81] and skin remains recovered from a

burial spot at the locality Puesto El Rodeo[82] , both in Santa Cruz, are evidence of the use of deer skins in the domestic activities. Ancient explorers noted on their travels to the Patagonian channels that the skins were also employed as floor coverings inside tents although the hairs broke off easily. With respect to the Pehuenche, Luis de la Cruz[83] noted in 1835 that this group used the huemul skins for the manufacture of leather boots.

For shelter, the Tehuelche of eastern Patagonia mostly used guanaco hides, but huemul's as well. The framework of their huts consisted of rows of stakes and poles forced into the ground. The ends were bent over and tied to form an oval or circular foundation. The framework was then completely covered with hides sewn together. In even earlier times, the skins were used as windbreak. It consisted of hides sewn together and attached to a few poles stuck in the ground. One such reference is made by Ladrillero[84] in the narratives of his voyage to the Estrecho de Magallanes for a geographical survey of the region. By the winter of 1558 he had entered the western part of the Strait and explored the area and its natural resources. From his observations on the indigenous peoples he says that "their houses had sticks planted in the ground, where they put skins of guanacos, sheep and deer, so they were covered against the wind, and inside they put hay because it is warm, where they sit and lay to be warm…". Obviously, the mention of sheep is an error.

The use of hides for clothing against the rigors of the weather is mentioned since the earliest voyages of the 16th century. Antonio Vazquez de Espinosa made mention of the "Giant Patagones dressed with deer skins" in the narrative of his voyage. The skins of certain animals such as the guanaco (*Lama guanicoe*), fur seals (*Otaria byronia, Arctocephalus australis*), otter (*Lutra felina*), the coypu (*Myocastor coypus*), foxes (*Dusicyon*) and huemul furnished the clothing of the Patagonian natives. Some groups had the pretence of clothing in a strip of skin tied to the side or back of the body by a string around the waist or were enrobed in skins. In other instances a cape, sewn with the sinews of the ñandú, coypu or whale and fitting around the neck and extending to the knees, was the garment worn, except in the coldest weather when a kind of shoe served to protect their inferior extremities. On the Isla Campana, Ladrillero[85] observed that [the Indians] "were dressed with seal skins, deer and other animal skins, with which they cover their shoulders, that went down under their waist or sometimes down to the knees, and tied them up around their neck with a little thong. The skin went raw, with no treatment whatsoever, from the animal to men and the underpants did not exist". The chronicle of Miguel de Coicueta on the expedition of Francisco de Ulloa and Francisco Cortéz de Ojea in 1557-58, abundant in geographical discoveries, refers to the skin garment "made of seal and deer skins, not longer than below the waist", as observed among the native tribes of the Isla Wellington in Chile. Also Fray García Jofré de Loayza reported in 1526 on the aborigines of the Magallanic western inlet: "Their dresses are made of leather of deer, tied at the neck that covered them all the way down below their knees".[86]

The preparation process of the skins depended on the final use but the method consisted of a few basic steps[87] . Among the Alakaluf, for instance, Martín Gusinde reports that men's work was separated from women's work. The skinning was in the hands of the men whereas subsequent cleaning was the women's responsibility. The skin was then laid on a frame and stretched to its utmost tension to dry. When dried, it was scrapped on the inside to make the surface tolerably smooth. To soften a deer skin required much labor since the material is quite stiff. Four huemul skins sewn together to make a big cape or robe could measure about 115 to 170 cm, however, a single skin could also be enough for this purpose. The Alakaluf also employed the antlers and bones to make awls called *wáskalha*. They were shaped with a pumice stone to get them thin and women used them in basketry. In Argentina, the utilization of antlers and bones for the manufacture of awls and punches is supported by archaeological findings in the Neuquén province. [88]

Huemul skins were also used for a more perfected end: the leather shield[89]. From the end of the 17th century to the second half of the 19th century the Tehuelche adopted the leather shield as protection against spears and spades to mount organized raids. It was made from seven layers of huemul, guanaco and ox-hides. They also used a helmet made of colt leather. The Tehuelche shield resembles a tunic consisting of two pieces: the front piece was intended for chest protection, and the other for back protection. It reached above the knees and could weigh over 13 kilograms. The sleeves had fewer hides and were sewn at both sides from the neck down. The lower part was considerably wider for protection of the chest, abdomen and legs, but it did not allow easy movements. There are only three examples of this shield existing today: one in the La Plata Museum, Argentina, another in the Museum of Natural History in Santiago de Chile, and a third one in the Museum of the Man in Paris. The latter belonged to the collection of the Saint Germain de Laye Museum and in 1863 it was donated to the Museum of the Man by M. Grandidier. It was likely acquired by Dumont d'Urville, Alcides d'Orbigny or Louis Antoine de Bougainville. The shield was probably taken to France by Bougainville between 1766 and 1769. The indigenous peoples of Pampa-Patagonia borrowed this cultural trait from the Araucanian culture and it is reasonable to assume that the shield ceased to be used when firearms were introduced.[90]

Towards the end of the 19th century, the huemul drew the attention of the Swiss voyager Georges Claraz[91] who believed it strange that no one showed an interest in this deer earlier, especially considering that their skins had been shipped from Carmen de Patagones (Río Negro, Argentina) to Europe via Buenos Aires for almost half a century. Some local tradesmen at Carmen de Patagones knew that the Tehuelche used the hides to make their shields, but no one gave details about the animal. Others contended that it resembled the mule because of the size of the ears. What became of this trade is uncertain, however, Claraz believed that when the value of the skins began to decline, the Tehuelche ceased to trade them.

## CAVE PAINTINGS AND MUSIC

The indigenous peoples were close observers of the animals that shared their habitat and depicted some of them in rock paintings. The animals constitute the largest subject of these paintings, most probably those that had a crucial economic significance. Moreover, they were depicted in the belief that it was possible to appropriate something of the power inherent in the animal.

In the region comprised between the Santa Cruz and Chubut basins (Santa Cruz, Argentina) are important archaeological sites of the native cultures. Right near Río Pinturas are several localities known for their wall paintings. The rock art in this area extends back by around 8,000 years BP[92]. Subsistence was heavily dependent on the consumption of guanaco and this animal is mainly recorded in rock art against only three possible representations of the huemul[93]. At Cueva de las Manos, a site located at the base of a stepped cliff, the same pigments found on a scapula of huemul that served as a palette were used by the natives to produce the paintings. The two archaeological layers of these drawings have been dated to around 4,600 and 2,300 years BP[94].

There was another possible pictorial representation of the huemul. About 25 km from the origin of the Río Limay, Neuquén, there is the famous cemetery that bears the name of the river. A few meters from its bank a reddish crag contained a human figure alongside the front part of a horned quadruped done in red ochre. The archaeologist Milcíades Vignati[95] speculated that it was the representation of a huemul. Unfortunately, this rock was removed to place a memorial monument of Carlos Ortíz Basualdo, the discoverer of the ruins of the Jesuit Mission in Lago Nahuel Huapi. The huemul occur rarely in rock

art and this could be explained by the abundance of guanaco and its economic significance.

Scrutinizing the ethnographic record of the Patagonian natives, one finds only a faint image of the huemul. A trace of it can be gleaned in the music of the group Kawéskar or Alakaluf.[96] The musical repertoire of this reduced group of Puerto Eden, situated along the western coast of the Isla Wellington in the Magallanes province, consisted exclusively of songs which were sung without gestures and corporal or instrumental percussion. The themes are often descriptive and the text are brief sentences. One of them refers to *yeqchal*:

*yeqchal* "deer of the Andes"; *yetenaq* "it runs"; *narhatawan* "it defecates"; *aqseptawan* "it is on the side of a hill"; *yefaytawan* "it eats"; *yenaqtas* "looks everything around"; *qayasa* "?".

## SUNAM: REAL OR UNREAL?

It is difficult to find tracks of the huemul in the Andean surroundings, but it is even more difficult to trace it in Indian legends. Only one of these arose among the Tehuelche and it was made known by Fray Mocho in his *"En el mar austral"*: "It resembles the guanaco but of stouter build, somewhat similar to the deer in hair and height. Its antlers are not bare; they are covered with thin velvet from the tips to the middle. They have a long face and a narrow forehead. This trait makes them look innocent or extremely silly". According to a friend of his "the Tehuelche clung to the belief that the huemul had fallen from the moon and it was claimed that it was very scarce because the doe would have only one offspring in its whole life, and that would occur in a year with two eclipses, of the sun and of the moon". He also remarked that he had not known an Indian that had ever seen a young huemul.

This mysterious atmosphere is also nurtured by the comments of Enrique E. Gigoux at the beginning of the 20th century, "When in certain periods they were not seen as often as normal in the southern areas they inhabited, in the popular imagination they took refuge in the mysterious city of the Caesar's, which only they had been able to find and inhabit safely, and they were believed to be part fantasy and part real".

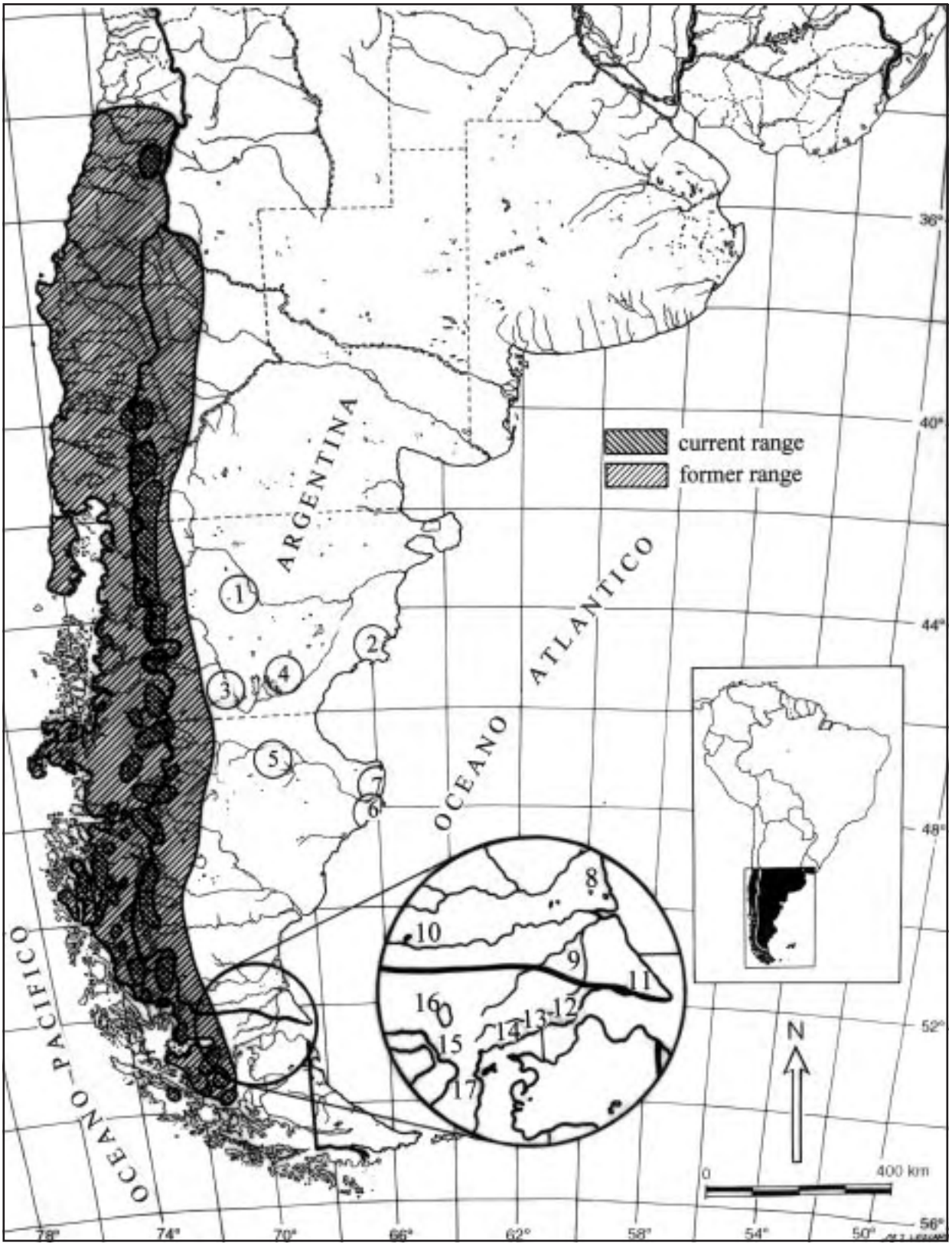


**Fig. 1.** The historical and current distribution of the huemul based on recorded accounts and habitat suitability (adapted from Díaz 1993 and López et al. 1998). Numbers represent historical observations in the steppe (see Annex, this volume).

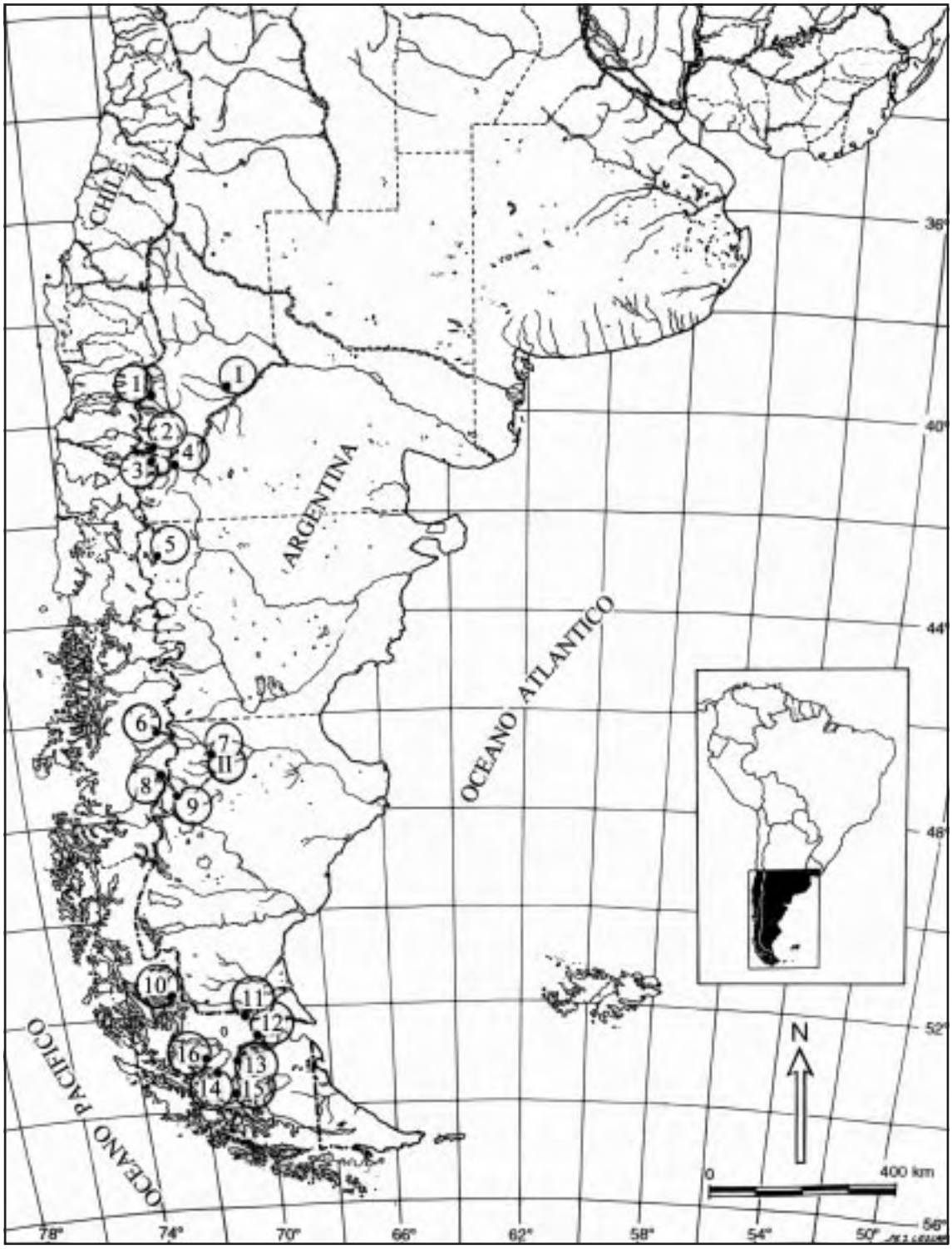


**Fig. 2.** Location of the principal archaeological sites at which huemul remains have been found: 1. Alero IV del Tromen; 2. Los Cipreses; 3. Cueva Traful and Cuyín Manzano; 4. Cementerio Río Limay; 5. Las Mellizas and Alero del Chamán; 6. Las Guanacas and Alero Fontana; 7. Cueva Arroyo Feo; 8. Entrada Baker; 9. Cerro Casa de Piedra and Alero Dirección Obligatoria; 10. Cueva del Medio, Cueva Lago Sofía and Dos Herraduras; 11. Cueva Fell; 12. San Gregorio; 13. Cabo Negro-Bahía Laredo; 14. Punta Baja; 15. Punta Santa Ana and Bahía Buena; 16. Isla Englefield. Also mentioned in the text are I. Picún-Leufú, and II. Cueva de las Manos.

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8 P. Viegas Barros, pers. comm.
9 Claraz 1864.
10 C. Chehébar, pers. comm.
11 J. M. Smith-Flueck, pers. comm.
12 Wolffsohn (1910) points out that in the northern tract where the huemul has been hunted for many years it could probably be less trustful.
13 Prichard 1902a
14 La Chacra 1936.
15 Prichard 1902a
16 Prichard 1902a.
17 For historical remarks on behavior towards humans see, for example, Allen 1905, Osgood 1943, Gigoux 1928, Prichard 1902a, Skottsberg 1911.
18 La Chacra 1936.
19 Lieberman 1962.
20 La Chacra 1936.
21 Iglesias 1965.
22 Housse 1953.
23 Pine et al. 1979.
24 Texera 1974.
25 Díaz 1993.
26 Waterhouse 1838-39.
27 Lista 1881.
28 For distributional data of huemul I profited from Acosta 1792; Adventure and Beagle 1839; Angelis 1972; Bertrand 1886; Brosses 1756; Castillo 1887, 1979; Chacon y Pery 1874, Córdoba 1788-89; Cox 1863, Cruz 1835; Destéfani 1983; Fernández de Navarrete 1945-46; Fernández de Oviedo y Valdés 1851-55; Fitz Roy 1839; Fontana 1886; Goicueta 1879, Guerrero Vergara 1880-81, Hawkesworth 1774; Ibar Sierra 1879; Latorre 1880; Lista 1975; 1896a, 1896b, 1896c; Medina 1888; Menéndez 1896-1900; Moreno 1879, 1898, 1969; Moyano 1880; Musters 1871; Narración de los viajes de Adventure y Beagle 1932-33; Neumeyer 1951; Nodal and Nodal 1621; Nordenskjöld 1897; Novo y Colson 1885; O'Connor 1884; Onelli, 1904; Pastells 1920; Patagonia 1917; Poeppig 1835-36Prichard 1902a, 1902b, 1910, Roa 1884a, 1884b; Rodhe 1883; Rogers 1879; Sarmiento de Gamboa 1950; Seixas y Lovera 1690; Serrano Montaner 1886; Shipton 1965; Simpson 1875; Skottsberg 1911; Steffen 1898, 1909-10; Vazquez de Espinosa 1948; Viedma 1972; Villarino 1972.
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31 In Adventure and Beagle (1839) a list of the fresh provisions procured for the Beagle's crew included 9 deer hunted in 1832 (5 specimens hunted in September and 4 in October) and 11 deer hunted in 1833 (7 specimens hunted in August and 4 in September).
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59 Kraglievich 1932.
60 Borrero 1997.
61 Aldridge 1988.
62 Casamiquela 1975; Claraz 1988; Moreno 1879.
63 Pearson 1987.
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67 Borrero 1994; Mena and Jackson 1991.
68 Mena and Jackson 1991.
69 Sir B. Spencer reports in the journal of his expedition to Tierra del Fuego: "Yaghans talk of two animals with horns (deer?) long ago on Isla Hoste. The deer came down to Kasuani Point in winter, but were killed in the very hard winter when Hanufs [bad man of Yaghans] died out. In hard winters all kinds come to shore and cove to be fed. Even foxes come down". At present, there is no evidence to support the notion that deer inhabited this island.
70 Moreno 1901.
71 The Huemules frequented the Hoyas Otway and Skyring. This group was observed for the last time in the Patagonian channels in 1879 during the voyage of the corvette Magallanes of the Chilean Army.
72 Bird 1946.
73 Mena 1997.
74 Vignati 1947.
75 Skottsberg 1919.
76 Dixie 1880; Martinic 1985.
77 Rusconi 1961.
78 Perea 1989.
79 Claraz 1864; Dabbene 1911; Yepes 1943.
80 Durán 1991-92; Rosales 1937; Rusconi 1961; Yepes 1939.
81 Aschero 1997.
82 Ceirano 1995.
83 Cruz 1972.
84 Guerrero Vergara 1880-81.
85 Guerrero Vergara 1880-81.
86 Quoted in Gusinde 1991.
87 Cooper 1946, Latchman 1915; Prieto 1997.
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89 González 1970; Orbigny 1945; Vignati 1931.
90 Cooper 1925.
91 Claraz 1864.
92 Borrero and McEwan 1997.
93 Aschero 1997; Gradín 1995.
94 Aschero 1997.
95 Vignati 1944.
96 Stratigopoulou 1980-81.

# ANNEX

Locations in the arid Patagonia where the huemul has been observed in the past.

## ARGENTINA

1. Hilly area south of the Río Chubut, Chubut (Roa 1884b).
2. Bahía Camarones, Chubut (Viedma, in Angelis 1972).
3. Along the Río Senguerr as far as Choique Nilahue situated near its junction with Río Genoa, Chubut (Onelli 1905).
4. Hilly area between the Río Chubut and Senguerr as far as 25 or 30 km from the Atlantic coast, Chubut (Onelli 1905).
5. Area south of the Río Deseado, Santa Cruz (Burmeister 1901).
6. Puerto Deseado, Santa Cruz (Byron, in Hawkesworth 1774; Cavendish, in Destéfani 1983; Manuscript Add.M 17603 (see text); Moreno, in Osgood 1943, Lieberman 1962 and Prichard 1902a).
7. Cabo Blanco, Santa Cruz (Adventure and Beag1e 1839, Appendix).
8. From the Río Santa Cruz to the Estrecho de Magellanes, Santa Cruz (Viedma 1972).
9. Neighbourings of the Río Chico basin, Santa Cruz (Lista 1975).
10. Morro Philippi, Santa Cruz (Ibar Sierra 1879).

## CHILE (Region of Magallanes)

11. Western mouth of the Estrecho de Magellanes (Ladrillero, in Guerrero Vergara 1880-81).
12. Primera Angostura (Sarmiento de Gamboa, in Pastells 1920).
13. San Gregorio (Sarmiento de Gamboa, in Pastells 1920).
14. Segunda Angostura (Loayza, in Fernández de Oviedo y Valdez 1851-55).
15. Otway and Skyring Sounds (Fitz Roy, in Adventure and Beagle 1839).
16. Laguna Blanca (Bertrand 1886).
17. Area between Punta Dungeness and Chabunco (Sarmiento de Gamboa, in Pastells 1920).

# Rodulfo Armando Philippi

# 2

## RODULFO ARMANDO PHILIPPI

In 1851, the German physician and biologist, Rodulfo Armando Philippi, arrived in Chile to begin what would be a life devoted to teaching and research of natural history. Notably, he was the first in that country to teach the subject of natural history as a science.

Philippi was born in Charlottenburg, just west of Berlin, on 14 September 1808. After his general schooling, he attended the University of Berlin and attained his degree of medicine and surgery on 26 April 1830. During the same year, he wrote his thesis and first publication devoted to the Orthoptera of Berlin. Philippi studied natural sciences under the famous H. F. Link (1769-1851) and the zoologist H. C. Lichtenstein (1780-1857). Then in July 1830, he left for Italy to undertake various exploratory expeditions, particularly in Sicily, where he engaged himself in research on marine fauna and geology with special interest in volcanic phenomena. In addition to his enthusiasm for molluscs, he was interested in almost everything about animal life.

When Philippi returned to Berlin in 1833, he devoted himself to research and teaching with emphasis on zoology and botany. Some of his notes on natural history started to appear in several scientific publications, mainly in the Archives für Naturwissenschaften [Bonn]. At the politechnical school of Casel he became a professor of natural history and geography, and soon after its director.

In 1841, Philippi was commissioned by the Prussian government to collect samples of plants and animals of scientific interest in Chile. In 1851, he settled in the same country. Upon his arrival in Santiago he met and befriended the professor of physics and chemistry Ignacio Domeyko. After some months devoted to teaching in Valdivia, Philippi returned to Santiago where he took the post of director of the National Museum. In this position, he continued with great success the work of Claudio Gay, the illustrious French naturalist and longtime resident of Chile. Additionally, Philippi was professor at the University and was commissioned to design and direct the Botanical Garden.

Philippi made several geographical explorations in different Chilean provinces and his work notably increased the collections for the National Museum, mainly in the fields of botany, zoology, geology and ethnology. When he passed away on 23 July, 1904, he had published over 349 papers covering many topics of natural history, with Chilean botany and paleontology being his main emphasis. Many of his works appeared in the Annals of the National Museum, which was founded by him. His life and works have been highly valued in Chile and in other countries.

As Philippi's contributions to some of the early works on the genus *Hippocamelus* have been considered important to early taxonomists, we include these publications here. Furthermore, many subsequent authors referred to his works as late as 1941. However, several factors led Philippi to make erroneous conclusions concerning the classification of the two species of *Hippocamelus* and other regional cervid species. In the subsequent chapter, Werner T. Flueck reanalyzes these interpretations of Philippi.

*The pages have had to suffer a reduction to eighty per cent of their original size, and compensation for this reduction should be made to the scales shown on the original drawings.*

# ANALES

DEL

# MUSEO NACIONAL DE CHILE.

PUBLICADOS POR ÓRDEN DEL GOBIERNO DE CHILE.

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PRIMERA SECCION.

## ZOOLOJÍA.

Entrega Nº 2.

## EL GUEMUL DE CHILE.

POR EL

DR. R. A. PHILIPPI.

*CON UNA LÁMINA.*



SANTIAGO DE CHILE.

1892.

Es ahora mui sabido que el célebre animal fabuloso, descrito por Molina como un caballo de pezuñas partidas i denominado por él por este motivo: *Equus bisulcus*, el *Huemul*, *Guemul*, *Guamul* o *Huamul*, no es otra cosa que una especie del gran jénero de *Cervus*, i que no tiene absolutamente nada de caballo. El señor Gay ha figurado en la *Hist. física i política de Chile*, Zool. I, tab. 10 i 11, un indivíduo mui jóven que se conserva embalsamado en el Museo, i leémos p. 161 otra descripcion de su cráneo que no existe mas en el Museo. El señor Gervais, colaborador del Sr. Gay, apoyándose en este cráneo, ha creido que el *guemul* debia ser una especie distinta del *taruga* o *taruch* del Perú, *Cervus antisensis* d'Orb., i de la misma opinion era tambien mi finado amigo don Juan Diego de Tschudi, cuando me visitó, creo en 1859, i vió en el Museo un guemul macho embalsamado. Yo no puedo participar de la opinion de estos distinguidos naturalistas. Es verdad que no poseémos ningun ejemplar del ciervo peruano para poderlo comparar con nuestro guemul, pero las descripciones que los señores D'Orbigny i Gervais, así como tambien Tschudi, han dado de este animal i sus figuras son bastantes para justificar mi opinion, pues convienen exactamente al guemul chileno.

Haré notar desde luego que nuestro Museo posée otro animal jóven, figurado por Gay, i el macho adulto que vió Tschudi i que proviene de la hacienda de Cauquenes, otro ejemplar cazado por el comandante D. Enrique Simpson a orillas del Rio Aisen, un cráneo de un macho adulto, al que faltan desgraciadamente los huesos nasales e intermaxilares, i cuatro pares de astas, entre las cuales uno con las astas nuevas, cubiertas todavía de la piel; estas astas varían bastante entre sí, como se verá, aunque guarden siempre el tipo específico, que es la bifurcacion. Traduciré ahora la descripcion del *Cervus antisensis* de D'Orbigny i Gervais (*Voyage dans l'Amérique méridionale par Alcide D'Orbigny*, tom. IV, 2me partie, Mammifères, p. 28[1]), indicando en su lugar las pequeñas diferencias que presentan nuestros indivíduos, así como las que ofrece la descripcion de Tschudi. D'Orbigny dice: «Este ciervo es poco mas o ménos del tamaño del Axis, pero su cuerpo es mas pesado i recuerda mas bien al ciervo porcino o al ciervo mejicano. El hocico está pelado, hai delante de los ojos, fosas lacrimales de mediana lonjitud; todos los pelos del pelaje son bastante largos, duros, algo quebradizos i mas o ménos contorneados en espiral u ondeados, morenos, jaspeados de un amarillo-pajizo. [El guemul tiene, segun Gay, p. 160 «el pelaje de bruno-flavo, jaspeado de flavo mas o ménos dorado.] Cada pelo es de un color pardo, bastante claro en su parte oculta [o basal] despues mas liso i de un matiz mas intenso hácia la punta; cada uno tiene en su punta un anillo de color amarillo-pajizo en la estension de dos a tres líneas, pero la porcion terminal vuelve a ser parda. [Gay dice: cada pelo es de un bruno ahumado en su mayor lonjitud, i muestra junto a la punta un anillo mas vivo del mismo color, i despues otro de amarillo-paja

[1] No puedo cotejar la primera descripcion dada del animal en los *Nouv. Ann. du Mus. de Paris*, tom. III, p. 91.

o amarillo dorado que ocupa cerca de dos líneas de lonjitud, i el cual es seguido de una pequeña porcion negra colocada justamente en la punta del pelo, pero en una estension que escede algo la de la porcion amarilla.» Se vé, que es la misma cosa.] Sigue d'Orbigny: «La cabeza, el cuello, el tronco i la parte esterna de los miembros presentan el mismo matiz jaspeado. *El hocico está rodeado de blanquizco.*» [Gay dice: «pero la parte del labio mas próxima al hocico es *negruzca*, lo cual no sucede en el *C. antisensis.*» En nuestro ejemplar del Rio Aisen, el labio superior es mui negro, siendo anteriormente este color negro tan ancho como el hocico i haciéndose paulatinamente mas bajo hasta el ángulo de la boca; hai encima de cada lado una mancha redonda mui blanca. Esta mancha blanca falta enteramente en el indivíduo grande de Cauquenes, i en cuanto al indivíduo pequeño, no veo un contraste tan grande entre la parte «negruzca» del labio i lo «blanquizco» que rodea al hocico, como aparece en la descripcion de Gay. Las orejas están jaspeadas en su esterior como el cuerpo mismo i tienen pelos blanquizcos en su cara interna. No hai ninguna traza de este color cerca del ojo [el ejemplar de Cauquenes tiene un anillo blanco mui marcado al rededor del ojo, i lo mismo el otro del Rio Aisen, como el de Gay], pero volvemos a encontrar este color (blanco) mas o ménos mezclado de amarillento o de gris debajo del menton, en lo alto del cuello, en los sobacos, las íngles, la cara interna de las patas, la rejion anal, en la parte inferior de la cola, en los talones i sobre los tarsos [«canons»] en su lado posterior. La parte dorsal de la cola es del color del cuerpo. Los pelos de la rejion vecina al ano son mas largos que los otros, i es probable que la piel tiene, como en el venado de Europa i algunas otras especies, la facultad de enderezarlos.» Gay dice que los cañones son de un color fulijinoso; en nuestros ejemplares no hai nada de blanco en los tarsos, son mas bien fulijinosos como lo dice Gay; de un blanco mui pronunciado es solo la parte interior de los muslos.

Gay dice que en su *Cervus chilensis* «el pecho i el vientre son mas brunos que el resto del cuerpo», particularidad que d'Orbigny no ha notado en el *C. antisensis*, pero sí, Tschudi, como lo veremos.

Si uno compara la descripcion que Tschudi dá del *Cervus antisensis*, que él llama erróneamente *antisiensis*, encuentra mas diferencia entre esta i la de D'Orbigny, que entre la del viajero i naturalista frances i la del *Cervus chilensis*. Leémos en la p. 241 de los «*Untersuchungen über die Fauna peruana*»: El borde de los labios es blanco. En la línea mediana de la frente corre una faja de un pardo oscuro que se divide hácia los cuernos en dos brazos diverjentes. [Esta faja es mui marcada en la figura de D'Orbigny, i es singular que este autor no dice de ella absolutamente nada. En la figura de Tschudi, que muestra la cabeza vista por el lado, no se pudo dibujar. Este dibujo está bien marcado en el guemul de Cauquenes, es poco visible en el del Rio Aisen, e imperceptible en el indivíduo jóven]. Debajo de esta faja corre otra de color gris blanquizco, que nace del ángulo superior esterior de la cavidad lacrimal i *rodea al ojo en forma de círculo.* [Indica pues claramente el círculo blanquizco, que en el guemul rodea a los ojos, un carácter mui visible, omitido en la descripcion dada por Gay, omitido igualmente en la lámina dada por Tschudi, lám. XVIII, así como en la figura dada por D'Orbigny.] — Tschudi dice que en el lado interior del tarso hai una mecha de pelos en forma de pincel; D'Orbigny no menciona esta particularidad, i yo tampoco veo cosa semejante en nuestros ejemplares.

El color del *Cervus antisensis* no es el mismo en las láminas de D'Orbigny i de Tschudi, i en ámbas es mucho mas pálido que el de nuestros machos del guemul, que son tambien bastante mas oscuros que el indivíduo jóven observado i figurado por Gay. La figura de

D'Orbigny es de un bayo bastante claro, la de Tschudi de un color gris de ratoncito. Daré ahora las medidas dadas por D'Orbigny i por Tschudi, reduciendo las del último al sistema métrico, i las comparemos con las de los

| | *Cervus antisensis* Taruga | | *C. chilensis* Guemul |
|---|---|---|---|
| | D'Orbigny | Tschudi | de Aisen |
| | m. | m. | m. |
| Lonjitud del cuerpo entero | 1,200 | 1,20—1,30 | 1,66 |
| „ del tronco | — | 0,51 | 0,96 |
| „ del cuello | — | 0,20 | 0,27 |
| „ de la cabeza desde la punta del hocico hasta las astas | — | 0,18 | 0,24 |
| „ de la oreja | 0,125 | 0,14 | 0,20 |
| „ de la cola | 0,100 | — | 0,12 |
| Distancia entre las orejas | — | 0,11 | 0,08—11 |
| „ entre las astas | — | 0,045 | 0,05 |
| Altura de las estremidades hasta el dorso | 0,700 | 0,66 | 0,80 |

El guemul de la hacienda de Cauquenes tiene las mismas dimensiones que el de Cauquenes.

Se vé que nuestros guemules son un poco mas grandes que las tarugas del Perú; algunas diferencias en las medidas del detalle, resultan probablemente de la dificultad que presenta la mensura de partes que no tienen límites mui fijados. En resúmen, no encuentro ni en el tamaño ni en las descripciones del esterior, caractéres suficientes para distinguir como especies al *Cervus chilensis* del *Cervus antisensis*. No los hai tampoco en las astas, ¿los habrá acaso en el cráneo? Me parece que no. El señor Gay (o probablemente mas bien el señor Gervais) ha tenido únicamente el cráneo de un guemul jóven, que tenía solo cuatro pares de dientes molares en lugar de los seis que tiene el animal adulto, tres de mamon i uno de adulto, los otros dos pares estaban todavía dentro de las alveolas, i aunque esto señale algunas pequeñas diferencias en comparacion con el cráneo adulto del *Cervus antisensis*, no es posible, a mi juicio, considerarlas como suficientes para establecer una nueva especie. En efecto, tratándose del cráneo de un animal no adulto todavía, ¿qué significa que los incisivos son algo mas pequeños i el espacio interorbital mas ancho?

D'Orbigny no dá ningun detalle sobre el modo de vivir de la *taruga*, se contenta con decir: «Este ciervo se encuentra en las rejiones mas elevadas de la cordillera oriental de Bolivia, es sobre todo comun en los alrededores de La Paz, de Cochabamba i de Chuquisaca, pero desciende rara vez mas abajo del nivel de 3500 m. [La Paz se halla a 3705, Cochabamba a solo 2575 m. sobre el nivel de mar], habitando esta zona hasta las nieves perpétuas. Su ajilidad es mui notable.» Mucho mas detallada es la descripcion de Tschudi. Dice: La taruga es propiamente un animal de las rocas. Vive en pequeñas tropas, en los declives rocallosos de la altiplanicie, i duerme de dia en el desmonte de las rocas o entre peñascos. La hemos sorprendido varias veces al medio dia en cuevas. En la tarde avanzada i en la madrugada, ántes de la salida del sol, come las escasas yerbas i musgos [ningun cuadrúpedo come musgos]; para beber busca los valles o las llanuras. Cuando es perseguida huye con gran lijereza, pero uno que anda a caballo puede cansarla fácilmente, a no ser que se retire a los peñascos repechados, pues entónces es casi imposible su persecucion. Cada tropa está capitaneada por un macho viejo, que se distingue, por lo comun, por un color mas claro i un tamaño mayor. Hemos traido un cuero de un macho tal, que



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se parece muchísimo por su color al del *Felis concolor* o leon de América. Los diferentes matices resultan principalmente del mucho roce contra los peñascos i de lo fácil que se quiebran los pelos; segun queden de estos los anillos claros u oscuros, es tambien el pelaje mas claro o mas oscuro. Las astas se remudan cada año, i las nuevas quedan por algun tiempo cubiertas de la piel como en las especies europeas.»

Gay ha tenido noticias mui imperfectas del guemul. Dice: «Los guemules son mui raros en Chile y no frecuentan mas que los altos vericuetos de las cordilleras, desde la provincia de Colchagua hasta la de Concepcion, escapando con una rapidez, solamente comparable a la del vuelo, a las persecuciones de los cazadores o de cualquier otro enemigo. Solo los vaqueros tienen ocasion de verlos mui raramente i a gran distancia ..... los machos tienen, segun se dice, dos cuernos pequeños i bifurcados.» El guemul se encuentra en Chile desde el Rio Cachapual hasta el Estrecho de Magallanes, habitando en la parte poblada de la República las altas cordilleras, pero descendiendo hasta el mar en la costa de la Patagonia occidental. El indivíduo jóven, único ejemplar de su especie que Gay ha visto, i uno de los machos embalsamados de nuestro Museo, provienen de la hacienda de Cauquenes, en la cual ya no existen mas, i parece que han sido siempre raros (faltando quizas enteramente), hasta la provincia de Ñuble, en la cual se ven con alguna frecuencia, de modo que existe en ella un Cerro de los Guemules i una Hacienda de los Guemules. Varias veces los guemules pastean allí junto con los animales vacunos i bajan con estos hasta entrar en los corrales, cuando se arrean en otoño de la cordillera a las invernadas de las llanuras bajas. Pero son mui frecuentes en la Patagonia occidental i en el Estrecho de Magallanes, donde los vió Wallis[1] de distancia, como lo ha reconocido Molina. La descripcion de aquel viajero ha dado a Molina los rasgos principales de su descripcion del *Equus bisulcus*, todo lo demas es pura fantasía.

Los cuernos del *Cervus antisensis* son mui particulares, siendo simplemente ahorquillados. Los pitones principales se dirijen hácia atras, siendo encorvados al mismo tiempo hácia afuera, i sus estremidades son poco diverjentes. Un poco mas arriba de la base nace el segundo piton, el que se dirije hácia arriba i tambien un poco hácia adelante; su tamaño varía, pues algunas veces es casi del grandor del piton principal i otras mucho mas corto; al ángulo que forma con el piton principal es poco abierto. La parte basal indivisa de las astas es mui gruesa, está comprimida i muestra elevados listones lonjitudinales mui fuertes, mas o ménos tuberculosos, que se continúan aun sobre los ramos, pero dejando comunmente la punta de éstos lisa i cilíndrica, en una lonjitud mas o ménos grande. En el ángulo de la division hai una línea o cresta elevada, que se prolonga mas o ménos sobre el piton principal, i muestra a veces tubérculos mui grandes. El borde circular de la base de las astas está fuertemente desarrollado, i muestra siempre tubérculos gruesos mui prominentes.

Tal es, en jeneral, la conformacion de las astas, pero las variaciones individuales son mui grandes, a lo ménos en el *Cervus antisensis* chileno, i es mui singular que en los cinco pares de las astas osificadas que conserva nuestro Museo, dos tienen una de las astas diversamente ramificada, i eso de tal manera que un naturalista que encontrase uno de estos cuernos suelto, no vacilaría por un solo momento en declarar, que él debe provenir de una especie de ciervo mui distinta al del *Cervus antisensis*. Conviene pues describir estas astas por separado.

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[1] Hawkesworth, *Voy.*, t. 102, p. 38.

No conozco de las astas de la *taruga*, del *Cervus antisensis* del Perú, mas que la figura que muestra al animal entero en la lámina de D'Orbigny, la que he copiado. Este naturalista dice que la lonjitud del piton posterior es de 17 cm., la del anterior de 14 cm. Véase la fig. 1 de mi lámina. (Tschudi figura un indivíduo cuyas astas no han llegado aún a desarrollarse i están todavía cubiertas por la piel.) El ramo mayor es una pequeñez mas corto que en el animal embalsamado de Cauquenes de nuestro Museo, el menor algo mas corto; véase la fig. 1, i compárese con la fig. 5, que es la de una asta del guemul de Cauquenes.

La del guemul del Rio Aisen, fig. 4, tiene el ramo principal mas largo, pues mide 34 cm., i el piton anterior mucho mas corto, midiendo solo algo mas de 7 cm.; es tambien notable por la gran elevacion de los tubérculos en los listones de la parte anterior de la base del cuerno.

El cuerno del guemul de Magallanes, véase fig. 3, tiene igualmente sus dos pitones mui desiguales; el posterior tiene 17 cm. de lonjitud, como en el indivíduo de la taruga figurado por D'Orbigny, pero el anterior solo $7^1/_2$ cm. En este indivíduo los tubérculos de los listones están ménos desarrollados, pero los listones se prolongan hasta mucho mas arriba, i sobre toda la cresta que se nota en el ángulo de la division del cuerno.

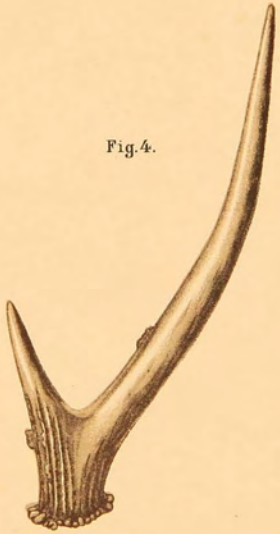
Es singular que los ejemplares que tenemos de las partes mas australes tengan el piton anterior corto, pero se necesitaría mas material para poder decir que esto es la regla jeneral, i que los guemules de Patagonia i Magallanes constituyen una variedad constante.

El cuerno de un guemul de la provincia de Ñuble, figurado bajo el número 2, es mui grueso i fuerte, tiene sus listones, crestas i tubérculos mui desarrollados, i presenta en el cuerno del lado derecho un tercer piton, dirijido hácia afuera i encorvado hácia arriba. Este mide, en línea recta, $4^1/_2$ cm., el ramo de donde arranca, $11^1/_2$ cm., i el piton posterior 19 cm.; el grosor de la base es algo mas de 4 cm. en el sentido de adelante para atras, i de $3^1/_2$ cm. en el sentido trasversal; mui ancha es la base del cuerno derecho al oríjen del tercer piton.

El par de astas, figurado bajo el número 6, proviene igualmente de un guemul de la cordillera de Chillan, es el mas pequeño de los que poseémos, i mas anómalo aun que el anterior, siendo el cuerno derecho normal i estando el izquierdo compuesto de cuatro pitones. Los pitones normales son iguales en ambos cuernos, el posterior mide 14 cm. de largo, el del lado derecho es mas delgado que el del otro lado, i su punta parece haber sido quebrada, cuando el cuerno estaba todavía cartilajinoso. El ramo anterior mide en ambos cuernos casi 11 cm., el del cuerno izquierdo produce desde la base misma de éste un piton del largo de casi 4 cm.; el ramo posterior o principal tiene su piton accesorio un poquito mas arriba de la mitad; este piton mide solo $2^1/_2$ cm. Los dos pitones supernumerarios son horizontales i se dirijen un poco hácia afuera. Los listones están mui desarrollados, pero solo los del lado interno del ramo anterior de la parte derecha muestran tubérculos, i éstos mui prominentes.

Todas las figuras de la lámina, por supuesto con escepcion de la de la cabeza copiada de la obra de D'Orbigny, son la tercera parte del tamaño natural.

Santiago, Junio 24 de 1890.



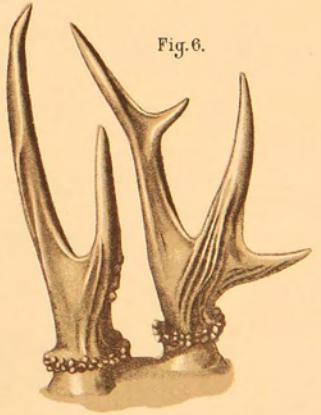


Fig. 2.

Fig. 1.

Fig.3.

Fig.5.

Fig.4.

Fig.6.

*R. A. Philippi del.*

Fig.1. *Cabeza entera.*- Fig.2. *Asta de Chillan.*- Fig.3. *Asta de Magallanes.*– Fig.4. *Asta del Rio Aisen.*- Fig.5. *Asta de Canquenes* - Fig.6. *Asta de Chillan.*

# ANALES

DEL

# MUSEO NACIONAL DE CHILE.

PUBLICADOS POR ÓRDEN DEL GOBIERNO DE CHILE.



## PRIMERA SECCION.

## ZOOLOJÍA.

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# CERVUS ANTISENSIS, CHILENSIS, BRACHYCEROS

POR EL

Dr. R. A. PHILIPPI.

*CON 4 LÁMINAS.*



SANTIAGO DE CHILE.

1894.

Hace algunos años que llegaron al Jardin Zoolójico de Santiago, que es anexo al Instituto Agrícola, tres indivíduos del *Venado de Cajamarca*, dos machos i una hembra. La hembra murió a consecuencia de una herida causada por un macho; al contrario, los machos vivieron mas de dos años, i mudaron en este tiempo los cuernos, que resultaron ser iguales. Ahora hai, en el Museo Nacional, un macho embalsamado i el esqueleto completo de otro, i dentro de poco se verá tambien la hembra embalsamada.

Los cuernos son ahorquillados, aunque de un modo mui particular, así es que este venado pertenece al jénero o subjénero *Furcifer*, i ántes de haber estudiado mejor estos animales, yo mismo había creído que ellos podían ser el verdadero *Cervus antisensis* de D'Orbigny, el *taruga* de los peruanos, a pesar de la gran diferencia que mostraban sus cuernos con los de este último, porque la esperiencia me había enseñado que la forma de los cuernos es mui variable en nuestro guemul, tan semejante al taruga (véase mi memoria sobre el «Guemul de Chile» en los Anales del Museo Nacional); así es que no valen nada para la distincion de las especies en el grupo de los ciervos, que ha sido denominado *Furcifer*. Pero la comparacion minuciosa de nuestro animal con las descripciones que D'Orbigny i Tschudi han dado del *Cervus antisensis*, me hizo ver que es una especie distinta que denominé *Cervus brachyceros*. He dibujado el animal, i envié este dibujo junto con una descripcion detallada al señor Sclater, secretario de la Sociedad Zoolójica de Londres, suplicándole de compararlos con un ejemplar embalsamado del taruga, que suponía existía en las colecciones de la sociedad. Este señor me contestó con fecha Mayo 24: «Lo he examinado cuidadosamente.... Mi opinion es, que el animal será el verdadero *Cervus antisensis*..... Whitely trajo del Perú ejemplares de esta especie.» A mas de esto me aconsejó de consultar la memoria de Sir Victor Brooke en los «Proceedings» de la Sociedad Zoolójica de 1878, i me devolvió el dibujo i la descripcion.

Mientras mi carta iba a Londres i volvía la contestacion, tuve la suerte de poder comprar un cráneo completo de un ciervo de Bolivia, que es evidentemente el verdadero *Cervus antisensis* de D'Orbigny, como lo prueba la procedencia i las diferencias que indica Gervais en la Histor. física i polít. de Chile de Gay (Zool. I, p. 161), entre los cráneos del *Cervus antisensis* i del *C. chilensis*, nuestro guemul, del cual había conseguido, pocos dias ántes, un cráneo completo, procedente del Alto-Bolivia. (Hasta entónces poseíamos solo un cráneo de Magallanes, que carecía de la parte anterior.) Pude ahora comparar los cráneos de las tres especies, del *taruga*, *C. anti-*

*sensis,* del *venado de Cajamarca, C. brachyceros* i del *guemul, C. chilensis,* i establecer las diferencias específicas en sus cráneos.

El taruga i el guemul son tan parecidos en su esterior, que es mui fácil el confundirlos (véase la lámina I), i las descripciones del primero, dadas por D'Orbigny i Tschudi, convienen casi enteramente al guemul, pero el taruga es mas pequeño, hasta los cuernos son los mismos, sin embargo, los cráneos ofrecen diferencias notables, i desde luego diré que los dientes incisivos del guemul son mucho mas grandes. El venado de Cajamarca (v. lám. II) se distingue, a primera vista, de las otras dos especies por ser mucho mas esbelto, por tener las piernas mas largas, el pelo mas fino, mas corto i recortado; conviene con el taruga en los dientes incisivos pequeños, pero el cráneo es mui diferente como pronto haré ver.

Daré ahora descripciones detalladas de las tres especies, debiendo contentarme con reproducir, en cuanto al *Cervus antisensis*, solo lo que han dicho sobre su esterior D'Orbigny i Tschudi, porque hasta ahora no me ha sido posible conseguir un animal embalsamado.

## 1. CERVUS ANTISENSIS D'Orb., el taruga.

Lám. I, fig. 2.

Repeto toda la sinonimia que ha dado de este animal Sir Victor Brooke, en los Pr. Z. S. 1878 p. 924, agregando solo algunos datos por él omitidos.

1834. *Cervus antisensis* D'Orb. Nouv. Ann. (i no Arch. como cita Brooke) du Mus. de Paris III, p. 91.

? Cerf d'Antis Puchéran Dict. univ. d'hist. nat. de Charl. D'Orb. III, p. 328, omitido por Brooke.

1844—46. *Cervus antisiensis*[1] Tschudi. Unters. üb. d. Faun. per., p. 241, lám. XVIII, omitido por Brooke.

1847. *Cervus antisensis* D'Orb. Voy. Amér. mérid. IV, 2, p. 28, pl. 20, omitido por Brooke.

1869. *Anomalocera Huamul* Gray. Scient. Opin. 1869, p. 384.

1869. *Xenelaphus huamel* Gray. Proceed. Z. S. 1869, p. 497.

1872. *Xenelaphus leucotis* Gray. Catal. of Rum. Mamm., p. 89.

1872. *Xenelaphus anomalocera* Gray. Ann. Nat. Hist. ser. IV, vol. X, p. 445.

1873. *Xenelaphus chilensis* Gray. Ann. Nat. Hist. ser. IV, vol. XII, p. 160.

1874. *Furcifer chilensis* Gray. Ann. Nat. Hist. ser. IV, vol. XIII, p. 332.

1875. *Cervus antisiensis* Sclat. Proceed. Z. S. 1875, p. 46.

1878. *Cariacus antisiensis* Sir Victor Brooke. Proceed. Z. S. 1878, p. 924.

? *Creagoceros antisiensis* Fitzinger, segun Schäff, Zool. Gart. 1890, p. 233. (Es dudoso, si este Creagoceros se refiere al *Cervus chilensis* o *antisensis.)*

Es singular que Tschudi, Sclater, Brooke, Fitzinger escriben *antisiensis* en lugar de *antisensis,* pero es mucho mas singular que Sir Victor Brooke no cita el Viaje de D'Orbigny i la obra de Tschudi, siendo que estos dos naturalistas son los únicos que han visto al *C. antisensis* en su patria, cazándolo i describiéndolo prolijamento después. Uno se siente casi inclinado a creer que Sir Victor Brooke no ha conocido o consultado las obras de D'Orbigny y de Tschudi.

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[1] Mal por *antisensis.*

Se vé, por la lista arriba enumerada, que tenemos cinco nombres *jenéricos: Cervus, Anomalocera, Xenelaphus, Furcifer, Cariacus,* a los que hai que agregar quizás *Creagoceros.* ¡Qué riqueza! qué adelanto! qué provecho para la ciencia!

Tschudi, cuya descripcion es mas prolija que la de D'Orbigny, dice: «Las fosas lacrimales son mui grandes [D'Orbigny: «larmières de longueur moyenne»]; las orejas largas; el cuello corto; el cuerpo mui rechoncho; la cola mui corta; las estremidades son sueltas; los pelos del hocico son mui cortos i así como los de la frente los mas blandos de todo el cuerpo; los de las mejillas i del occiput son un poco mas largos; en la parte superior del cuerpo tienen la lonjitud de cerca de 2 pulg. (5,5 cm.), son ondeados i tan broncos, que se quiebran luego al refregarlos; en la barriga son mas cortos, pero los que rodean la cola mas largos; los de ésta alcanzan a medir 3 pulg. (8,2 cm.). El *pelaje del lado interior de los muslos es largo i blando, siendo los pelos del escroto los mas largos.* [En el guemul los pelos del lado interior son igualmente mui largos i blandos, en el *Cervus brachyceros,* al contrario, son mui cortos, están recostados i aplicados a la piel.] En el lado interior de los tarsos se nota una mecha de pelos de la forma de un pincel.

«El muslo es negrusco, el borde de los labios blanco; en la línea mediana de la frente corre una faja de un pardo oscuro, que se divide en dos brazos hácia los cuernos. Debajo de esta faja corre otra de un gris blanquisco, que comienza en el ángulo superior i posterior del ojo, rodea a éste en forma de un círculo hasta el ángulo posterior e inferior de la fosa lacrimal, de donde corre una faja mas ancha i mas corta del mismo color hasta el ángulo anterior del ojo. [En la figura que da Tschudi i que es bastante mala, no se vé traza alguna de este dibujo, ni tampoco, en el tarso, de la mecha de pelos en forma de pincel. D'Orbigny dice: «Il n'existe aucune trace de cette dernière couleur (blanchâtre) à l'œil.»] En la base de cada oreja hai una mancha cordiforme de un gris de plata. La mandíbula inferior, la garganta i *el cuello son blanquiscos.*» En el guemul todo el cuello es del color del dorso.

«Toda la parte superior del cuerpo es, con escepcion de algunos matices insignificantes, del mismo color; cada pelo es casi hasta su mitad de un color lila claro, limitado por un anillo pardo claro, al cual sigue otro pardo oscuro, i a este un anillo de un blanco amarillento ante la punta corta, que es de un pardo oscuro. Como los pelos están tupidos i son tiesos, se ven solo los anillos de un blanco amarillento i las puntas pardas oscuras, así es que el pelaje parece jaspeado con estos dos colores. Para indicar una coloracion jeneral podemos decir, que la parte superior del cuerpo es de un pardo amarillento. La raíz de la cola es negra, pero la cola misma es arriba i abajo blanca. [D'Orbigny dice: «Le dessus et la base supérieure de la queue sont de la couleur du dos», lo que es mas probable]; el vientre es mucho mas oscuro que el dorso. [D'Orbigny no habla de esta diferencia.] La parte interior de las estremidades es mas pálida, i sobre todo la parte posterior de la barriga i la parte interior de los muslos, que son enteramente blancos; la mecha de pelos, en la raíz del pié de que se ha hablado arriba, es de un pardo rojizo i se destaca bastante de la coloracion de las tibias.» Mas tarde dice Tschudi, que el color del pelaje varía bastante, i se detiene largamente sobre este punto.

Los cuernos parecen ser mui variables, como los del guemul; ya los del tipo normal del subjénero Furcifer, que Sir Victor Brooke figura i describe en los Proceed. Z. S. en el lugar citado i que he copiado en la lámina I, fig. 3, difieren de los del animal figurado por d'Orbigny, cuya copia se vé en la misma lámina, i mucho mas diferentes son los cuernos del cráneo de nuestro *Cervus antisensis.* Sobre los cuernos mui diferentes del «tipo», Gray ha establecido su jénero *Xenelaphus.*

Daré, mas abajo, las dimensiones en comparacion con las del *Cervus brachyceros.*

## 2. CERVUS CHILENSIS Gay i Gerv., el guemul.

Lám. I, fig. 1.

1782. *Equus bisulcus* Molina. Saggio sulla storia naturale del Chilì.
1816. *Hippocamelus dubius* Leuckart. Dissert.
1842. *Cervequus andicus* Lesson. Nouv. tabl. du Règne anim., p. 175.
1846. *Cervus chilensis* Gay et Gerv. Ann. Sciences nat., Febrero 1846.
1847. *Cervus chilensis* Gay et Gerv. Gay Hist. fís. y polít. de Chile. Zool. I, p. 159, lám. 10 i 11 macho jóven, olvidado en el trabajo de Brooke!
1849. *Capreolus leucotis* Gray. Proceed. Z. S. 1849, p. 64. Mam. t. 12 (segun Brooke) una hembra. Esta lámina falta en mi ejemplar de los Proceedings.
1872. *Cervus chilensis* Sclater. Proceed. Z. S., p. 45 (un cuerno).
1872. *Huamela leucotis* Gray. Ann. Nat. Hist. X, p. 445.
1878. *Cariacus chilensis* Brooke. Proceed. Z. S. 1878, p. 924.
1890. *Cervus antisiensis* (en lugar de *antisensis*) Schäff, Zool. Gart., p. 228 con figura (? Schäff, no indica de que parte de la América del Sur provino el animal del Jardin Zoológico de Berlin, que describe).

Como se vé, esta especie lleva seis nombres jenéricos, i el libro de Gay parece no haber sido conocido por Sir Victor Brooke.

Nuestro museo posée tres ejemplares machos adultos i un jóven, todos embalsamados. Encontré en 1851 un animal adulto como soporte de un escudo de armas chileno; proviene de la Hacienda de Cauquenes, que está limitada al norte por el Rio Cachapoal, que forma tambien el límite boreal de la rejion habitada por el guemul, mientras el Estrecho de Magallanes es su límite sur; fué obsequiado, segun me han dicho, por el Coronel D. Pedro Urriola[1]; había igualmente el macho jóven, que se parece mucho a la figura dada en la obra de Gay, nadie supo decirme de donde provenía. El segundo, que he figurado, proviene de la boca del Rio Aisen, situada en 45° lat. sur, i lo debemos al capitan D. Enrique Simpson de la marina de guerra; este mismo señor trajo tambien para el museo, el cuero de una hembra, pero el preparador que tenia entónces, declaró que era defectuoso i que no se animaba a embalsamarlo, i desde entónces ha desaparecido del museo, como tantos otros objetos. He comprado el tercer ejemplar, hace pocos meses; proviene de la parte superior del Rio Longaví en una latitud $36^1/_4°$. Está embalsamado en la actitud de querer dar un brinco.

Describiré el segundo ejemplar, pero daré ántes las dimensiones de los tres.

| | Guemul de Aisen | Cauquenes | Longaví. |
|---|---|---|---|
| | m | m | m |
| Lonjitud, desde la punta del hocico hasta el arranque de la cola . . | 1,66 | 1,52 | 1,67 |
| „ del cuello, desde los cuernos[2] . . . . . | 0,38 | 0,38 | 0,40 |
| „ del dorso . . . . . | 0,94 | 0,90 | 0,92 |
| Altura del crucero . . . . . | 0,82 | — | — |
| Lonjitud, desde la punta del hocico hasta el ojo . . . . . | 0,13 | 0,14 | 0,14 |
| „ „ „ „ „ „ „ los cuernos. . . . . | 0,26 | 0,25 | — |

[1] Actualmente el guemul no existe mas en esta hacienda, i es menester marchar mucho mas al sur para encontrarlo.
[2] En la figura parece ser mas alto, porque el animal embalsamado tiene la pierna estendida i derecha.

| | Guemul de Aisen | Cauquenes | Longaví. |
|---|---|---|---|
| | m | m | m |
| Lonjitud de la oreja . . . . . | 0,19 | 0,20 | 0,15 |
| „ desde el codo hasta la punta de las uñas . . . . . | 0,54 | 0,55 | 0,54 |
| „ desde el calcáneo hasta las uñas . . . . . | 0,35 | 0,33 | 0,35 |
| „ de la cola con los pelos . . . . . | 0,16 | 0,15 | 0,12 |

Si comparamos las formas del cuerpo de nuestro guemul con las figuras del *C. antisensis*, no encontraremos diferencia alguna que justifique separarlo del taruga. La figura que el doctor Schäff ha dado, segun el animal vivo del Jardin Zoolójico de Berlin, en el periódico «Jardin Zoolójico» es, en verdad, de cuerpo mucho mas corto, pero en el texto leémos, p. 230, en contradiccion manifiesta con la figura: «el tronco es comparativamente largo.» No puedo encontrar, como ya lo tengo advertido, diferencias en el pelo. Los pelos son ondeados i están anillados, como en el taruga, i son del mismo largo i de un color gris claro en la mayor parte de su lonjitud, teniendo ántes de la punta parda un anillo de un amarillo bastante vivo del ancho de casi 3 mm., así es que el color jeneral es jaspeado i de un pardo amarillo como en el taruga. Del mismo color es todo el cuello que, en la descripcion de Tschudi i en la figura del *C. antisensis* dada por D'Orbigny, es blanquisco en la garganta. La barriga es tambien del mismo color pardo amarillento, con escepcion de la parte posterior; así como las piernas, escepto el lado interior del brazo, que es blanquisco i el lado interior de los muslos, pues este es de un blanco puro como la parte posterior de la barriga; ambos están cubiertos de un pelo del largo de dos pulgadas como en el taruga; esta parte blanca de los muslos está bien separada del color pardo del resto. Pelos mui largos i blancos cubren tambien la parte inferior de la cola, la superior es del color del dorso. Los piés están cubiertos con pelos cortos i recostados, aplicados contra el cuero, pero igualmente anillados. Dos ejemplares del guemul tienen en el lado interior de la articulacion del calcáneo la mechita de pelos mas largos, descrita por Tschudi en el artículo del taruga, pero el indivíduo figurado *carece enteramente de éstas*. La cabeza es mas bien gris que parda, está cubierta con pelos cortos, recostados, que tienen solo un centímetro de largo; son de un color gris pardo, pero la base i un anillo debajo de la punta son blancos. Entre los cuernos i en el occiput hai pelos mas largos del color jeneral del dorso que pasan, poco a poco, a la lonjitud de los de la nuca. En la frente hai un lunar triangular de pelos levantados, pero algo mas cortos que los del occiput. No hai ninguna traza de la faja oscura, ahorquillada arriba, descrita por Tschudi, pero los ojos están rodeados de un círculo blanquisco. Mui particular es un lunar de color casi castaño en cada mejilla, formado por pelos largos, tupidos i erguidos. Esta conformacion parece ser individual; el guemul de Longaví tiene en este lugar solo pelos cortos recostados, como en lo demas de la cabeza, i el de la Hacienda de Cauquenes tiene todas las mejillas cubiertas de pelos flojos bastante largos, que muestran una mancha oscura en el mismo lugar, en que el del Rio Aisen tiene los pelos alargados, levantados i oscuros. Este individuo muestra en la línea mediana de la nariz i de la frente la faja oscura parda, ahorquillada arriba, descrita (pero no figurada) de que habla Tschudi, tratando del taruga, pero que está bien marcada en la figura de este dada por D'Orbigny.

El guemul de Aisen tiene una mancha triangular de color castaño en el labio superior, que está bordada arriba con blanco (una mancha casi igual se nota en la figura del taruga dada por D'Orbigny), i otra mas pequeña de cada lado del menton. Si uno quisiera dar importancia a estas diferencias en el pelaje i coloracion de la cabeza, debería hacer de los tres indivíduos del

guemul tres especies distintas. Compárese está descripcion del guemul con la del taruga, i compárense tambien las figuras de estas dos especies i luego se verá que estos dos animales son *mui parecidos* por no decir idénticos, i no *mui distintos* «very distinct», como asevera Brooke, i que no pueden censurar los naturalistas que los han tomado por modificaciones lijeras de la misma especie, como yo había opinado ántes, lo mismo como Burmeister, últimamente el doctor Schäff, pero el cráneo prueba la diferencia específica de los dos.

## 3. CERVUS BRACHYCEROS Ph., Venado de Cajamarca.

Lám. II.

Este animal es mas elegante en su porte, tiene las piernas mas altas, el pelo lustroso, bien aplicado contra el cuero, no lacio i flojo como las dos especies antecedentes, en fin cuernos tan distintos que no pueden suponerse que entren en el círculo de las variaciones que ofrecen los cuernos del guemul i del taruga.

Doi ahora las dimensiones, comparándolas con las del *C. antisensis.*

| | *C. brachyceros* | *C. antisensis* | |
|---|---|---|---|
| | | D'Orb. | Tschudi |
| | m | m | m |
| Lonjitud, desde la punta del hocico hasta el arranque de la cola | 1,14 | 1,20 | 3′ 11″ = 1,28<br>4′ 5″ = 1,40 |
| Altura en el crucero | 0,66 | 0,70 | 2′ 3″ = 0,75 |
| Lonjitud, desde la punta del hocico hasta el ojo | 0,115 | — | — |
| ,, de la oreja | 0,115 | 0,125 | 5″ 6‴ = 0,14 |
| ,, desde la punta del hocico hasta los cuernos | 0,17 | — | — |
| ,, desde el codo hasta la punta de las uñas | 0,42 | — | — |
| ,, desde el calcáneo hasta la punta de las uñas | 0,30 | — | — |
| ,, de la cola | 0,10 | 0,10 | — |
| ,, de los cuernos | 0,09 | — | — |

El venado de Cajamarca es, pues, algo mas pequeño que el taruga.

El color del dorso i de los lados i de la mitad anterior de la barriga, así como de la parte anterior de las piernas, es como en el venado, pero varía segun viene la luz de diferente lado, es pronto mas oscuro, casi de un pardo algo rojizo, pronto mas bien un gris amarillento, como en la figura del taruga; el cuello es un poco mas claro por delante, pero no blanco; la parte posterior de la barriga i el lado interior de las piernas son de un blanco puro i están recubiertos de *pelos cortos, finos, recortados, bien aplicados contra el cuero, i esto tambien en la parte interior de los muslos,* mientras que esta parte tiene pelos mui largos i flojos en las dos especies anteriores. Aun los pelos del cuerpo están recostados, son lisos i lustrosos, pero mas groseros; su largo es de dos centím., son en la mayor parte de su lonjitud de un pardo claro, en la raíz blancos, en la punta de un pardo oscuro, i tienen ántes de la punta un anillo de un amarillo claro. Es mui marcada en los muslos la línea de separacion de la parte blanca i de la parte parda del lado posterior, puesto que los pelos largos pardos son levantados, i están con sus puntas recurvados para adentro; el escroto i el pénis están cubiertos igualmente de pelos cortos i recortados [en el *C. antisensis* estos pelos son mui largos].

La forma de la cabeza no ofrece nada de particular, pero los ojos están mas distantes de los cuernos, i el muslo es mas corto que en las dos especies anteriores. La mayor parte de la

cabeza está cubierta de pelos cortos, bastante finos i recostados, pero la frente tiene un espacio triangular bien separado, en el cual los pelos son largos, levantados i parecidos a los del dorso, así es que la cabeza, vista del lado, parece tener la frente combada. [Aun en el guemul se nota que los pelos de la frente son algo mas largos i están un poco levantados, pero hai una transicion paulatina a los otros i la diferencia se nota apenas.] Falta enteramente al venado de Cajamarca el espacio cubierto de pelos largos, oscuros, que muestra el guemul de Aisen en sus mejillas. — La coloracion de la cabeza es particular. La frente tiene el mismo color que el dorso, las mejillas i la nariz son grises, la línea mediana de la nariz es casi negra; el menton es blanquisco, pero ántes de la punta se nota una manchita negrusca; sobre la mitad posterior del labio superior se ve una mancha blanquisca, que se une con la parte blanca del menton; la punta del hocico es negra, pero el borde de los labios blanco; los ojos están rodeados de un anillo blanquisco. Blanco es tambien el ángulo posterior de la mandíbula inferior i la base de la oreja en su parte anterior. Las orejas mismas son largas, están cubiertas por afuera de pelos cortos, recostados, del color jeneral del animal, al interior negras i casi desnudas, pero algo peludas hacia los bordes, que muestran pelos blancos de lonjitud regular. Nuestro ejemplar tiene tambien en la articulacion del calcáneo con la tibia, al lado interior, una mecha de pelos mas largos de un blanco puro, pero no llama mucho la atencion i no tiene ninguna semejanza con un pincel.

Los cuernos son mui particulares, mui cortos, pero mui gruesos, ahorquillados, con ramos mui cortos, véase la figura 3 en la lámina II que representa los cuernos del animal embalsamado de tamaño natural, i la fig. 3 de la lámina III que muestra los cuernos del esqueleto del otro macho mitad del tamaño natural. La forma varía poco, i no hai igualdad perfecta en los dos cuernos del mismo indivíduo. Los ramos son mui lisos, la base mui arrugada i verrucosa, la rosa es mui gruesa, con verrugas mui gruesas, mucho mas grandes que en el guemul.

El venado de Cajamarca se distingue, pues, fácilmente en su esterior del taruga i del guemul, mientras es mui difícil hallar caractéres esteriores para distinguir estos, uno de otro; para poderlo hacer, sería necesario tener, simultáneamente a la vista, indivíduos vivos o embalsamados de estas dos especies.

## COMPARACION DE LOS CRÁNEOS DE LOS *CERVUS BRACHYCEROS* I *C. ANTISENSIS.*

Si miramos los cráneos de arriba, véase lámina III, fig. 1*a* i 3*a*, notamos luego:

1°. Que el occiput tiene una forma mui distinta: en el *C. brachyceros* se adelgaza para atras i es troncado, en el *C. antisensis* es poco adelgazado i semicircular. Mas grande es aun la diferencia cuando se mira este hueso por atras, véase mas adelante.

2°. Las protuberancias óseas, que llevan los cuernos, son mas distantes entre sí en el *C. brachyceros* que en el *C. antisensis*, i esto no solo relativa sino absolutamente, siendo que esta distancia es de 4 cm. en el cráneo del *C. chilensis* i de casi 5,5 cm. en el del *C. brachyceros*, aunque este es algo menor; son un poco mas delgadas en el último.

3°. El liston lonjitudinal, que corre en medio de la frente, es mas angosto, pero mas elevado, casi aquillado en el *C. brachyceros* que en el otro.

4°. Los hoyos encima de la órbita son en este mas angostos, ménos hondos, pero están mejor limitados que en el *C. antisensis.*

5°. El foramen naso-maxillare tiene otra forma, remata arriba en una punta sencilla como en el *C. chilensis*, mientras que está redondeado en su estremidad, i muestra ademas una espina bastante prominente en el borde del cráneo del *C. antisensis.*

6°. Los huesos nasales del *C. brachyceros* son mas angostos i de la lonjitud de los frontales, (en el cráneo de la hembra son un poco mas cortos; no se puede decir, si esta diferencia es sexual o simplemente individual); su márjen anterior está profundamente escotado, de modo que presenta tres puntas agudas; en fin la nariz es mui comprimida, su dorso angosto.

7°. Todo el hocico es mas angosto. En la forma del hocico i del occiput el cráneo se parece mas al del *C. chilensis* que al del *C. antisensis.*

8°. El márjen inferior de la órbita sale mas afuera en el *C. brachyceros*, lo que hace aun mas notable el adelgazamiento del occiput i del hocico.

Miremos ahora los cráneos del lado, véase lam. IV, fig. 2 i 3.

1°. Los huesos nasales del *C. brachyceros* son mas declives que los del *C. antisensis.*

2°. El foramen naso-maxillare presenta tambien en esta vista diferencias notables, se conoce que es mas ancho que en el taruga, que aun su borde anterior es distinto etc.

3°. En el cráneo del *C. brachyceros* se observa un canto marcado, que nace debajo del foramen naso-maxillare i corre paralelo al márjen inferior del hueso maxilar hasta el hueso intermaxilar, siendo que esta rejion está redondeada en el *C. antisensis.*

4°. El hueso intermaxilar está separado por bastante distancia del hueso nasal en el *C. antisensis*, mientras que alcanza casi a tocarlo en el *C. brachyceros.*

De mas importancia quizás son las diferencias que nos muestra el hueso occipital, cuando lo miramos por atras, véase lám. III, fig. 1 *b* i 3 *b.*

1°. En el *C. brachyceros* la parte perpendicular es mucho mas angosta (57 mm.) que en el *C. antisensis* (66 mm.), aun si queremos dar al primero 1 ó 2 mm. mas por ser el cráneo un poquito mas pequeño.

2°. El márjen superior del foramen magnum está escotado en el *C. brachyceros* i, al contario, presenta una prominencia en el *C. antisensis.*

3°. La cresta semicircular, que separa la parte perpendicular del hueso de la parte superior i de las laterales, es lisa i cortante en el *C. brachyceros*, pero áspera i como porosa en el *C. antisensis*: ¿Dependerá acaso esto de la edad?

El primero de los dientes incisivos es el mayor, tiene la forma de una pala oblícuamente troncada, el segundo es un poco mas corto, tiene apénas la mitad de la anchura del primero, es mui oblícuamente troncado; de cada lado hai un surco paralelo al borde; mas angostos i mas cortos son aun el diente tercero i cuarto, pero muestran los mismos surcos; el surco interior es siempre el mas corto. El primer diente no tiene sino un leve indicio de estos surcos. Véase lám. III, fig. 1 *c.* Los incisivos del *C. antisensis* son casi idénticos. El diente canino falta enteramente, o bien cae tan luego, que en el estado adulto no queda vestijio de su alveola. No veo tampoco traza del canino en el cráneo de mi taruga.

No puedo encontrar otra diferencia entre el cráneo del macho i el de la hembra de mi *C. brachyceros*, por supuesto haciendo abstraccion de las protuberancias que llevan los cuernos en el primero, sino que los huesos nasales son en la hembra mas cortos (55 mm.) que los huesos frontales (64 mm.). Me ha llamado la atencion que casi todas las suturas del cráneo son mui crespas.

## DIFERENCIAS ENTRE LOS CRÁNEOS DE LOS *CERVUS ANTISENSIS* I *C. CHILENSIS.*

Gervais, que pudo comparar el cráneo de un jóven guemul macho del largo de 7 pulg. 10 líneas con el del *C. antisensis*, indica las diferencias siguientes entre ellos, véase la Zoolojía de la obra de Gay I, p. 161. «Este carácter [de los cuernos] aproxima mucho [el guemul] al *C. antisensis* D'Orb., que se encuentra en las cordilleras de Bolivia; pero los incisivos [del guemul?] son algo mas pequeños i el espacio interorbital es mas ancho. El hueso incisivo llega hasta los huesos de la nariz, i se une a ellos en una lonjitud de ocho líneas [? en la figura esta sutura mide solo 2 líneas i media, i como la figura es mas que la mitad del natural, puesto que mide casi 5 pulgadas, resulta solo una lonjitud de la sutura de 3,4 pulgadas] cada hueso nasal está algo escotado en su borde anterior; la sutura maxilo-palatina es transversal. El cráneo que tenemos tiene siete pulgadas i diez líneas de lonjitud..... solo cuatro pares de muelas han salido de las alveolas.... en fin la mandíbula superior tiene pequeños colmillos.» La figura muestra que en la mandíbula inferior habían salido *cinco* muelas afuera.

El carácter de los huesos incisivos o intermaxilares unidos a los nasales distingue, pues, el cráneo del guemul del cráneo del taruga. Voi a indicar las otras diferencias.

Visto de arriba el cráneo (lám. III, fig. 1 *a* i 2 *a*), se nos presentan las siguientes variedades:

1°. El *C. chilensis* muestra una prominencia como muralla, que corre desde las prominencias que llevan los cuernos, en direccion paralela hasta la órbita; en el taruga no hai indicio de la tal prominencia, en el *C. brachyceros* tampoco.

2°. El hoyo lonjitudinal, que hai en la frente de cada lado encima de la órbita, es mucho mas hondo, pero mas angosto que en el *C. antisensis.*

3°. Vemos en la línea mediana de la frente del *C. antisensis* un rodete, del cual no hai vestijio alguno en el guemul, el que, al contrario, en la mitad anterior de la frente tiene una depresion marcada.

4°. Los huesos nasales son mas largos en el guemul (96 mm.) que en el *C. antisensis* (76 mm.); sus márjenes superiores son rectilíneos i forman júntos un ángulo algo agudo; en el taruga están arqueados con una pequeña escotadura en el punto donde se juntan; tienen otra forma, i la mitad inferior de la nariz está mucho mas comprimida en el guemul que en el taruga.

5°. La abertura nasal del *C. chilensis* es mucho mas corta que la del *C. antisensis*, i el borde anterior un poco distinto.

6°. El hocico del guemul es mucho mas angosto.

7°. El occiput, visto de arriba, es mas angosto posteriormente en el guemul, aproximándose en su forma al del *C. brachyceros.*

Si miramos los cráneos del lado (lám. IV, fig. 1 i 2), notamos lo siguiente:

1°. La rejion interorbital es mucho mas deprimida en el taruga que en el guemul, i la rejion nasal mas elevada; la altura del hocico en la rejion de la estremidad anterior de los huesos nasales es en el *C. antisensis* de 34 mm., en el *C. chilensis* de 27 mm.

2°. El hueso lacrimal muestra en el *C. antisensis* un hoyo poco profundo con un gran agujero en el centro; en el *C. chilensis*, al contrario, un hoyo mui hondo no perforado; los dos agujeros en el borde anterior de la órbita son mui grandes en el *C. antisensis* i chicos en el *C. chilensis.*

3°. El foramen naso-maxillare es mui diferente en las dos especies, en el guemul está separado por un tabique rectilíneo del profundo hoyo del hueso lacrimal, es mas corto i no desciende tanto como en el *C. antisensis*; forma arriba un ángulo puntiagudo, mientras que en el taruga la estremidad superior del foramen está redondeada i dividida en dos, por una punta que sale del borde como una espina.

4°. En el guemul los huesos intermaxilares se tocan con los nasales en la lonjitud de 9 mm. [pero no de ocho líneas como dice Gervais, podemos suponer que por un error de pluma ha escrito líneas en lugar de milímetros], mientras que hai en el taruga un espacio de 3 mm. de ancho entre estos huesos.

5°. El hueso maxilar del guemul es mas alto en su centro (15 mm.) que el del taruga (10 mm.).

6°. Los huesos parietales son casi planos en el *C. antisensis* i bastante combados en el *C. chilensis.*

7°. Los huesos maxilares son mucho mas largos en el *C. chilensis*; la distancia entre el foramen naso-maxillare i el hueso intermaxilar es casi el doble que en el *C. antisensis.*

Omito las diferencias en la forma etc. de la mandíbula inferior entre las dos especies, porque algunas llaman poco la atencion, i otras son la consecuencia necesaria de la forma mas o ménos ancha del hocico.

Todos los dientes del guemul son mas fuertes que los del taruga, sobre todo hai una gran diferencia en los incisivos, que tienen el doble tamaño de los del *C. antisensis*, aunque Gervais dice lo contrario en el lugar arriba citado. Compárese la lám. III, fig. 2*c*, dientes del guemul, con la fig. 1*c*, dientes del taruga. (Nuestro cráneo de está última especie había perdido la mayor parte de sus dientes).

La inspeccion de la parte perpendicular del occiput, dibujada en la lám. III, muestra a primera vista, que esta parte del cráneo es poco diferente en los guemules i tarugas, mientras que difiere mucho mas en el *C. brachyceros.* En el *C. chilensis* el márjen superior del agujero occipital está anchamente escotado; en el *antisensis* es prominente en su parte central. En el *C. chilensis* vemos un surco lonjitudinal mui ancho i bastante hondo que desciende en la mitad inferior de la altura hasta el borde del agujero occipital, en el *C. antisensis* hai apénas un indicio de este, pero en la parte superior desciende, en la línea mediana, una especie de liston lonjitudinal ancho arriba, angosto i casi cortante abajo, que se pierde en la mitad de la altura. El *C. chilensis* muestra dos profundos hoyos transversales contiguos al márjen superior de los cóndilos, estos hoyos son poco hondos i mucho ménos sensibles en el *C. antisensis.*

Debo decir algunas pocas palabras sobre los cuernos de las dos especies tan parecidas entre sí, el guemul i el taruga. A las formas del primero, dibujadas en mi memoria «El guemul de Chile» tengo que agregar dos mas. La primera es la de los cuernos del cráneo que tenemos. Estos cuernos, dibujados en la lám. IV, fig. 1*a* i 2*a*, como se mostraban despojados de la cutis peluda que los cubre todavía i que no quise quitar, son perfectamente duros, así es que han adquirido ya su magnitud definitiva. Se elevan perpendicularmente i las puntas de los ramos posteriores, que se deben considerar como el cuerno principal, distan solo ocho centímetros una de otra. Los dos cuernos son casi iguales, sus ramos están encorvados del mismo modo i pueden considerarse como normales i típicos, aunque difieren bastante de la forma del cuerno que Brooke da como típica del subjénero Furcifer.

Los otros cuernos son mui distintos, i se comprende que un naturalista podría establecer sobre ellos, no solo una especie sino un nuevo subjénero, si no supiesemos que los cuernos son mui variables en esta seccion del jénero ciervo; se hallan en el guemul embalsamado que proviene del valle del Rio Longaví, i los he dibujado en la lám. IV, fig. 4. Son mui diverjentes i se inclinan mucho hácia atras, todo lo contrario de los cuernos del cráneo fig. 1; el ramo anterior del cuerno derecho es mui largo i produce luego, despues de su oríjen, otro ramo corto i puntiagudo; el ramo mayor muestra en su lado esterior, un poco debajo de su punta, una prominencia obtusa, que no es otra cosa que el principio de un ramo. En efecto, el gran ramo del cuerno izquierdo tiene en este lugar un verdadero ramito corto i puntiagudo; el ramo anterior de este lado es casi igual al ramo del cuerno derecho, i tiene en su base el mismo diente corto i puntiagudo, pero ademas, un poco debajo de su centro, muestra tambien una prominencia obtusa o sea el rudimento de otro ramo, así es que podemos decir que tiene cinco puas.

La circunstancia, de que se han establecido jéneros o subjéneros en el taruga, basados sobre cuernos anómalos prueba que aun en esta especie varían los cuernos; lo prueban tambien los cuernos del cráneo que tenemos, veáse lám. IV, fig. 2 i fig. 2 *a*. Están mui aproximados uno al otro, pues la distancia entre las apófises óseas es solo de 43 mm., son mui diverjentes i están inclinados mucho hácia atras. Cuando el animal fué muerto no estaban todavía maduros, las estremidades son todavía blandas i sus puntas cortadas; el cuero que los cubría, había sido quitado. El ramo principal del lado derecho se ensancha notablemente arriba, el corte prueba que estaba para dividirse en dos ramitos; ántes de su medio actual había emitido un ramito corto *dirijido atras i al interior*. El cuerno izquierdo es mucho mas corto que el derecho, i no tiene otro ramo que el correspondiente al ramito inferior del cuerno derecho, pero que es un poquito mas largo. El ramo principal del cuerno derecho tiene, debajo de su bifurcacion terminal, una protuberancia que no pudo indicarse en la figura. La lonjitud del cuerno derecho es desde la rosa hasta la bifurcacion 11 cm., la del cuerno izquierdo 9 cm., la distancia entre las puntas habría sido algo mas de 20 cm.

Examinemos ahora un poco el valor de los caractéres empleados para distinguir el jénero o subjénero Furcifer de los demas ciervos. Sir Victor Brooke indica como tales en su trabajo «On the Classification of the Cervidae» Proceed. Zool. Soc. 1878, p. 924 los siguientes: «Cuernos del largo de la cabeza, con un fuerte ramo ocular (fig. 17 *a*), [que he reproducido en mi lámina I, fig. 3], curvado adelante i arriba, i formando ángulo recto con el simple tronco, que está adelgazado en una punta aguda. Todo el cuerno [beam] está suavemente encorvado hácia adelante.» Hemos visto que los cuernos de los *Cervus antisensis* i *C. chilensis*, únicas especies del jénero o subjénero Furcifer, son mui variables en su forma, i si quisiéramos atenernos a los caractéres, que nos da el señor Brooke, ninguno de los guemules de nuestro museo, ni el cráneo del taruga mismo, podrían entrar en el jénero Furcifer.

Sigue: «Fosa lacrimal profunda, pero de moderada estension de adelante para atras.» Hemos visto que solo el *Furcifer chilensis* tiene esta fosa mui honda, pero no el *Furcifer antisensis* (ni el *Cervus brachyceros*), luego el taruga debería escluirse del subjénero Furcifer i formar nuevo subjénero.

«Ampollas auditorias mui poco infladas, arrugadas en su superficie esterior.» No tengo nada que observar.

«Ramo ascendiente del hueso premaxilar [intermaxilar, incisivo] articulando [sic!] con los nasales.» Hemos visto, que esto se observa solo en el *F. chilensis*, pero no en el *Furcifer antisensis* (ni en el *Cervus brachyceros*); habría, pues, otra razon para retirar el *Furcifer antisensis* del jénero

(Gray) o subjénero (Brooke) Furcifer, i de hacer de él un nuevo jénero o subjénero; el *Cervus brachyceros* sería el tercero.

«Estremidades libres de los huesos nasales, formando juntos una sola punta.» Hemos visto que este no es el caso, ni en el *Furcifer chilensis*, ni en el *Furcifer antisensis* (ni en el *Cervus brachyceros!*), véase la lám. III.

«Incisivos centrales escediendo mui poco («very slightly») en tamaño al par contíguo, i solo poco espatulados.» En el guemul no hai mucha diferencia, es cierto, pero ¿cómo es en el taruga?; a juzgar por la dentadura del *C. brachyceros*, tan semejante por su dentadura, debe haber *mucha* diferencia, i el primer diente incisivo de este ciervo se puede mui bien llamar espatulado.

«Colmillos superiores en los dos sexos.» No veo ningun vestijio de colmillo en el cráneo del *Furcifer antisensis* (ni en el masculino ni en el feminino del *Cervus brachyceros*); parece que solo el *C. chilensis* los tiene, i que son caedizos. «Rinario como en Cariacus. Estatura mediana.»

¿Qué valor tienen, pues, estos caractéres jenéricos o subjenéricos? Evidentemente ninguno.

Me permito preguntar en jeneral ¿qué ventaja hai en subdividir tanto hasta los jéneros mas naturales, sea en la botánica, sea en la zoolojía i, sobre todo, en dar a cada subdivision el título de *subgenus* i un nombre particular? Los inconvenientes son mucho mas grandes que las ventajas: en primer lugar, se carga demasiado la memoria, i en segundo lugar, lo que es mucho mas importante, se levanta una barrera casi invencible entre los especialistas i los naturalistas que abrazan un campo mas vasto, i mucho mas entre los especialistas i las personas ilustradas que no son naturalistas de profesion. Si yo quisiera decir en un trabajo, que no fuera destinado a los especialistas del ramo, que existen en las cordilleras del Perú, de Bolivia i de Chile tres especies de Furcifer o de Cariacus, a lo ménos las nueve décimas partes de mis lectores preguntarán ¿qué cosa es un Cariacus o un Furcifer? Será una planta? un pájaro, un caracol, una serpiente?, pero si digo que hai en esas rejiones tres especies de *Cervus*, todo el mundo lo entiende. Si digo: «hai en Chile muchas especies de murides o musideos», puedo estar bien seguro que no habrá veinte personas en Chile que sepan lo que son estos murides, i la mayor parte creerán que deben ser animales raros, que tienen solo interes para los sabios, i no lo pueden tener para nadie mas, puesto que no tienen un nombre que se conoce. Lo mismo sucede con las plantas. Si yo dijera que había hallado en alguna parte un *Leiolobium*, poquísimas personas, aun entre los botánicos, sabrían que cosa es, mientras todo el mundo, aun legos en la botánica, lo sabrían, si yo hubiese empleado la palabra de *Nasturtium* en lugar de *Leiolobium*.

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IMPRENTA DE F. A. BROCKHAUS, LEIPZIG.

Fig. 1

Fig. 3

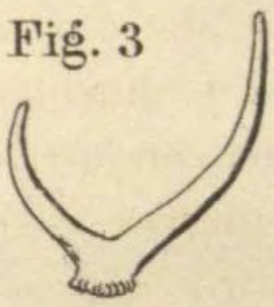


Fig. 2



*Dr. R.A. Philippi del.*

Fig. 1. *Cervus chilensis Gay et Gerv.* – Fig. 2. *C. antisensis D'Orbigny.* – Fig. 3. *Furcifer Brooke, cornua.*

Fig. 3a

1/1

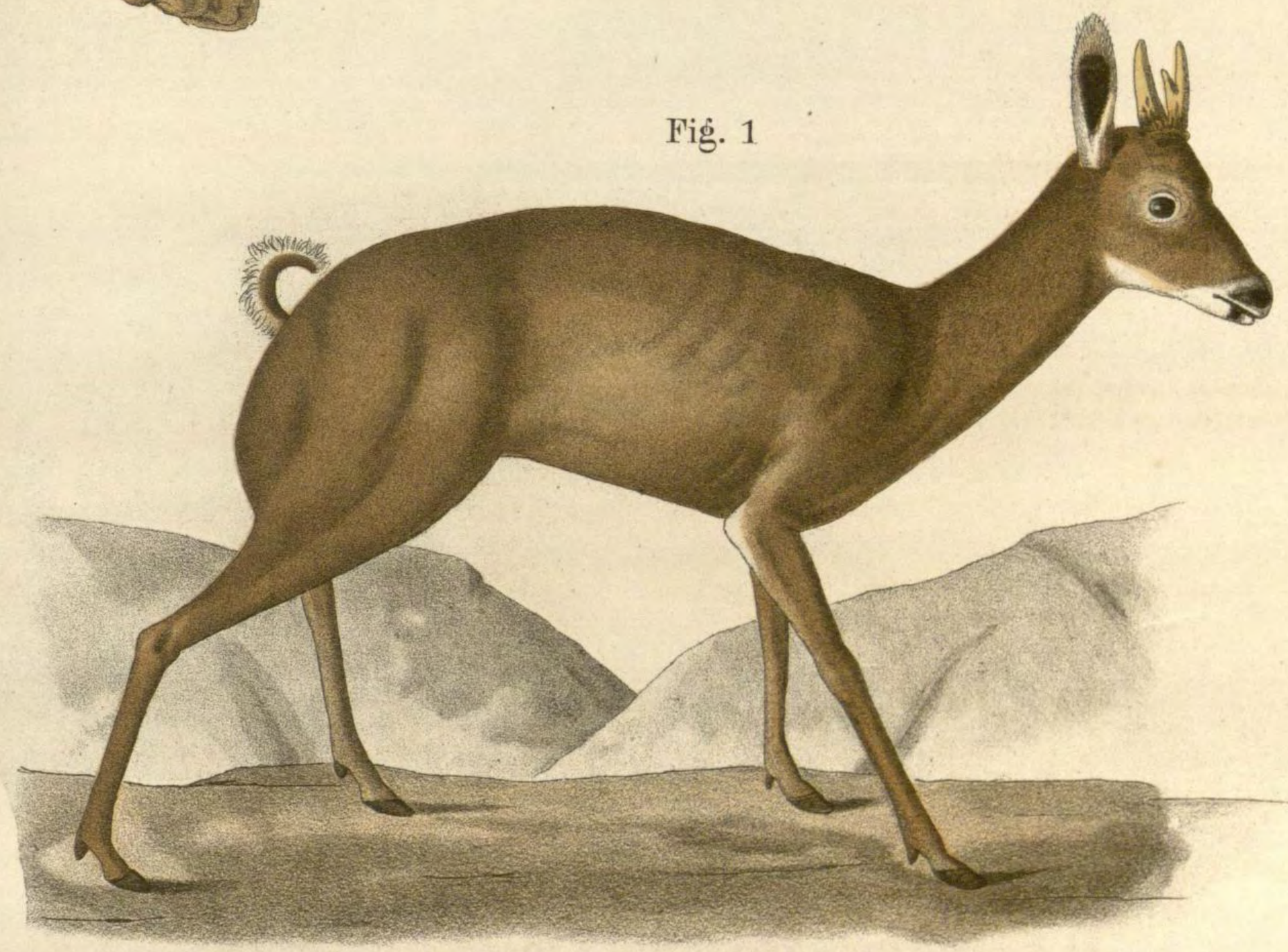
Fig. 2

1/2

Fig. 3b

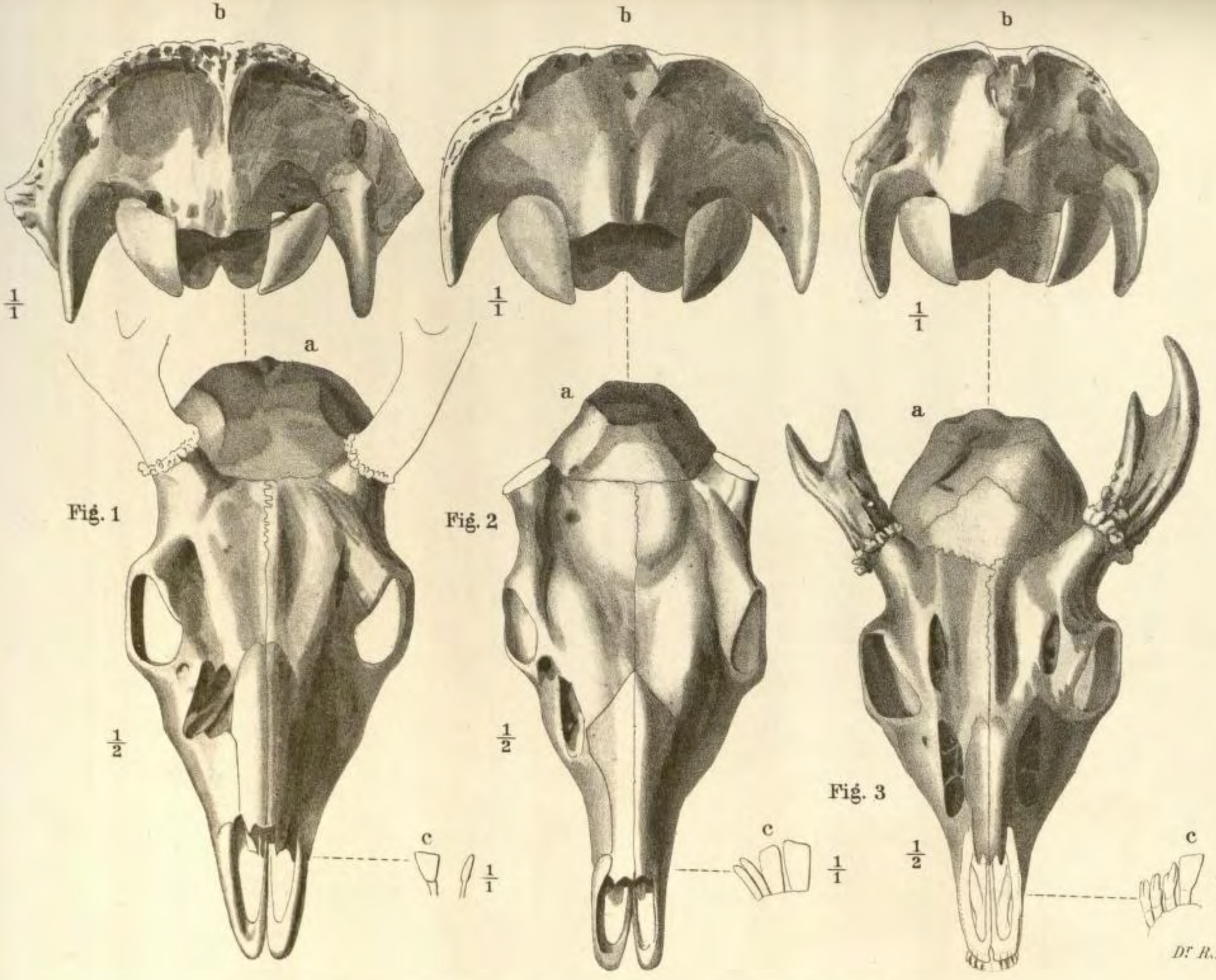
1/1

Fig. 1



*Dr. R.A. Philippi del.*

*Cervus brachyceros Ph.*




Dr. R.A. Philippi del.

Tab. III.

Fig. 1 *a, b, c. Cervus antisensis.* — Fig. 2 *a, b, c. C. chilensis.* — Fig. 3 *a, b, c. C. brachyceros.*

Fig. 1

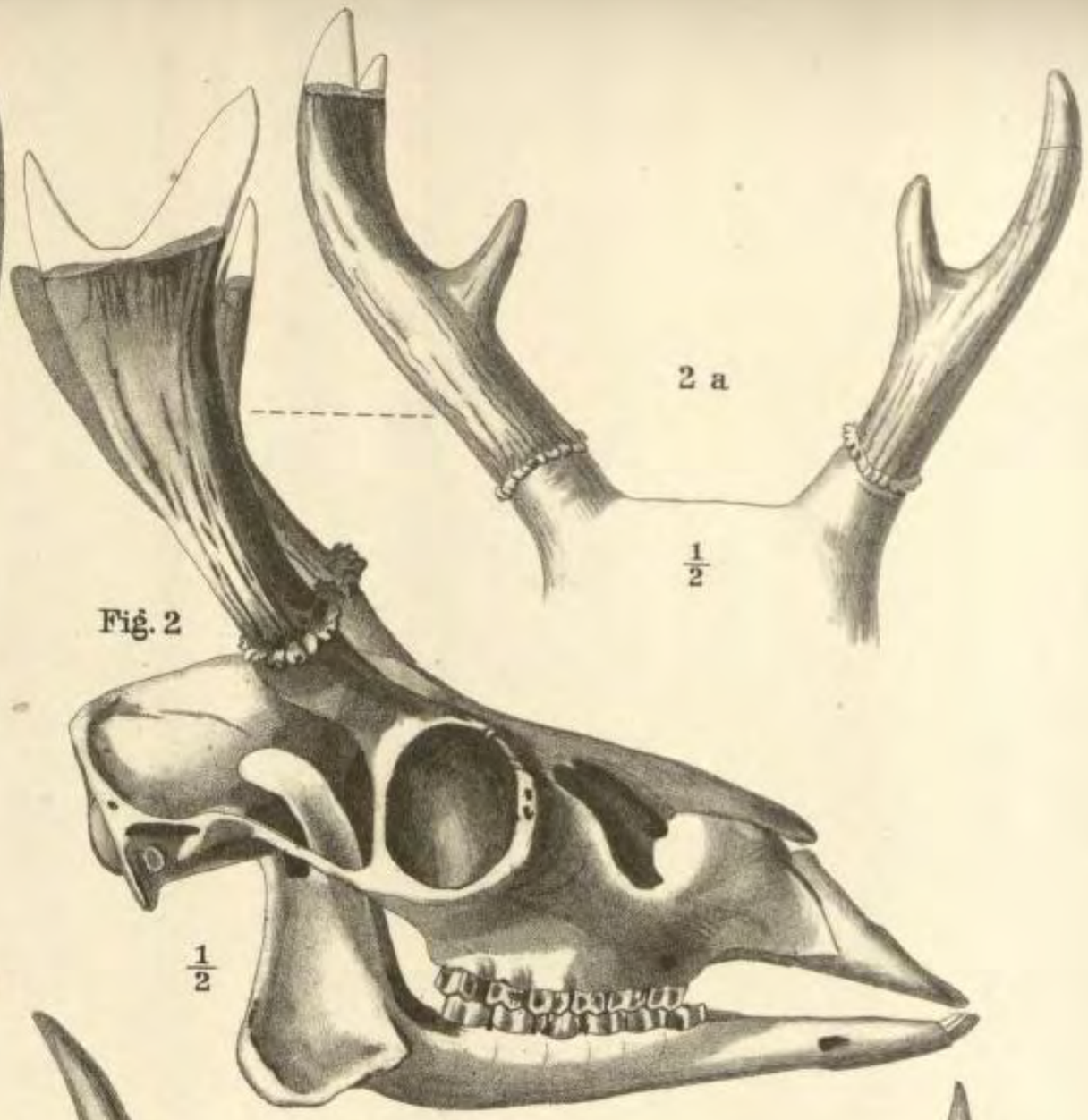
1 a



$\frac{1}{2}$

$\frac{1}{2}$

Fig. 2



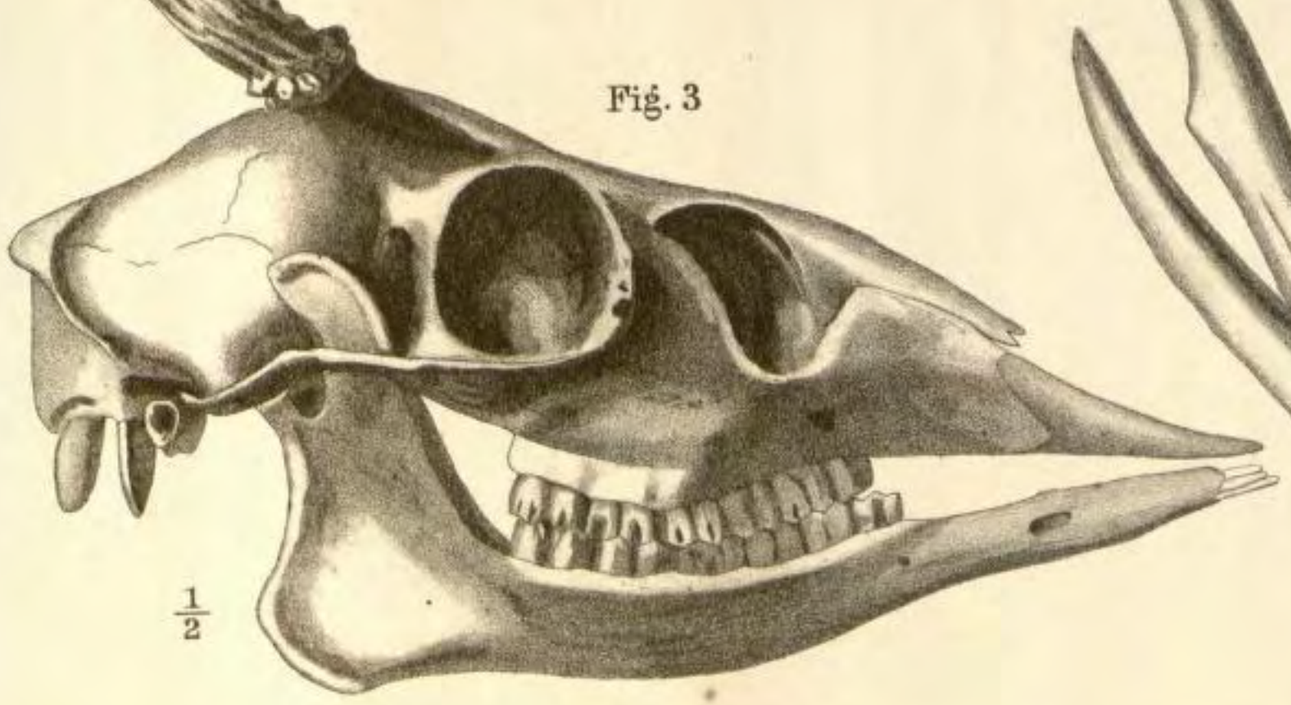
2 a



$\frac{1}{2}$

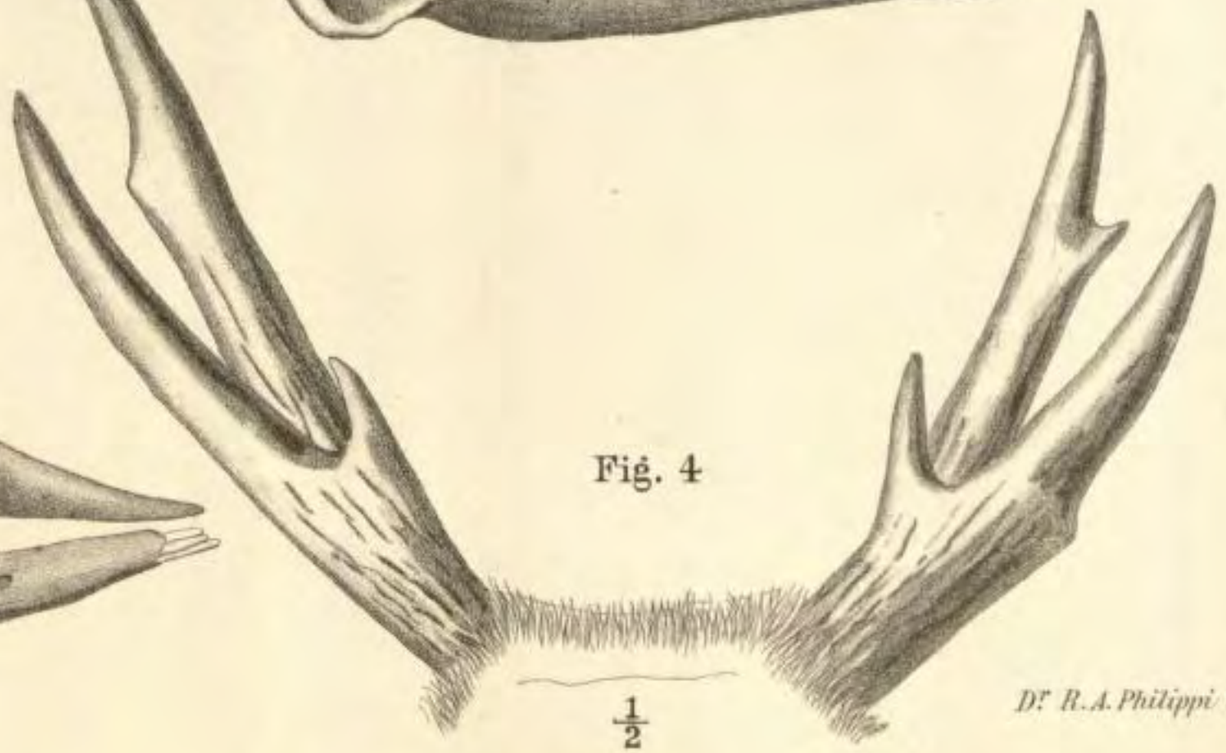
$\frac{1}{2}$

Fig. 3



$\frac{1}{2}$

Fig. 4



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Tab. IV.

*Dr. R.A. Philippi del.*

Fig. 1. *Cervus chilensis.* — Fig. 2. *C. antisensis.* — Fig. 3. *C. brachyceros.* — Fig. 4. *C. chilensis de Longavi, cornua.*

Werner T. Flueck, Ph.D.
CONICET

# Remarks on the misclassifications of huemul, taruca, and *Cervus brachyceros* by Philippi (1894) [13]

# 3

In essence, the corrected labeling of the skulls in Philippi's paper are as follows:

a. The skull labeled by Philippi as huemul *(Cervus chilensis)* in Tables 3 and 4 is a taruca (*Hippocamelus antisensis)*.

b. The skulls labeled by Philippi as taruca *(Cervus antisensis)* and a new species *(Cervus brachyceros)* in Tables 3 and 4 belong to completely different genera (named *Cariacus* spp. by Nehring [8]).

At that time two schools of thought were prevalent: several authors believed that there is only one species of Andean deer, occurring from southern Chile to Ecuador, while others claimed that the huemul and taruca represented two different species. Philippi believed that the huemul and taruca were the same species with simply two different current names according to their location. He published this opinion on various accounts and as late as 1892 (e.g. [10, 11, 12]). However, as he stated in his 1894 paper, in 1893 he purchased a skull from Bolivia which he considered to be from a taruca. At the same time he received another complete skull from Alto-Bolivia which he considered to be from a huemul and used it as such because he only had one available huemul skull (!) from Magellanes, but with the anterior half missing. These two newly acquired skulls together with some from another cervid species kept at the Santiago Zoo lead to his publication of 1894]4690 on the differences between *Cervus antisensis, C. chilensis* and *C. brachyceros*. As late as 1941 this paper by Philippi still caused taxonomic confusion [3] and Krieg [4] continued to consider huemul and taruca as only subspecies. However, Nehring already correctly criticized Philippi's paper in 1895 as follows [8]:

1. Nehring states that Philippi [13] did not cite and consider two reports by Nehring about huemul and taruca [6, 7], although Philippi cited every other existing publication even when of doubtful content.

2. Nehring said that the "very old colleague Philippi" (who was 86 when publishing this article) unfortunately had arrived at several erroneous conclusions, principally because he used a cervid skull bought in 1893 from Bolivia.

3. Philippi identified this bought skull from Bolivia as a taruca without sufficient critic. Furthermore, Philippi used a rather unfounded note published by Sclater [16] and included *C. brachyceros* along with the taruca and the huemul in the same taxonomic group.

4. Nehring based his conclusions on examining an adult male skull and a mounted head of taruca from scientific collections, a live male taruca living several years at the Zoological Garden he worked for, the skin and skull of the aforementioned male, the skull and full mount of an adult huemul in their museum, a skull of a male huemul collected in Patagonia, another skull of a male huemul from Patagonia, and a skull of a male huemul from southern Chile.

Nehring's specific results were as follows:

a. The skull identified by Philippi as taruca belongs to the genus *Cariacus*, most likely C. *peruvianus*, or Peruvian mazama (also see Matschie [5]).

b. The newly declared species by Philippi, *C. brachyceros*, also belongs to the genus *Cariacus*.

c. Based on Nehring's specimens it is clear that both taruca and huemul have very deep antorbital pits (lacrimal fossa) which are depicted as shallow in Philippi's *Cervus antisensis* and *C. brachyceros*. Furthermore, the rostral fenestration is small in both taruca and huemul, however they are large in Philippi's *C. antisensis* and *C. brachyceros*.

d. The premaxilla reaches and borders the nasal bone in both taruca and huemul in the same way. However, *C. antisensis* and *C. brachyceros* in Table 4 of Philippi show clearly that these bones are separated, as occurs in *Cariacus*.

e. In male taruca and huemul the pedicels are nearly parallel to the main antler beam. In *Cariacus*, on the other hand, the main beam clearly leans posteriorly and in older individuals the tips recurve forward, as Philippi noted for his *C. antisensis* and *C. brachyceros*.

f. In taruca and huemul antlers, the side branch (usually one) always points forward and is sloping upward. *Cariacus*, however, has a tendency toward multiple points and particularly a lower point (a brow tine) bent inwards (e.g., Fig. 2a, Table 4 in Philippi).

g. The antlers in Fig 4 (Table 4) of Philippi's "huemul" are thus unlikely from *C. chilensis*.

h. The incisors of both taruca and huemul are very similar and have the peculiarity that the $I_2$ is nearly as big as $I_1$,and also $I_2$ and $I_3$ are very big (as published by Nehring [7]). Philippi, however, maintained that the incisors of taruca and huemul were different, another indication that the *C. antisensis* skull is erroneously identified.

i. Philippi considered a drawing by Schäff of a taruca as incorrect[17]. However, Nehring states that it was the only drawing based on a live animal which had lived at their Zoo for several years. Furthermore, he had seen it many times himself while observing it or feeding it over the years and thus confirmed that it was an absolutely correct drawing of a real taruca.

j. Based on skull measurements of taruca and huemul in his collection, Nehring determined that the *Cervus chilensis* skull of Philippi was a taruca skull, which also explained why other

dimensions and the antler shape were more similar to taruca.

k. The huemul has a higher snout with a ram-like profile while the taruca snout is lower and proportionally longer, without a ram-like profile, supporting that Philippi's *C. chilensis* was a taruca.

**An interpretation of what happened:**

Although huemul and taruca have both been placed in several genera including *Cervus*, *Mazama* and *Cariacus* [9], the identity of Philippi's *Cervus antisensis* and *C. brachyceros* remains open. Nehring placed both specimens in the genus *Cariacus*, but there are alternative possibilities of interpretation.

On the one hand, a *Mazama nemorivaga* was described to occur sympatrically with taruca [9]. According to Whitehead [19] the authors referred to the grey brocket deer (*Mazama gouazoubira*). In addition, a *Mazama tschudii*, also called *Cariacus whithelyi*, was said to live sympatrically with taruca [9, 16]. According to Whitehead [19] it also referred to grey brockets inhabiting at elevations up to 4,900 m. A third species was described as *Cariacus peruvianus* [9, 16] or *Mazama americana peruviana* [19] which apparently normally lived at elevations at 3,350 m below the altitudinal range of the taruca. However, taruca are known to also occur down to elevations of 2,500 m [14]. Matschie [5] refers to *Cariacus peruvianus* as one of the *Mazama* species which occurs in taruca areas based on the collection site, but he also states that it gets replaced further north by *C. virginianus* [i.e., the white-tailed deer, *Odocoileus virginianus*]. Also Sclater [16] believed that *C. peruvianus* was a southern diminutive race of either *C. virginianus* or *C. columbianus* (i.e., *Odocoileus*). Whitehead [19] lists *Odocoileus virginianus peruvianus* as well as some *Mazama* sp. as occurring in or near potential habitat of taruca. Therefore, it is possible that Philippi bought and received specimens of either *Odocoileus* or *Mazama* species. Smith et al. [18] evaluated skull dimensions of white-tailed deer and *Mazama* species from South America. Based on their measurements, it is likely that Philippi's *Cervus brachyceros* was a mazama deer and his *Cervus antisensis* a white-tailed deer. As a result, Cabrera [3] considered several features of the huemul skull as only of specific importance because Philippi's description of taruca features did not coincide with his observations on huemul skulls. However, these features may represent generic significance.

It is interesting to note that Philippi published a note in 1870 [11] in response to an article describing a new cervid species from Chile. He said that it is impossible that the people in Chile would not know such a large and unusual animal as described, and therefore concluded that it was not a new Chilean cervid. He certainly believed the author that the specimens were PURCHASED in Valparaiso, but added that it was common to obtain specimens imported to Valparaiso from anywhere in Latin America including Mexico, even live animals. He then warned scientists to be careful when obtaining specimens from another country before drawing conclusions. However, in his publication of 1894, Philippi used one bought skull of a Bolivian deer to describe a taruca, i.e., he assumed that it was a taruca based on its geographical origin. He further said that a few days earlier he had obtained a complete skull of a huemul (his assumption) from the Alto-Bolivia, which he then used as the "huemul" skull because his only available skull from a true huemul (as it came from Magellanes) had its anterior half missing. His *Cervus brachyceros* skulls were accompanied by their respective skins and based on their description it is clear that these cervids were not related to huemul or taruca. However, he did not explain how these deer arrived at the Santiago

Zoo. Based on its body size it could easily be a white-tailed deer or a mazama. Whitehead [19] indicates that 20 kg is the body weight of the smallest races of white-tailed deer in South America, while *Mazama americana* and *M. gouazoubira* reach 65 and 25 kg, respectively [1, 18, 19]. Therefore, there is great overlap of body size between South American white-tailed deer and mazama, and the skulls labeled by Philippi as *Cervus antisensis* (taruca) and *C. brachyceros* belong to either of these two genera.

I determined the most likely identity of the skulls examined by Philippi as follows (see also Fig. 3 in this book):

1. The skull labeled as *Cervus chilensis* or huemul belongs to a taruca (*Hippocamelus antisensis*):

   A. The skull came from Alto-Bolivia.
   B. The size clearly corresponds to taruca [8].
   C. The shape and proportions indicate it to belong to taruca [8].
   D. The 25 degree angle formed between the pedicels is typical of *Hippocamelus* [3].
   E. The antlers shown in Fig. 4, table 4 of Philippi [13] and labeled as huemul clearly differ from those of *Hippocamelus.* The pattern of multi-branching, the inwardly curving brow tines, the 65-70 degree angle between antler beams, and the description of hair agree with those of *Odocoileus*.

2. The skull labeled as *Cervus antisensis* or taruca belongs to white-tailed deer (*Odocoileus virginianus*):

A. The skull was bought in Bolivia which is within distribution of white-tailed deer.
B. The premaxillae do not reach the nasal bones [3, 15].
C. The antlers branches turn posteriorly and the 65-70 degree angle formed between pedicels is typical of *Odocoileus virginianus* [3].
D. The brow tines are oriented inwardly and the antlers exhibit multiple forking, characteristics of *Odocoileus virginianus* [3].
E. The form of the rostral fenestration is not typical of *Hippocamelus*.
F. The nasal bone lengths is 76 mm (70-88 mm in *Odocoileus virginianus* ; 70 mm in *Mazama americana* and 58 mm in *M. gouazoubira*) [18].
G. The skull size is within the range skull size for *Odocoileus virginianus*.
H. The posterior ends of the nasals are separated such that a small process of the frontals extends wedge-wise between them, a feature typical in *Odocoileus* but not in *Hippocamelus* [3].
I. The mandibular incisiform dentition and canines are typical for *Odocoileus* [3].

3. The skull labeled as *Cervus brachyceros* belongs to red brocket deer (*Mazama americana*):

   A. The shoulder height was 66 cm: in *Mazama americana* it can reach 71 cm, and in the brown brocket (*M. gouazoubira)* it averages 61 cm..
   B. Antlers can bifurcate in *M. americana* (such as Fig. 3, Table 3 in Philippi) [2, 19].

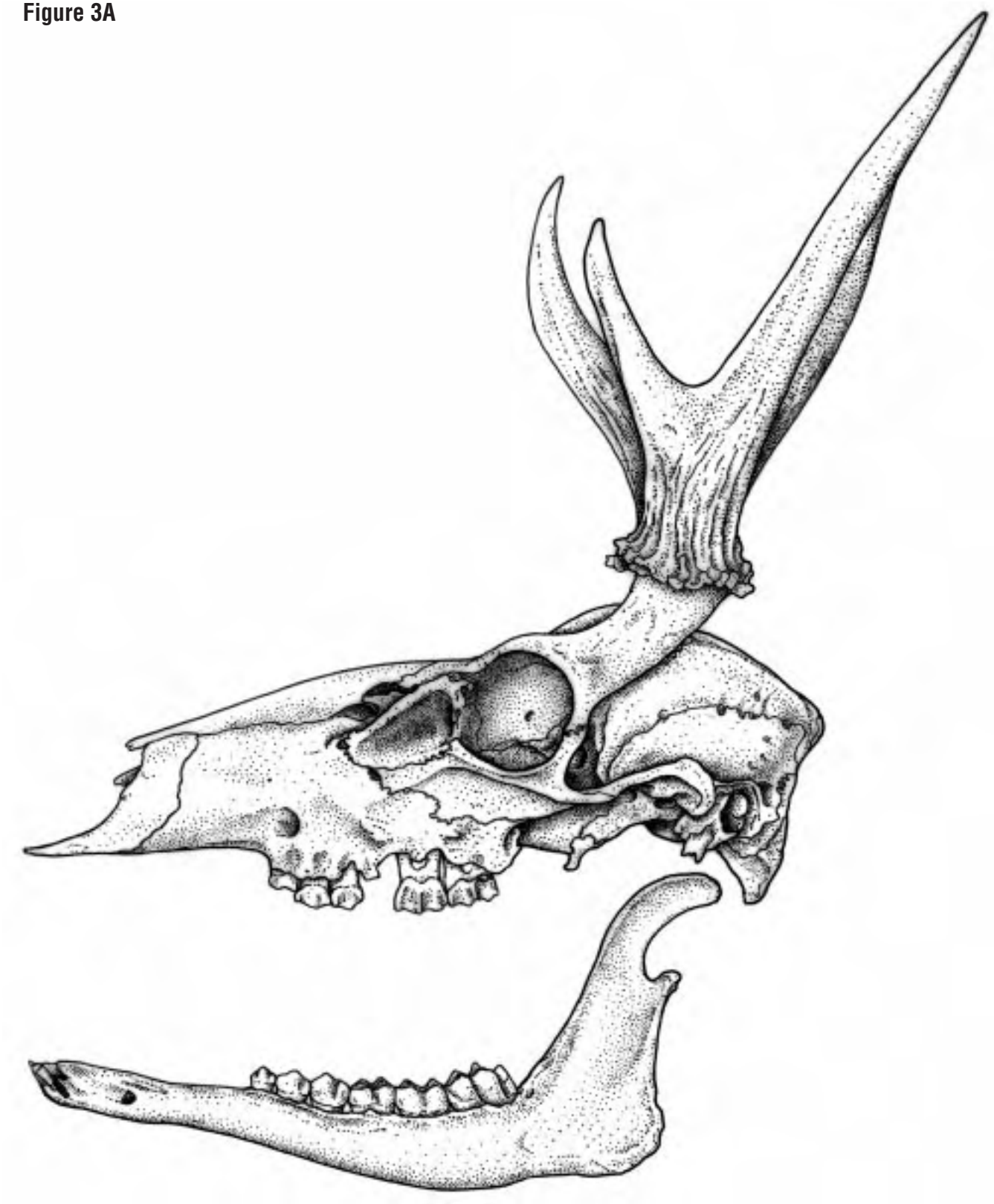
C. The rostral fenestration, the angle formed by the pedicels and general physiognomy agree with the *M. americana* skull depicted in Redford and Eisenberg [14].

D. The skull length coincides with that shown by Redford and Eisenberg [14], in both cases of adult males. Branan and Marchinton [1] measured skull lengths even larger.

E. The fur was described as shiny, a feature typical of *M. americana* [14].

F. Philippi identified three animals that were brought to the Santiago Zoo some years earlier as "venado de Cajamarca", without reporting the provenance. "Cajamarca" was the normal spelling for the presently used "Catamarca" in Argentina, and the Chileans in particular used the 'j' much more than the Argentines, but both used it until about the turn of the last century (C. Sharp, pers. comm.). At latitude 26, bordering Chile, lies the Argentine province of Catamarca. This province is situated within the geographical range of taruca, as well as *Mazama americana* and *M. gouazoubira*. Therefore, the "venado de Cajamarca" most likely originated from the province of Catamarca, Argentina. Another possible origin is the province Cajamarca in northwestern Peru. However, according to Whitehead [19], only brown brockets occur in that region.

**Figure 3A**



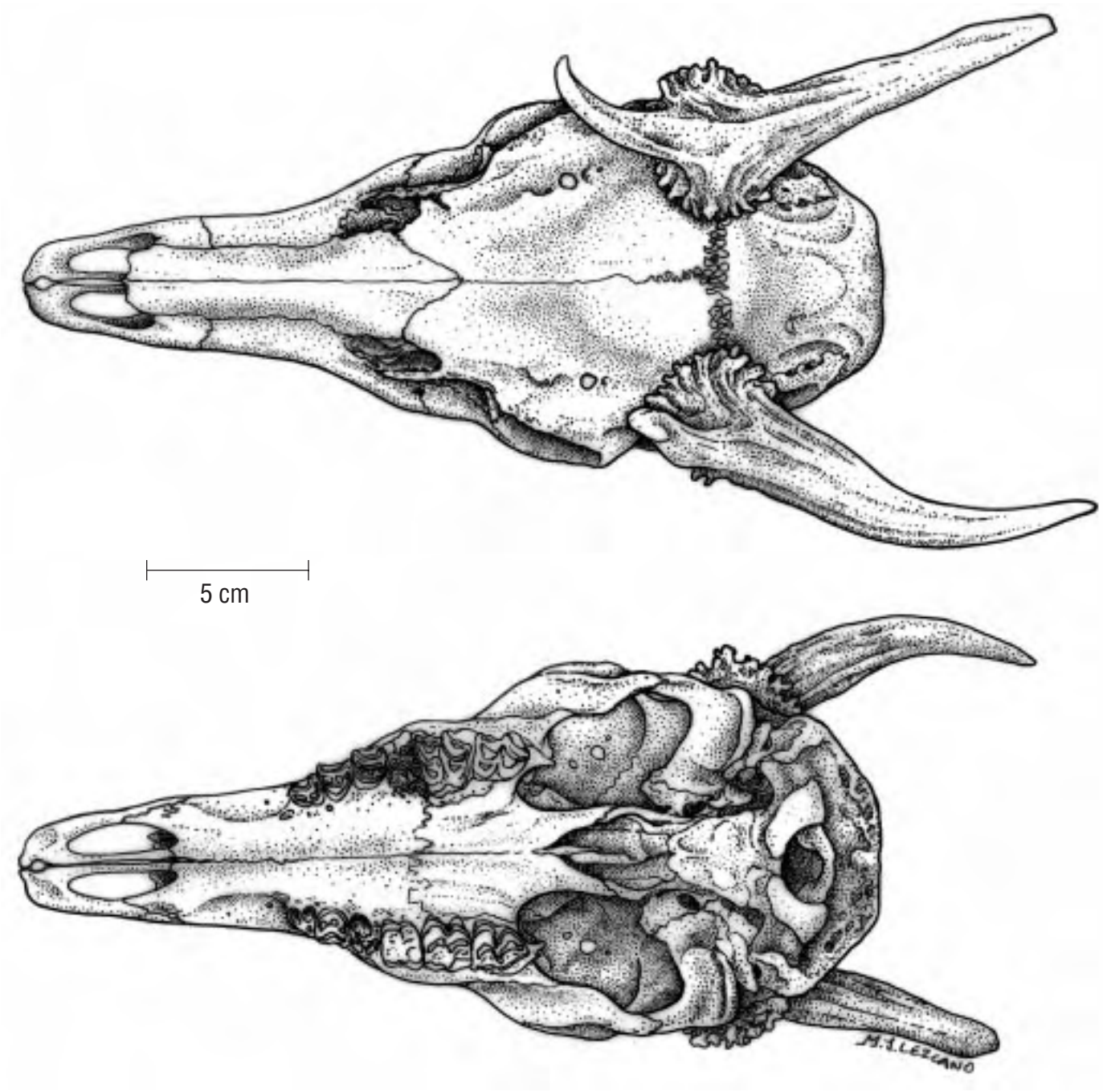



**Fig. 3** A skull of an adult huemul male (specimen Nº 073) collected in Nahuel Huapi National Park by Vera in 1995. The lower mandible was collected in Los Glaciares National Park by A. Serret in 1996. These are stored in the repository of the Thechnical Delegation of the National Parks at Nahuel Huapi under the direction of E. Ramilo.

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Jo Anne Smith-Flueck

# The Current Situation of the Patagonian Huemul | 4

## BACKGROUND

### *Current distribution*.

The huemul (*Hippocamelus bisulcus*) (pronounced hw~y-mül) is the only large native herbivore to reside in most of the sub-antarctic false-beech (*Nothofagus* sp.) forest habitat, only occurring in Chile and Argentina. This distinction places this deer species in an important role at the community level. Saving this large endangered mammal requires protection of its native habitat as it is apparently very sensitive to certain environmental changes and disturbance. Distinguished as an "umbrella species" in ecological terms, the efforts to protect this native deer will produce manifold results in that many other species- both fauna and flora- will in turn be protected, thereby maintaining the biodiversity of the community. The loss of such a unique species from its community-in which it fills a special niche- could conceivably have a strong impact on the food web, essentially meaning that many other plant and animal species of this beech forest community would be affected.

During the past two centuries, the numbers of huemul in Chile and Argentina have dwindled significantly, perhaps even as much as a 99% decline from levels before the European arrival [203]. Huemul now occupy substantially less of an area than in the recent past [149]. The distributional range in Chile, for instance, has decreased by more than 50% [51,181]. Whereby they once existed between the latitudes 33-34ºS to 54ºS (see Diaz, chapter 1), there remains in Chile only a small population surviving at the northern most limit (36º50'S) with the remaining populations found between 40-54ºS [149]. In Argentina, its historical distribution was at least from 36.5ºS to 52ºS (see Díaz, chapter 1)[30,43,47,279] but recent reports indicate huemul are presently limited between 40- 51ºS [3,149,231] (see map, Figure 1). Additionally, the populations in both countries have become highly fragmented consisting of small subpopulations which often are isolated. If this trend continues, it is clear that the future survival of this species is in peril. Recognizing this fact, the International Union for the Conservation of Nature has classified the huemul as an endangered species since 1973 [121].

### *Population status*.

The total number of huemul remaining in the world is roughly estimated to be between 1000 to 2000 individuals. In 1988, before concerted efforts by both countries to survey remaining populations, Putman estimated only 400 to 900 total individuals in both countries [196]. More recently, the total number of huemul in Chile has been estimated between 375 to 1,000 individuals [51]. Lopez et al. [149] calculated a

minimum number of 781 huemul for both countries; however, they emphasized that the actual number is higher. Using data collected to establish population estimates of several populations and information compiled by Serret [231] on the remaining populations in Argentina, we calculated approximately 670 individuals to remain in Argentina [244].

The huemul has been considered one of the species with the greatest risk of extinction in Argentina [29], yet there still is insufficient data available from which to base sound conservation decisions for most populations. In recognition of this problem, the first binational meeting of Chile and Argentina was held in 1992 to develop strategies for the conservation of the huemul [3]. With representatives from government agencies, non-governmental organizations and universities, it was agreed that immediate action must be taken to save this large native herbivore. Since then, there have been two more additional meetings held in 1995 and 1998- taking place in Chile and Argentina, respectively- where it was agreed that efforts have not been enough as huemul numbers appear to have decreased in 2 of 4 protected populations that have been monitored over a long term; for the remaining populations, the population dynamic trends are still unknown. Each of these meetings resulted in a final report which included recommendations of basic strategies needed to be pursued in order to protect this endangered species [2,3,155]. An international electronic conference was also held through the support of the Mountain Forum in West Virginia to evaluate research priorities. The conservation effort must be maximized and, as quickly as possible, basic ecological and biological information on key subpopulations- as prioritized at the international meetings- must be collected to assist natural resource managers to make the best decisions.

## TAXONOMIC CLASSIFICATION

The huemul belongs to the subfamily Odocoileinae of the family Cervidae within the order Artiodactyla. The huemul's subfamily Odocoileinae is shared by several genera: *Odocoileus, Capreolus, Hippocamelus, Ozotoceros, Pudu, Blastocerus,* and *Mazama* [196,273]. It's closest relative is the only other deer of the same genus, the taruca, *Hippocamelus antisensis.*

As to the possible evolutionary origin, the huemul is believed to have either directly evolved from *Odocoileus,* which may have been an ancient inhabitant of South America, or to be a direct descendent of *Blastomeryx,* which is considered the direct ancestor of the subfamily Odocoileinae. While much is known about the biology of Odocoilines of the northern hemisphere such as the white-tailed (*Odocoileus virginianus),* black-tailed and mule *(Odocoileus hemionus),* and roe deer *(Capreolus capreolus),* disappointingly little is known about many of the South American species. Of all intensely studied Odocoilines, species from the genus *Odocoileus* would be the huemul's closest relatives.

Confusion about the huemul's place within the taxonomic groups began with the very first recorded observation of the animal by Captain V. Wallis during his journey through the Magellan Straits in 1767. He noted that it appeared like a wild ass but had split hooves and darted away with the speed of a roe deer. Molina must have based his first description in 1782 on Wallis' observation, comparing many of the huemul's features, including the voice, to that of a wild ass when baptizing it with the Latin name *Equus bisulcus*. He replaced his original Latin description of the huemul by an Italian one in 1810 where he then described the similarities of the animal to that of a wild boar (*Sus scrofa*), gnu (*Bos* sp.), tapir, rhinoceros, camel, hippopotamus, and hyrax. In Lueckart's Latin dissertation of 1816 [141], he evaluated the literature available at that time on huemul and described why it was not like any of these animals; he also recommended the replacement of the genus *Equus* with *Hippocamelus.* In 1833, confusion still reigned as to the genuine characteristics of the huemul when the Chilean coat-of-arms depicted it as an

animal with the mane and tail of a equid and forked hooves [175].

*Hippocamelus bisulcus* has had many common names throughout its history, many of which originated from the native Indians (see Diaz, chapter 1). The popular name of huemul, given to both species of the genus *Hippocamelus*, originated from the Araucanian people according to Molina. During the 20th century, the tendency has been to address *H. bisulcus* by the compound name, Chilean huemul, to distinguish it from the Peruvian huemul, more commonly known as the taruca. Although Chilean huemul may have been appropriate when it was thought that all Argentine populations were extinct [51], the more relevant name for today would be Patagonian huemul, for it is the only *Hippocamelus* to inhabit the Patagonian region of Argentina and Chile. Already accepted as such by some, it has been called the huemul of Patagonia by Gray in 1873, the Patagonian guamul by Allen in 1905 [5] and more recently the Patagonian huemul by Redford and Eisenberg [203]. Others have recently referred to it as the Andean huemul; however, this does not distinguish it from the taruca, also known by that same name, unless clearly specifying it to be the southern Andean huemul [121].

## GENERAL BIOLOGICAL ASPECTS

### *Morphology and Physiognomy*

**General appearance.** There has been a variety of descriptions given on the appearance of the huemul. It has been described as having certain features resembling the roe deer [132], chamois (*Rupicapra rupicapra*) [131] and even the reindeer (*Rangifer rangifer)* [22] and the fawns have been said to look like wild lambs [75]. With their large ears, they also resemble the mule deer of the western USA (see Photo 1). In 1897, Heck (cited in [75]) described a taruca in captivity, noting that both the external appearance and behavior were very much like that of an ibex (*Capra ibex ibex*). The hooves for instance have hard, sharp edges, which is indicative of ungulates that have adapted to mountainous terrain [132]. The stance of the huemul is different from other cervids in that the proportion of the leg length to body length is shorter in huemul and the hind legs appear bent (see photo 2). In Franke's photo of the fallow deer (*Dama dama*) with the huemul in the pens (see Photo 17) one can see the difference between the straight slender hind legs of the fallow deer on the right side of the photo from the crouched posture of the huemul on the left. This type of body structure may be an adaptation to the rocky steep terrain that the huemul is often found to inhabit.

Although morphology is an area of research well covered for many other cervids, there is a paucity of morphological measurements available from live individuals or skeletons of huemul [5,23]. Cabrera [23] conducted the only valid study known to compare the skull of huemul to other South American cervids, clearly showing how to differentiate it from the other genera. Some areas of research topics still to be covered include skeletal growth, growth in fawns, aging of adult and young huemul by development or wear of dentition, and comparison of skulls and other body measurements from different geographical areas.

The huemul is similar to the taruca in its body size and build, cranium, and pelage (see Photo 2). For both species, the females are the smaller of the two sexes. The taruca is slightly shorter than the huemul having a shoulder height of 74 to 80 cm for adult males and 69 to 71 cm for adult females[175,273]. In comparison, the huemul stands about 80 to 90 cm in height [51,112,273]. Recorded measurements for shoulder height include 78 cm [178], 81 cm [51] and 84 cm [256] for adult females and 79 cm [178], 80 cm [184], 90 cm [51], 93 cm [5], and 100 cm [86] for adult males. A few measurements for body length are available and

although one can assume that the head has been included in the total measurement, it is not always clearly stated as such. Published recordings for body length include: 140 cm [256], 163 cm [51], 168 cm [178] and 170 cm [112], 158 cm, 173 cm and 175 cm [5] for adult males; 140 cm [256] 151 cm [51], 155 cm [5] and 157 cm [178] for adult females; and 158 cm (includes head)[183], 166 cm (see Philippi 1892, chapter 2), 166 cm, 152 cm and 167 cm (see Philippi 1894, chapter 2, includes head) for five adults of unknown sex. Chest girths were reported by Allen [5] as 97 and 114 cm for adult males and 114 cm for an adult female. Hind foot length of adult males were 43 cm [5] and 47 cm [178] and for an adult female, 43 cm [178].

For weight, Whitehead [273] claims the weight for adults to fall between approximately 70 to 100 kg; however, Drouilly [51] mentions weights varying between 40 to 100 kg, Osgood [178] provides the only recorded measurements of a healthy male at 100 kg. Texera [256] gave weights of several captive animals but these were sick and emaciated so the weights are not representative. It is apparent therefore that additional measurements for the body size and weight still need to be collected in order to establish an accurate range for the different sex and age groups.

Weights of different body portions of a juvenile male huemul were measured in kg as follows [281]:

| | |
|---|---|
| skin: | 2.550 |
| eviscerated carcass: | 30.443 |
| skull, mandibles, antlers: | 1.250 |
| sternum and ribs: | 4.224 |
| front leg: | 3.135 |
| hind leg: | 4.511 |
| pelvis, sacrum, tail | 4.050 |
| vertebrate column: | 7.640 |

These proportional weights are approximate and absolute weights are subestimates because the carcass dehydrated substantially before analysis [281]. Based on the reported carcass weight, this male would have had a minimum of 75 kg live weight.

Information on the anatomy and physiology of huemul is also lacking. This area includes the general morphology and growth of the species, patterns of dentition and tooth replacement, hematological parameters, scent glands, hormones, thermoregulation, antler development, reproduction, prenatal development, parturition, lactation, and defecation rates. Although some information that is available from research on other cervids may also apply to huemul, such extrapolations must be done with caution. Blood chemistry data on other cervids [140] can provide a general baseline to interpret a blood screening test from a huemul. Data on packed cell volume and red blood cell counts can relay important information about the nutritional status and health of an animal. For instance, low packed cell volume is symptomatic of anemia, often induced by prolonged hunger [17], which can occur after a harsh winter. Abnormal white blood cell counts indicate infection [17].

Anatomical measurements are available for only 2 fawns. The following measurements were made by Texera [256] for a newborn fawn immediately after death. However, these data are not representative as the mother died shortly after with a total body weight of only 26 kg; a healthy adult female should weigh between 70 to 80 kg.

| | |
|---|---|
| sex | female |
| age | 34 hours 20 minutes |
| weight | 2035 g |
| total body length | 61.5 cm |
| tail length | 4.5 cm |
| hind leg length | 20 cm |

| | |
|---|---|
| ear length | 8.5 cm |

A fawn died shortly after an illegal capture near Lago Puelo National Park in the spring of 1999 and was brought to the Technical Delegation of the Argentine National Park. Flueck and I performed a necropsy and recorded the following measurements and observations.

| | |
|---|---|
| sex | female |
| age | few days |
| total weight | 6,350 g |
| total body length | 80 cm |
| tail length | 8 cm |
| head length | 19 cm |
| hind foot length | 26 cm |
| shoulder height | 49 cm |
| girth | 44 cm |
| left kidney | 18 g |
| right kidney | 15 g |
| liver | 140 g |
| spleen | 3 g |
| heart | 62 g |

One anatomical feature as yet unstudied in the huemul consists of the scent glands. These glands are an integral part of the social interactions between individual deer and have evolved to suit the environment in which a species lives. Forest and swamp dwelling cervids have an average of three scent glands, while species of open habitat have an average of five glands [273]. The number of scent glands is also greater in deer from arid versus humid climates [172]. At least one gland, the tarsal gland, has been noted to be part of the huemul's anatomy [5], located on the inner surface of the hind leg. We confirmed on the necropsied fawn from Lago Puelo National Park that gland is marked by a white tuft of hair. Close relatives, the taruca [212] and species in the genus *Odocoileus*, all possess this same gland.

Huemul are physiologically well adapted to the extreme climatic conditions of the harsh Patagonian environment. Like other cervids, they most likely accumulate fat during summer and autumn to provide an energy reserve for the winter months. This reserve allows them to substantially reduce their food intake during the winter. In one study, penned mule deer were starved up to 64 days during winter without any apparent adverse effects [45]. This demonstrates that such a physiological adaptation by cervids can have profound benefits for wild animals when the fat reserves are large enough. In addition, the huemul is protected from low temperatures by its thick fur coat (see Photo 3). It does not have to expend extra calories for thermoregulation until critical temperatures go below -50 degrees centigrade [256].

**Dentition.** The huemul has a total of 32 teeth and a dental formula of $\frac{0\text{-}0\text{-}3\text{-}3}{3\text{-}1\text{-}3\text{-}3}$.
This is the same as in taruca, mule and white-tailed deer of North America. For several cervids, the number one incisors (I1) make up nearly half the width of the total cutting edge which includes 6 incisors plus 2 canine teeth. In the huemul and taruca this is different in that each tooth of the cutting edge has the same width. Thus, the first two incisors comprise only 1/4 the width of the total cutting edge [174].

The timing of milk and permanent teeth eruption varies amongst cervids. At birth, the white-

tailed deer has no milk teeth whereas in the mule deer all deciduous teeth have broken the gums between birth and week three [240]. In comparison, the newborn huemul which Texera observed had all its milk teeth showing at birth [256]. From measurements taken this spring on the few day old fawn, we also observed all milk incisors and canines out but the second premolars (P2) were just beginning to break through the gums on the mandibular with a tiny bit more of the P2s exposed on the maxilla. Meanwhile, the third and fourth premolars were half way out. No molars had yet erupted. At one year of age, the white-tailed deer has 60% of its permanent teeth, whereas the mule deer only has 20-30%. Although we still need further data from huemul fawns to confirm the exact stage of development at one year, Texera [256] estimated that about 30% of the permanent teeth are erupted by one year of age. Whereas the white-tailed deer have all permanent teeth by 25 months of age, the mule deer takes 30 months. In comparison, permanent tooth growth for huemul was estimated at 30 months of age [256].

**Antlers.** The only mammals to have antlers are the deer species although not all deer possess them [196]. For those species that do have antlers, it is the male who grows them in pairs with the exception for the reindeer and caribou *(Rangifer tarandus)* where both male and female have antlers.

Antlers of all cervids are shed annually and regrown from the pedicel which is a basal disc of bone connected to the cranial bone by its compact cortex which has a spongious core [18]. The developing antler is supplied with blood vessels surrounded by a thin grey fuzzy skin referred to as velvet. Once the antler bone is formed, the blood vessels are restricted at the base of the antler and the velvet dries out and begins to fall off, leaving a blood-tainted whitish colored antler. Although Montecinos [168] states that huemul start to grow the first antler at 10 months of age, W. Flueck and I filmed and photographed several 5-6 month old males with hard antler knobs of about 1-2 cm in length (see Photo 4). Thus the 10 month old males which Montecinos observed were males just beginning to grow their second set of antlers which would become spikes. Our observations also agree with the fact that Odocoileinae have their first antler development within the first 5 months of life [18:106]. The observation by Montecinos that the males at 10 months of age were rubbing their heads on the ground just before starting antler growth actually indicates that they were shedding their first set of antler knobs.

The number of points and the ramification of the antlers vary from one species to another. The huemul antler can vary from a fork to a 5 pointed beam [18:72,178], though the most common form is a forked antler [168] (see Figure 3, Photos 2 and 6). Huemul are classified as telemetacarpal deer whose first antlers are generally knobbed (see Photos 4 and 5) versus plesiometacarpal deer whose first antlers are mostly spikes. Using the huemul's antler growth pattern, Bubenik and Bubenik [18:72] grouped it with the following telemetacarpal deer species: pudu (*Pudu pudu*), *Mazama sp.*, the extinct *Algamaceros (Blastocerus) blicki*, marsh deer *(Blastocerus dichotomus)*, mule deer, white-tailed deer, roe deer, pampas deer *(Ozotoceros bezoarticus)*, reindeer, caribou, the extinct broad fronted moose *(Alces [Libralces] latifrons)* and the extant moose *(Alces alces)*.

The age of an animal can not be accurately defined by the antler shape and size; however, antlers generally get longer as an animal ages and the diameter, particularly at the pedicel, increases. Size and shape is also related to nutrition and hormones. As a male passes his sexual prime, the antlers will decrease in size though the diameter of pedicel will remain large.

The velvet area with blood vessels is sensitive to touch for the animal during the period of growth. However, once the velvet begins to dry off the animal will assist its removal by rubbing its antlers frequently on branches and small tree trunks, leaving scars where bark has been removed by the antler points. This behavior is known as fraying and is the reason for the coloring of the antler. In one area with lenga trees (*Nothofagus pumilio*) frayed by a male huemul -as determined by microscopically

identifying hair found stuck on the branches- W. Flueck and I measured the lower and upper distance from the ground of the tree scars and the diameters for 18 marked trees. The maximum height reached by males when fraying the tree bark ranged from 74 to 113 cm with an average of 92 cm. The lowest border measured between 14 to 52 cm with an average of 28,7 cm above the ground. Frayed trees had an average diameter at breast height (dbh) of 8 cm ranging from 3,5 to 13 cm. It is likely that fraying by introduced red deer (*Cervus elaphus*) and huemul can be distinguish by the difference in height and the dbh of trees selected.

Very little information is available on the timing of antler casting and subsequent growth of new antlers. From a few observations made by Godoy [89], it appears that the males lose their antlers in late August to early September which is near the end of winter. On 27 August, he mentions seeing young and adult males who had antlers covered with velvet, some with forks and a height no more that the length of their ears (10 to 15 cm). In contrast, Montecinos [168] said antler casting is from the second half of July to mid-August. Soon after casting the antlers, the new ones begin to grow. He said that just before the new antler growth begins, the animal can be seen rubbing his head against the ground and on bushes.

In 1985 in Rio Claro, Montecinos [168] observed the growth of antlers in 2 males of 10 months of age. One began rubbing his head in mid-October and growth was first apparent by the end of the month. At the end of 150 days the antlers had reached 80-100 mm in length and velvet began to drop off. In early August, they were shed. The second male began growth of his antlers on 29 November. Montecino states that the average growth rate for antlers is 10 mm per 5 days with growth completed in 120 to 140 days and the longest branch reaching approximately 250 mm in adult males. Whitehead reports maximal antler length of 34.5 cm [273].

**Hair Coat.** The hair of the huemul has been described as resembling the chamois and mountain goat (*Oreamnos americanus*) in its coarseness [133:173]. Both the huemul and taruca have hair similar to the winter hair of roe deer (the only deer from Europe in the same subfamily of Odocoileinae).

The hairs of the huemul are undulated and vary from winter to summer (see male with molting summer coat in Photo 2). The winter coat hairs are 5 to 7 cm long whereas the summer ones are 3 to 4 cm long. The animal is also darker and more distinguished in color in the summer than in the winter (see Díaz, Chapter 1, for detailed description of hair coat color). The hairs are shortest on the face, outside of the ears, and undersides of the extremities. They are somewhat longer on the legs with the breast and tail having the longest hairs [21,22,82] (see Photo 6). The winter coat provides complete insulation down to a critical temperature of -50 degrees CE [256]. Critical temperature is a term which refers to that temperature above which an animal does not need to expend extra energy for thermoregulation. The huemul's coat most likely evolved as an adaptation to the strong cold winds of Patagonia (wind chill factor) as the ambient temperatures never drop as low as -50 degrees CE. This adaptation would also allow the huemul to withstand the icy-cold waters of the Andean lakes and rivers even in winter, thus providing an escape route from predators such as the mountain lion (*Puma concolor*).

Even the fawns have a special adaptive coat to protect them against the cold (see Photo 7). Their coat is notably different than those we have observed from black-tailed deer fawns in the Cascade Mountains of California and red deer calves, being of a fairly thick wooly nature and without spots. An interesting observation was made when we removed the dead fawn from cold storage. We thought the refrigerator was malfunctioning as the hair was not cold to touch. Texera [256] described the fawn's coat color as a dark coffee brown in various tonal gradients over the body. This would break up the pattern and provide a type of camouflage against predators.

***Reproduction***.

For deer species of the temperate climate, the rut is well defined and will occur at more or less the same time of the year, independent of the latitude [62,144,151]. The short mating season of temperate deer, occurring in late summer and autumn, is timed to produce offspring during the season of highest food quantity [144]. For huemul, the breeding period has never been clearly defined for any population. It may possibly vary from one population to another, being noted to generally be between mid-February to mid-April in Rio Claro National Reserve [190], whereas between March to May for the Nevados de Chillán population [192]. One observed doe in the Rio Claro reserve underwent estrus 20 March in 1982 and 15 March in 1983 [190]. This same doe was accompanied by various bucks over the entire two study periods of 1982 and 1983 which lasted 8 and 9 weeks, respectively. Wallmo [268] noted some variation in the length and timing of the breeding period among populations of mule and black-tailed deer- close relatives to the huemul. Differences may be associated with the wide range of environments involved. In Utah, Robinette et al. [209] calculated that a 300 meter rise in elevation was associated with a seven-day delay in the fawning period.

Very little information is available on the gestation, parturition and weaning period for the huemul. We do know, however, as with all species of deer living in cold and temperate climates, huemul too have a restricted birth season [144]. The parturition period appears to be early spring when food of high nutritional quality is most abundant, principally during the months of November and December [4].

Parturition dates available in the literature are as follows:

- In the month of October: a fawn was seen at the Tamango National Reserve [4];
- mid-November: two fawns were observed and estimated at 2-4 days old [78];
- November 20, 1999: a fawn died which was captured at Lago Puelo, Chubut, Argentina, several days old at death (Smith-Flueck and Flueck unpublished data);
- November 28, 1973: a birth was observed [256];
- end of November, a captive female gave birth to a dead calf at Isla Victoria in Nahuel Huapi National Park [77];
- December 26, 1978: a fawn was seen at Torres del Paine and was estimated to be one month of age [200];
- December 14, 1986: a fawn was found at Rio Claro National Reserve and estimated to be 5-7 days of age [168];
- December 24, late 1930's: a healthy fawn was born to captive female at Isla Victoria in Nahuel Huapi National Park [77];
- January 8, 1986: a fawn seen at Rio Claro and estimated to be 10-15 days old. From observations of the mother, its birth had to be sometime after December 20 [168];
- January 8, 1985: a fawn was found at Rio Claro and estimated to be 3-5 days of age [168];
- January 26, 1988: a fawn seen at Rio Claro of about 1 to 1.5 months of age [168].

Females give birth once a year and almost always to only a single fawn [168,187]. During 10 years of breeding taruca in captivity, no twin births were observed [75]. The gestation period is assumed to be approximately 200 to 220 days [168] but has never been determined from direct observation. Only twice have newborn fawns been observed [77,256]; however, the fawn observed by Texera lived only a few hours. As with other newborn cervids during the first month of life, huemul are not very agile and walk unsta-

bly, thus spending most of their time bedded and hiding and constantly change their bedding site to avoid predators. Weaning is assumed to occur around the fourth month of age, however this has never been studied [4]. One fawn at 5 months of age was still observed nursing [168].

During the late 70's, the fawn-adult female ratio was ca. 1:2 for huemul in the Nevados area [187]. Since 1980, reproduction appears to have drastically decreased there as fawns have been detected on only 33% of the surveys [193]. Female fecundity- the rate at which a female produces female offspring- may be too low for many populations and may be a major reason for population decline. In southern Chile, a female monitored from 1981 to 1986 was pregnant every year but raised only 3 fawns during those years, one of which died within six months [4,193]. Observations from Rio Claro suggest some females bear young only in alternate years [188]. Generally among cervids, females become fertile at a half or 1 ½ years of age, producing their first offspring at age one or two, and thereafter annually. White-tailed deer commonly become fertile at ½ years of age [265]. It is less common in mule and black-tailed deer but also occurs if environmental conditions are good . Robinette et al. [211] found breeding success in 6-8 month old does in Utah to be less than 3 per cent. It appears huemul too can breed at 6 months though the probability is unknown. Texera [256] documented a female huemul, bred at 6 months of age, giving birth to a fawn. Regardless of the potential to breed at a young age, another female huemul did not reproduce for the first time until reaching age four [193]. Low productivity needs to be evaluated as it could be one of the factors seriously hampering the growth of the huemul population. The remaining subpopulations with their extremely small sizes will be relatively slow to recover if few births occur per year.

***Life Span.***

No ones knows the maximum nor mean life expectancy for huemul. One radio-collared male at the Tamango Reserve is estimated to be over 14 years since he was aged to be 4 years old when captured in the spring of 1990 (Velásquez, pers. com.). We can expect then that huemul females might live beyond 14 years as the overall life expectancy is shorter for males than that of females in deer species in general [196,214]. In the Berlin Zoo, a male of the closely related taruca, or Peruvian huemul, died from the bombing of World War II, after being maintained there for 10 years, 7 months and 18 days; having arrived there from the wild as an adult, he thus had to be from 12 to 13 years of age or more at death. Currently, the best we can do is speculate about the huemul's life span through comparison with other closely related deer species of similar body size. Among mammals in general, life span increases with body size and deer reflect this same general trend [196]. From studies in California, we know that the similar sized free-ranging black-tailed deer females can reach at least 18.5 years [72]. In captivity we had a female who lived to at least 21 years. The longevity record is from a black-tailed female on Gambier Island, British Columbia [214]. She became tame at about 2 years of age after having a single fawn and came to feed on a farm until she died in the winter of 1938-39 at an estimated 22 years of age.

The record for the oldest white-tailed deer may still be a captive doe who died at 19 years and 3 months of age in December 1951. She had stayed in good health until the end, with normal weight; however, her teeth were worn out [214]. Her teeth may have lasted longer than a wild deer as she had been fed on soft commercial feed. Teeth wear as a result of age and can be the determining factor in a deer's health condition. In the summer of 1987, we observed a major die-off of females in the Cow Creek black-tailed deer herd in northern California. Forty-one percent of radio-collared females were found dead in a resting position, with limbs folded back or beneath the body without evidence of predation or gross pathology. This recumbent posture is often observed in starved or diseased deer [268]. The average age of the dead females found during this summer die-off was 13.6 years [72]. The older does with a

maximum of 18.5 years had teeth which were worn down to the point of affecting their nutritional intake.

The mean life expectancy is difficult to calculate for any deer species but it is generally much lower than the maximum life expectancy since a high proportion of deer die in the early years of life. As an example, Sambar deer, *Cervus unicolor,* from Asia can live up to 24 years but the mean life expectancy is approximately only 10 years [8]. This average can also change depending on environmental conditions. For instance, heavy hunting on a certain age group of males can reduce the mean life expectancy of the whole population. The average life span may have decreased for the huemul in recent years as collected old shed antlers generally tended to be much bigger in the past than current ones (Serret pers. com.).

## SOCIAL BEHAVIOR AND ORGANIZATION

Very little information is available from field or captive studies on the social behavior and organization of the huemul. A major obstacle for behavioral field studies is to locate those animals which are at low densities in very steep terrain. Then because of human disturbance, there is the additional problem of individuals in some populations no longer allowing observers to approach at desirable distances to conduct systematic scientific observations. Much could be learned by collecting empirical data from captive animals, but several unsuccessful attempts many years ago to maintain huemul in captivity have made officials leery to permit a well-planned captive breeding program using modern techniques available today. A radio telemetry study would be an ideal method to improve efficacy in locating individuals in terrain that is steep or with dense vegetation but this involves costs which are generally prohibitive for a developing country to handle alone.

Even though there are only a few papers describing huemul behavior, the information they provide is valuable and can act as a useful tool for wildlife ethologists when deciding what areas of huemul behavior to explore next. From a captive group in southern Chile, Texera [256] studied some of their biology and presented his observations of mother-fawn behavior during several hours following parturition. Franke also studied the behavior of huemul in a captive situation on Isla Victoria in the 1930's, however the meticulous notes that he reported to have taken [77] have been misplaced. Several interesting reports on behavior have been produced from observations of park rangers [89,168] and from a survey conducted by Fundación Vida Silvestre [237]. The few published studies conducted in the last 3 decades have provided some information on mating behavior [190,192], habitat use [78,80,189,193,200,228,247], movements [170,200] and feeding habits [4,38,78,247].

### *Mating Behavior*

Povilitis [190,192] has provided a good account of the adult male and female behavior during the mating season. Their courtship postures and movements are comparable to those reported for other New World deer. Bucks use a low-stretch posture which is similar to that described for white-tailed deer of N. America [85,106,134,145], caribou [44] and a variety of ungulates of Old World origin [83,269]. Courting huemul bucks approach females in ways similar to mule deer. In one classic courtship behavior, known as the low-stretch approach, the male mimics a fawn by approaching a female from the rear, with head held low. This is common in both mule deer and huemul but is not found in the white-deer. During another type of approach, known as rush courtship, the male stands rigid facing the female, and suddenly leaps

at her with his ears up and folded back. The huemul will have his head and neck above or level with the shoulders whereas a mule deer male rushes with his head and antlers lowered. The white-tailed deer male in comparison, during the rush courtship, utters a few weak grunts, strikes the ground with his front legs once or twice, then gallops silently after the departing female in an extended but not necessarily crouched position [85]. Whereas the rush courtship is the basic courtship style of the white-tailed buck, the mule deer and huemul bucks predominantly use the low-stretch posture approach. Also in contrast to the white-tailed bucks, the huemul and mule deer bucks perform a high amount of foreplay and non-copulatory mounting.

Additional courtship behaviors by the male huemul of the female include sniffing, physical tending, mounting, following (see Photo 8), chasing, vocalization (see section on communication) and flehmen [190]. A buck typically sniffs a doe's posterior, particularly the perineum, rump, and tail, but also includes the face, ears, withers, and back. Flehmen is a behavior performed by the male after inspecting a female's urine or sniffing her perineum. For instance, after placing his muzzle in the urine, he will suddenly raise his head to or above the horizontal position, and while slowly swaying it from side to side, squints his eyes, folds back the ears, slightly opens his mouth, and curls up his upper lip (see Photo 9). It is believed that flehmen, or lip-curling behavior, exposes urine to the Jacobson's organ at the top of the palate, thus sending signals to the buck of the female's estrus state [58].

Some male cervids such as mule deer and moose urinate on their tarsal gland on the inside of their hocks and then rub them together. This behavior known as rub-urination or hock-rubbing occurs mainly during the rut. Some captive black-tailed deer were observed to rub hocks throughout the year [84]. Huemul have not been seen to rub-urinate during the rut, however in two instances, one of which involved a frightened animal, bucks were observed to drop urine on a hind hock [190]. The evolutionary significance of urine- marking is not known, however, it has been suggested to be an olfactory intimidation mechanism [84]. Urine-marking has been shown during agonistic situations by black-tailed deer [145] and caribou bucks [57]. Low population densities of huemul may influence the level of aggression between males, whereby dominance displays (see Photo 5) are less frequent and less elaborate than between males of other cervids (see Photo 10). This might explain the lack of rub-urinating in huemul males and the reduced size and complexity of their antlers.

Huemul and *Odocoileus* bucks demonstrate serial polygyny [85,158,190]; the males are sexually opportunistic and tend to females in their area as they come into estrus. Huemul males, in addition, will associate with individual does well before and after mating, a behavior particular to huemul.

Alternative mating systems are found among cervids, including some species demonstrating intraspecific variation of the mating system, depending on the ecological condition. Mating systems can be influenced by demography of a population, resource distribution, predation risk, and availability and behavior of conspecifics [32,60]. Fallow deer, for example, have shown 7 different mating strategies: following, harems, dominance groups, stands, temporary stands, multiple stands, and leks [137,138]. Langbein and Thirgood found the ecological factors exerting an influence on the fallow deer's mating systems were buck density, doe density, habitat structure and tree cover. Red deer males typically defend harems when females are moving around in gregarious groups [33] (Photo 11). They will switch however, to defending territories once females begin to concentrate on localized resources [26] (Photo 10). Roe deer are territorial in forests [54] but not in open-field agricultural habitats [136].

The dominance group mating system is the only one which has been observed for huemul [190]. This consists of a multi-male sex group in which one male is dominant over all others and achieves most matings. Subordinate males are tolerated in the group, there is a relatively low level of male aggression within the group as compared to the other systems, and territoriality is not exhibited [137]. Huemul have yet

to be studied during the breeding season under various ecological conditions to determine whether the mating system may vary.

### *Group Size*

In the past, several historical accounts mention groups composed of large numbers of huemul (Diaz, this book). Prichard in 1902, told of an inhabitant who had seen a group of 100 individuals in the area of Lago Argentina [194]. In April of 1949, Grosse [94] observed groups composed of up to 10 animals in the valley of the Rio Huemul in the region of Aysen, Chile. In recent times huemul have not generally been observed in such large groups, but rather, most often in groups of one to five animals; this may be related to the type of habitat used. Perhaps all the historical accounts of huemul in large groups were from observations made in open, exposed areas where visibility of huemul was higher. Based on observations of 248 huemul groups, mean group size at the Rio Claro National Reserve in the Aysen region of Chile was 1.9 with a range of 1 to 5 [190]. At the Nevados de Chillán in Chile, mean group size was 1.3 [51]. Frid [78] recorded an average group size of 2.2 with a range of one to four individuals for a periglacial coastal population in the Bernardo O'Higgins National Park in Chile in 1990. For another population within the same park in 1995, Frid observed groups ranging from one to eight deer [80]. Male groups average 2.5 individuals (S.D.± 1.7) while female groups averaged 2.9 individuals (S.D.±1.5). Of 15 groups observed in Glaciares National Park in Argentina in 1996 [236], there was a mean group size of 1.1 animals with 1 to 3 individuals per group; all of these were composed of a single animal except for one with 3 individuals of unknown sex and age. In 1997, twenty group sightings of huemul in the same area revealed an average of 2.35 animals per group, ranging from 1 to 4 individuals [237]. When combining data from surveys conducted since 1992, group sizes at this park averaged 1.3 individuals [237]. In the Tamango National Reserve in Chile, where densities are among the highest observed for current populations, W. Flueck and I observed groups of 6 and 7 animals on several occasions during a 5 day period in May of 1993, with group sizes ranging from 1 to 7 in both forest and open areas. One can hypothesize that if huemul now form groups of smaller sizes in mountainous areas it may be due to a general decline in density. Historical accounts [94,95] and the current situation in the Tamango reserve and Bernardo O'Higgins National Park indicate that densities likely were higher in forested mountainous areas in the past.

Group size may be dependent on habitat type. White-tailed deer of North America living in open areas have larger group sizes than those living in closed forested habitats. The huemul have also been found in habitats ranging from closed forests to the open steppe. With information on group sizes from the various habitat types, one could determine if this species has also evolved intraspecific variation of the social system. Plasticity in terms of changing social behavior to best adapt to different environmental conditions may therefore be discovered to be a beneficial trait possessed by the huemul.

An inhabitant told me how he witnessed, during the autumn season a few years ago in the province of Chubut, a group of approximately 11 huemul (males, females and fawns). This observation was made in an old growth lenga forest. It is plausible that such a large number of individuals had come together for the rut. One may hypothesize that in areas where densities are high enough so that small groups are not dispersed too widely, the animals may come together during the breeding season to form larger social groups. Larger group sizes could also be a function of food availability in a particular area: where there is more food, the animals are able to forage in larger groups.

There appears to be some flexibility of group structure between populations but the reasons are still unclear. Adult huemul are most often seen alone but group structure can often be comprised of a

paired adult buck and female alone or joined by apparent offspring and subordinate males. The group composition with highest frequency observed by Serret and Borghiani at Los Glaciares National Park was a single adult female with a fawn (29%) . However when combining surveys of 1992, 96 and 97, single adult males were the most frequent group encountered at 19% [237]. In Rio Claro, Povilitis found all-male groups occurred infrequently whereas adult female groups were never observed [190]. In contrast, for a coastal Chilean population Frid observed adult males and females associating only twice out of 104 group sightings during the spring season [78]. Intraspecific variation of social systems is a common occurrence in the animal kingdom. Social behaviors of cervids can vary intraspecifically depending on the population density, resource distribution and availability, temporal overlap with relatives and competitors, predation pressure and distribution of potential mates [60,150].

Little is known about the seasonal changes in group structure. Povilitis found that bucks associated with does not only during estrus but throughout much of the year, for the Nevados de Chillán population and several populations in the Chilean interior. Most of the buck-doe pairs (75%) at Chillán were observed by him during the breeding season in autumn with pairs rarest in the spring to early summer season, when does were most likely seeking seclusion during the fawning period [192]. Frid also observed segregation of the sexes of the coastal population during the parturition period [78]. This separation during spring is also found with other species of deer [44]. However contrary to what Povilitis noted, the sexes of other deer species are separated most of the year. The sexes of the mule and black-tailed deer of the western United States separate during the spring, summer and winter months and only come together during the autumn mating season, known as the rut, and for a short period during the spring migration [250]. The same is true of the N. American elk, also known as wapiti (*Cervus elaphus*) and the European red deer. For all these deer species, the males most often form male groups outside the breeding season but can also travel alone. They often use the upper slopes or areas where the vegetation is generally of poorer quality leaving the best nutrition for the females who need to be physically fit during pregnancy and the lactation period. In contrast, groups consisting of only males or only females appear to be scarce for inland huemul. Buck-doe pairs for adult male and female huemul are a principal feature of huemul sociality [192]. Frid, on the other hand, did not observe buck-doe pairs in the coastal population, but his study coincided with the fawning period [78]. It is unknown as to how long the sexes remained segregated there. Perhaps the separation was only temporary with females joining the males once their young were old enough to escape predators. Behavior and patterns of habitat use might be expected to change as the offspring mature.

Individuals may associate with various different members of a population throughout the course of a day, and in doing so, move from one group to another. A tight bonding group might consist of a doe, fawn of the year and possibly her female young from the prior year (the yearling) as seen with deer of the genus *Odocoileus*. Even such a female with her offspring will frequently intermingle with groups of different size. In 5 days of observing groups at the Tamango National Reserve, we found that radio-collared adults (1 male and 2 females) associated with different animals throughout the day, with group composition continually changing. I observed similar dynamics with group structure in a social organization study of a migrating population of black-tailed deer in California [250] and in another study on the home range and movements of Rocky Mountain elk in northern California [69]. This continual mixing behavior can complicate field studies in which observers are trying to determine how many animals are using an area, particularly when it is not possible to individually distinguish every animal by sight in short-term studies. This is true of most cervids where often only males with antlers, or an animal with an unusual coat color, marking, disability or other unique feature, are readily distinguishable.

The pairing behavior of huemul during the rut [190,192] and the small group sizes generally observed

may be a function of the food availability in relation to the animal's body size. The social organization of African ungulates correlates with body weight [124] (see Table 1). Small species (3-60 kg) such as the dikdik and duiker live in the forests and tend to form small group sizes of 1 to 2 animals throughout the year and male-female pair bonds during the breeding season. Amongst African ungulates, as the body weight increases, the group sizes increased, the male-female breeding strategy changes and the feeding selectivity decreased. Jarman found ungulates of the second weight category (20-80 kg) preferred to live in the brush, riparian or grassland habitats, having a larger group size of 2 to 12 animals and a breeding strategy of the male with a harem. The feeding strategy of this sized ungulate was selective though less so than the smaller species. The pairing behavior of the huemul may be better understood through further studies of their social organization by comparing the food availability and group structure during the various seasons for different populations.

**Table 1.** The social organization of African ungulates in relation to their ecology (Jarman 1974 [124]).

| | Exemplary | Body Weight (kg) | Habitat | Diet | Group Size | Reproductive Unit | Antipredator Behavior |
|---|---|---|---|---|---|---|---|
| Group I | Dikdik Duiker | 3-60 | Forest | Selective browsing; fruit, buds | 1 or 2 | Pair | Hide |
| Group II | Reedbuck Gerenuk | 20-80 | Brush, riverine grassland | Selective browsing or grazing | 2 to 12 | Male with harem | Hide, flee |
| Group III | Impala Gazelle Kob | 20-250 | Riverine woodland, dry grassland | Graze or browse | 2 to 100 | Males territorial in breeding season | Flee, hide in herd |
| Group IV | Wildebeest Hartebeest | 90-270 | Grassland | Graze | Up to 150 (thousands on migration) | Defense of females within herd | Hide in herd, flee |
| Group V | Eland Buffalo | 300-900 | Grassland | Graze unselectively | Up to 1000 | Male dominance hierarchy in herd | Mass defense against predators |

### *Behavior Towards Humans*

Frequently I have heard people claim, as a matter of fact, how huemul will not do well in captivity because they easily become frightened and die from heart attacks. However accounts from the past point to the contrary: that the huemul is easily adapted to the presence of man and his activities. One of the most implicit examples of their adaptability was told by Franke [77] in his book of 1952. In the late 1930's, two adult pregnant females caught by dogs were brought to Isla Victoria in Nahuel Huapi National Park. Franke relates how he put these females inside a small pen the first evening. He then joined them but first made a small fire in the center to prepare the customary Argentine herbal tea, *yerba mate*, before falling asleep. He was aroused when the females approached him later that night to sniff his odor. The next night, they did the same and even sniffed at his face. After only a few weeks, they were tame

enough to eat from his hand and walk freely with him, his dogs and other animals. He also relates of another incident which involved a 6 month-old fawn which was caught during the winter by dogs in Traful. He took it into his home on Isla Victoria where it soon calmed down and began to eat. As he slept during the first night, he was startled awake by the fawn jumping onto his bed. It then slept with him throughout the night. Although this fawn had been caught by dogs and had some minor injuries, he got it to walk with the dogs the very next day. Two weeks later, the fawn began to sleep with the dogs and would walk freely with either him or the dogs, even in the open forest.

There are frequent historical accounts by travelers in Patagonia who witnessed huemul in undisturbed areas who were unwary and even curious of the strangers walking through their home range (see Díaz, chapter 1). In an observation by Augusto Grosse he relates, "On a small summit, 50 meters away, there were 4 individuals watching us with their heads raised. Surely they had seen us before we saw them. Suddenly the biggest animal separated from the group and, with a decided step, came towards us as if he wanted to attack us. But at a distance of approximately 15 meters he stopped and observed us with curiosity. Some beautiful antlers adorned his grey head. I calculated that his weight was more or less between 90 and 100 kilos. He observed us awhile longer with large and beautiful eyes. But suddenly, convinced that there was no danger for them, he began to walk again and, approaching circled around us to then return to his companions who were waiting patiently. Then all together, they walked towards a small forest of ñire and at the edge of this they lay down quietly without fear."

Recently a colleague came across a group of huemul that were so tranquil that he was able to film them together for 30 minutes. Unfortunately he later accidently wiped out the videoed material, leaving nothing to show us today. The animals were noted as being docile, allowing the photographer to come within a few meters. I have also observed such seemingly tame behavior among huemul in protected areas or areas with low disturbance where I was able to approach individuals within 10 meters (see Photos 12 and15). A bedded huemul could be approached by two people from opposite sides and then completely circled, yet it would not stand up (see Photo 12). Apparently, intense olfaction of human odor does not elicit an alarm reaction. However, in disturbed areas they do not tolerate human pressure and will flee even when at distances of 300 meters.

The huemul fawns in one protected area permitted me to come within 5 meters to take photographs, while they continued to browse and interact socially undisturbed (see Photos 4, 5 and 7). This is astonishing considering that these were wild animals who had probably rarely, if ever, seen human beings before. In contrast, captive newborn fawns of tamed does of a close relative, the black-tailed deer, are initially skittish around humans and must be worked with frequently during the first few weeks of life if they are to become tame like their mothers (pers. observ.). This instinctive nature to be wary of humans is quite normal for other cervid species. During the study of a coastal huemul population, Frid also found that the deer readily habituated to the observers and could be approached to distances of 5 m or less [78]. Such behavior indicates an undisturbed population.

Meanwhile, the Nevados de Chillan deer are very wary of humans [121,193]. Deer in one small isolated population within the Nahuel Huapi National Park also show a marked fear of man as they flee if approached closer than a distance of 200 m. This population, being one of the most accessible to a major city, has been harassed by trophy hunters in recent years [233,235,237] (Smith-Flueck, unpublished data). Huemul in one area of the Bernardo O'Higgins National Park allowed researchers to approach within 5 m in 1990, yet in 1995 could not be approached closer than 200 m (Frid pers. com.). Human activities had increased in this area due to an illegal introduction of cattle in 1991 [79]. In Los Glaciares National Park, Serret and Borghiani found that huemul observed at distances under 300 m always fled (n=10). From 300 to 500 m the reaction toward humans varied, whereas above 500 m they didn't react

and continued with their normal behavior [237].

### *Communications*

During a study on the breeding behavior, Povilitis [190] found vocalization to be common for the species. Does snorted when rushed or chased by bucks. One of the does who appeared more timid than the others when approached by the bucks, slammed her front legs down at times and alarm snorted when pursued. Bucks made several different sounds when with does depending on their activity. When approaching or following does they either gave a soft, guttural whine, often emitted in a series or, a medium-pitched grunt. When rushing or chasing does they produced a robust grunt, emitted in a rapid series. In comparison, a mule deer produces a low soft buzz, while the white-tailed buck most often grunts during courtship [85].

Vocal communication between males is common for cervids during the rut and this is no exception with huemul. The sounds emitted will vary from one species to another although they are generally produced during the same types of behavioral interactions. The huemul bucks emit a rapid series of sharp notes that descend in volume, similar to a "laugh". This sound, lasting 3 to 6 seconds, is produced while standing with the head slightly lowered and usually involves vertical movement of the muzzle. Povilitis [190] observed it to occur during or after an agonistic encounter between bucks, before or after thrashing or rubbing vegetation, when a buck entered the vicinity of a rival buck, and during courtship or when a buck watched a doe. The sound can be heard by human ears at a distance of 30 meters or more. Such communications may also serve the function of alerting other bucks in the vicinity of the calling male's presence and status. It is possible that males of older ages produce calls of a deeper pitch as occurs with other cervid species such as the red deer. In this way, males can recognize a rival's potential sexual status by the sound of his voice and may avoid encounters with males of superior age and strength. Other sounds produced by interacting bucks include grunts or whines and forceful alarm snorts from subordinate bucks [190].

Animals in family groups also communicate amongst one another. Povilitis [190] noted that a female and her female offspring often maintained close physical proximity. On one occasion, the daughter bleated repeatedly while searching for her mother, in what sounded like a prolonged, high pitched whine. When she finally spotted her mother at 40 meters, she produced a cry of much greater volume. To avoid being detected by predators, newborn fawns respond instinctively to cues given by the mother. Franke [77] observed this behavior of a newborn captive fawn on Isla Victoria in Nahuel Huapi National Park. After a few hours, the mother walked to the pasture with the fawn following close behind. He then noted that with each disturbance, the female stomped her front feet and the fawn went immediately down (cervid freeze).

Serret [234,237] also described various vocalizations made by huemul in Los Glaciares National Park . Vocalizations were heard while observing a male and female pair [234]. While in a state of alert with ears erect and their attention directed toward the observers, one of the animals produced 4 calls similar to the moo of a bull in the distance. During the hour of observation, the vocalizations continued. They were as follows:

1. Three calls consecutively, followed by a guttural clucking sound (a a a) similar to a laugh
2. On 3 occasions there was a single call followed by a clucking (o o o)
3. Three calls consecutively
4. A single call supposedly from the male and immediately afterwards he shook his head from side to side

Observations were also made of other vocalizations heard during various group sightings in the same park in January 1996 as follows [236] :

1. a fawn bleated at 6 meters from an observer and then ran into cover;
2. an adult female approached the observer to 10 meters and then stood in the alert pose; she ate a little, then defecated and urinated and finally gave a sharp call;
3. an adult male at 40 meters called and then ran away;
4. a yearling male at 10 meters called and the trotted away, breaking into a run.

Texera was watching a captive doe with her newborn fawn when a domesticated cat entered the pen [256] (see Franke's photo of huemul with cat, Photo 18). The female approached the cat with outstretched neck and head lowered to about 15 cm about the ground. Never was a vocal sound produced. She communicated only through body gestures by positioning herself between the fawn and the cat, eventually forcing the cat to move away from her young one and to leave the pen.

Texera also noted that the newborn fawn cried from time to time [256]. Its cries always brought the mother immediately to its side to lick it. Crying is common in young cervids, and is used to signal the mother in times of need or distress: for example, when they need to nurse, when they are lost, or when they are caught by a predator. The cries of the huemul are similar to the mule and white-tailed deer fawns [256].

### *Interactions with Native Ungulates*

The guanaco *(Lama guanicoe)* and Chilean pudu, the second smallest deer in the world, are the only native ungulates to have resided in parts of the huemul's distributional range. There appears to be scant information of any sort on the pudu in the wild and even less available on its interaction with the huemul. They do live in the more humid zones of the subantarctic forests and prefer the dense bamboo stands [169]. From our study in El Manso [247], signs of huemul in the bamboo stands indicated that these two species could sometimes overlap in use of habitat. This was verified during the big forest fire of 1999 in the southwest portion of the Nahuel Huapi National Park, when tracks of both species were spotted in an area containing bamboo (E. Ramilo, pers. comm.). Moreover, in a southeastern section of the park, a pudu was seen crossing the road within the same general area where huemul antlers had been discovered by a hiker a few years earlier. The National parks Los Alerces and Lago Puelo and some areas in Chile contain both species and provide the potential for sympatric relationships to occur.

Though the huemul and guanaco are sometimes found to inhabit the same areas in Patagonia, in general the huemul today is found to use steeper terrain than the guanacos. Several regions known to currently contain both species overlapping are at Tamango National Reserve in Chile, Glaciares and Perito Moreno National Parks in Argentina and possibly Torres de Paine National Park in Chile and Nahuel Huapi National Park in Argentina. Very little is known about the way in which the two species interact and about their use of habitat when sympatric. Tamango park warden Velásquez said that recently they discovered a new huemul nucleus further towards the steppe where they observed a group of 4 individuals feeding together with 11 guanacos [261]. There is also a lot of activity of both species at higher elevations in this reserve during the summer in areas with burnt lenga forests. In Torres del Paine National Park, the huemul have established themselves as a result of approximately 5 translocations over the past 2 decades. However they apparently are not near the areas with guanaco.

In 1864, Claraz [30] translated a passage from a letter written at the end of previous century by a Jesuit named Falkner. He was speaking of a valley inhabited by the Tehuelche Indians at 44ºS. latitude.

He was quoted as saying, “In the lowlands, there were many guanacos and equally as many huemul.” In the earlier part of the past century, Osgood mentioned seeing 6 huemul and 5 guanacos in the same place on the mountain Pico Richards in Chile [178]. It is likely that the huemul and guanaco lived together in many areas east and west of the Andean cordillera (see historical distribution map, Figure 1) until the huemul became extinct from these areas following the establishment of sheep and cattle ranching. Having lived sympatrically with the huemul and considering the interspecific social behavior of ungulates, it is not surprising that the guanaco has accepted the recent presence of red deer in its habitat. Not only do these two species use the same habitat in many areas but they can often be seen feeding together [67].

## HABITAT USE

The habitat with highest huemul use for each region which contains huemul will differ, depending on the availability of habitat types and the degree and type of disturbances throughout the habitat. Povilitis developed a table using topographical criteria to describe the primary habitat type for huemul in the Nevados de Chillán in Chile [191] (see Table 2).

**Table 2.** Primary habitat of huemul in the Nevados de Chillán, Chile (Povilitis 1997 [192])

| FACTOR | DESCRIPTION |
|---|---|
| Slope | more than 30-40 degrees; presence of rough terrain |
| Aspect | principally north and northwest |
| Elevation | sufficient sites at lower elevations to avoid the accumulation of snow over 30 cm. |
| Minimum area | no less than 300 ha of primary habitat |

Other factors to add to this table would include time of the year, description of any possible disturbances, and degree of disturbance.

For the past 6 years, Flueck and I have been conducting studies on a lake population in Chubut. Preliminary analysis of the data reveals that the preferred slopes are not as steep as those for the population in Chillán. This is no doubt a function of human disturbance which until now has been extremely low for this lake population. These animals are able to use areas down to the lakeshore (900 meters)- all within a lenga forest- without being disturbed unreasonably (see Photo 13). Although the animals of this population are found on slopes greater than 30º, they are more frequently found in the lenga forest at sites with slopes less than 25º. They also frequent the beach along the shore of the lake. In comparison to other areas where they are frequently encountered above tree line on the Andean grassy meadows and rocky slopes, they appear not to heavily use this area above the lenga forest. In all observations of this area, they have been found anywhere between 900 to 1500 meters above sea level.

We evaluated habitat use in an area which has since come to border with the newly established Río Azul-Lago Escondido Protected Area [247]. We described habitat features for locations of pellet groups, tracks, and animals sighted. Huemul signs were found between 1,000 meters and 1,750 meters eleva-

tion. Main summer use in this area appeared to occur above treeline in Andean meadows and rocky ridges, and lenga forests with 80% and 12.5% of the total use, respectively. Fewer pellets observed in bamboo (*Chusquea culeou*) habitat (1.25%) may be related to less use of the area, different defecation rates or difficulty in locating signs of animals in the dense vegetation. Only one of 4 sections surveyed in the study area contained horses with the other three lacking any notable kind of disturbance.

In a survey of the Cerro Pirque Provincial Reserve, which I conducted with the assistance of the North American botanist C. Davis, we noted various huemul tracks from 950 m to 1600 m, most of which were in the same area where cattle were seen grazing (900 m-1400 m). We were able to observe a healthy young adult male feeding in an open meadow between 2 small patches of lenga forest. He approached us to within 30 meters and was undisturbed by our presence. This was at 1350 m elevation just above a cliffy area which made it inaccessible to cattle. Nearly the entire bowl of the reserve which we were in was severely burnt in a fire of approximately 10 years ago and has been slow to recover due to the extremely steep slopes >45º and frequent windy conditions which further eroded the sandy soil down the slopes of the bowl. Cattle use has probably added to the slow recovery rate of the vegetation. The eastern slopes outside the bowl abuts a major national route and a small town, making disturbance from trekkers, paragliders and poaching another major concern for this isolated population.

In Los Alerces National Park in Argentina, all huemul signs registered in summer were at elevations greater than 1300 meters. However in winter, signs were found as low as 500 m along the roads (Lema in [155]). In Lago Puelo National Park the majority of signs discovered from 1993-1995 were found on slopes 30-40º. The elevation when recorded ranged from 700 m to 1800 m (Vidoz in [155]). In Perito Moreno National Park in a survey conducted in January of 1998, signs of huemul were noted between 800 to 1300 meters elevation. Ninety-one percent of all signs were between 800 to 950 meters [238], predominantly in the brush (45%) and open forest (29%) habitat types. Male use was greater in the lenga forests than other habitats (88%) where the younger trees were often marked by males fraying the bark with their antlers in late summer to remove the antler's velvet. When combining data from summer surveys conducted from 1988 to 1998 in this park, signs averaged at 872 meters elevation. In comparison, at Los Glaciares National Park huemul signs in January averaged at 500 meters elevation in 1997 [237]. In January of 1996 [236], signs were recorded at even lower elevations with most between 351 to 400 meters; use of slopes in total was between 200 to 750 meters elevation. For a Chilean population in the periglacial coastal region, deer predominantly used elevations between sea level and 150 m above sea level on either periglacial grassland or bluffs during the spring season. In less than 5% of the observation time were they found on the beach (0.2%), moorland (0.1%), and grassland-forest edge (4.3%), and were never seen in the forest [78]. For National Reserve Futaleufú, signs recorded from 1988 to 1995 were between 700-1500 meters elevation. According to this data, the animals were predominately using slopes of 25 to 45º with N and NE facing aspects in brushy vegetation near sources of water (Elzo and Grandón in [155]). In the section El Húngaro of the Tamango National Reserve, the only known radio telemetry study ever conducted on huemul revealed a short distance seasonal migration with animals using the higher elevations in summer. During winter, fall, and summer, individuals were found respectively at elevations of 150 m to 450 m elevation, 450 m to 700 m and 700 m to 1000 m (Bahamondes in [155]).

Learning about habitat preference for each population for each season of the year, especially by distinguishing the sexes whenever possible, can be insightful about which mechanisms might be responsible for the habitat selection made. Animals may migrate to less optimal habitats to avoid some kind of disturbance in the better areas. Choice of habitat, for instance, may be affected by noise and unpredictable movements created from human activity, such as from outdoor recreational activities like paragliding, or by pressure from predators, such as dogs. For the lake population in the Chubut province,

the lake serves as an escape route from predators such as the mountain lion or puma and dogs, with huemul seen on 2 occasions swimming to their safety (Brondo pers. com.). Frid found that the sexes of the Chilean coastal population segregated in their use of the habitat during the parturition [78]. The females and their fawns of that season principally used the cliffy ridges whereas the males remained exclusively on the flat periglacial meadows. Even though use of the meadow habitat expends less energy than the cliff habitat, the risk of predation is most likely greater there. Thus, despite the greater costs of foraging on the cliffs, it appears the benefits for the females are greater to stay there during the parturition season than to join the males on the periglacial meadows. Predator avoidance has been demonstrated on Isle Royale in Michigan for moose cows with calves who used areas of poorer quality food during the growing season than the solitary adults and yearling moose [53], and thereby avoided wolves. This is also a typical behavior of female mountain sheep who use areas with less risk of predation even with lower quality of food [15]. An alternative or additional explanation for the different use of habitat by the female huemul of the coastal population could be that site selection by females is also influenced by water requirements during lactation. It would be interesting to evaluate if this factor affects habitat use by the females of this population.

## POPULATION DEMOGRAPHICS

### *Population size and density*

In the past 5 years, most energy in advancing our knowledge about the huemul situation has been directed toward determining where the populations are, and confirming existing populations. This all required tremendous effort due to the difficult access into areas potentially occupied by huemul, the rugged terrain and extremely low population densities. However, this first step is a necessary prerequisite for future follow-ups and monitoring. Meanwhile, minimal effort has been focused on determining the number of individuals in a population or even population densities. With basic surveys crude estimates of population size and densities can be made. It is time to begin understanding trends in the population dynamics of more populations by conducting annual censuses. This information will be useful for translocation operations; viable populations can then be identified from which individuals can be taken to save other declining populations in immediate danger of extinction. For only three populations has a regular monitoring program been in progress. These include the: (1) Tamango National Reserve (2) Río Simpson National Reserve, and (3) Nuble Reserve. Of these three, only the one at the Tamango National Reserve appears to be viable (Lopez in [155]). Considerations are currently being evaluated whether to translocate individuals from this reserve to the Nuble Reserve where the population has declined drastically since the first studies began in 1970's [193].

Surveys of the huemul reserve Nevados de Chillan in Chile, conducted by Povilitis in1986, 1988, 1993, and 1995 have revealed a serious decrease in huemul numbers. This decline has been continuing since at least 1976 when Povilitis first began his well-documented research on this population. One can only assume that the same trend may be true for other populations of huemul in Chile and Argentina. This has created increased concern over the future state of this species.

The few populations where surveys have been conducted to determine the population size and density are worth noting here. These surveys generally entailed thoroughly hiking through an area containing huemul following methodology as described by Povilitis [185,187]. Location of all huemul signs and visuals are recorded on a topographical map. Also noted are the vegetation type of the site and topographical features such as aspect, slope, and distance to water. Signs include presence of tracks, fecal

pellets, hair, antlers, frayed trees, and skeletal remains. Sex and age of any individual observed is determined whenever possible.

The densities or number of individuals per square kilometer have never been accurately determined. Only rough estimations have been made for a few surveyed areas (see Table 3). Densities for the few populations censussed are estimated between 0.02 and 5.66 huemul/km².

**Table 3.** Density of huemul populations in Chile and Argentina.

| PLACE | DENSITY km² | TOTAL AREA km² | REFERENCE |
|---|---|---|---|
| Lago Largo, CL | 0.2 | 25 | Colomes 1978 [38] |
| Río Chillán, CL | 0.02 | 50 | Colomes 1978 [38] |
| Río Claro, CL | 1.2 | 10 | Colomes 1978 [38] |
| Nevados de Chillán, CL | 0.05 | 1000 | Povilitis 1979 [187] |
| Nevados de Chillán, CL | 0.02 | 3000 | Povilitis 1998 [193] |
| Bernardo O'Higgins NP, CL | 2.2 | 10 | Frid 1994 [78] |
| Bernardo O'Higgins NP, CL | 5.66 | 10.6 | Frid in press [80] |
| Tamango Reserve, CL | 5.45 | 11 | López 1997 in [155] |
| El Manso, AR | 1 | 12 | Smith-Flueck & Flueck 1997 [247] |
| Perito Moreno NP, AR | 0.35 | 17 | Serret 1988 [226] |
| Perito Moreno NP, AR | 0.5 | 12 | Serret 1989 [227] |
| Perito Moreno NP, AR | 0.73 | 30 | Serret 1990 [229] |
| Perito Moreno NP, AR | 0.68 | 37 | Serret 1991 [230] |
| Perito Moreno NP, AR | 1.2 | 17 | Serret & Borghiani 1998 [238] |
| Los Glaciares NP, AR | 0.45 | 40 | Serret 1995 [234] |
| Los Glaciares NP, AR | 0.67 | 21 | Serret & Borghiani 1996 [236] |
| Los Glaciares NP, AR | 0.8 | 20 | Serret & Borghiani 1997 [237] |

**Argentina.** In the study area of El Manso which is soon to become part of the Rio Azul-Lago Escondido Provincial Reserve in Río Negro, we performed scans regularly for 10 days from different vantage points with a spotting scope; however, huemul were seen only twice. From these sightings and tracks observed, we estimated a population size of 20 individuals with a minimum of 11 animals (including 2 fawns) for the 3,000 hectare studied area and densities of 1 individual/km² [247]. Our survey of the Cerro Pirque Provincial Reserve revealed that a small population- probably less than 10 individuals- used the interior slopes of the bowl formed by the surrounding mountains (unpubl. data).

Based on a survey of 4,000 hectares in P.N. Glaciares, Serret [234] estimated a minimum number of 18 individuals which included 3 fawns. In another section of the same park he found an increase in density from 0.66 individuals/km² to 0.8 individuals/km² between 1996 and 1997 [236,237]. Surveys conducted at P.N. Perito Moreno also showed an increase from 0.35 to 1.20 individuals/km² from 1988 to 1998 [226,238]. These increases may reflect a population increase but may also present an inaccurate picture of the population dynamics due to the crude surveying methodology. One must realize that for all surveys conducted thus far in Argentina on huemul populations, estimates have been based only on tracks and sightings of individuals during transect hikes. Alternative methods to estimate population size and density do exist. One type based on aerial surveys should not be considered because it will not produce accurate results due to the forest cover which prohibits spotting many individuals of the surveyed population. Systematic pellet group transects, on the other hand, are recommended as a means to most accurately measure population densities of huemul populations each year where trends in population dynamics can be observed and evaluated.

**Chile.** Most of the populations surveyed in Chile show signs of decline. For National Reserve Futaleufú, Aldridge in 1988 estimated 18-21 individuals. Through observations made by park rangers it has been noted that there were a large number of sightings between 1988 and 1989 but that the count has decreased since 1990. However, reasons for this decline have not been determined although pressure from human activities has been suggested (Aguirre and Domke in [155]).

In the Nevados de Chillán Mountains in central Chile, containing the Nuble National Reserve, the population was estimated at 60 individuals in 1997. This is a 58% decline in population size since the censuses began 20 years earlier [193]. Huemul have disappeared from at least 7 sites within the surveyed area of the Nevados de Chillán Mountains (Povilitis pers. com.).

For National Reserve Rio Simpson, the population appeared to be stable with 8 to 12 individuals including fawns between 1982 to 1986. Use of land for sheep and cattle production was intensified on the northern slope after 1984 and timber was exploited from 1987 to 1992 on the western slope. During this same period a decrease was observed with a total population size estimated at 4 to 5 individuals. In the years 1993 to 1995, the population has appeared to stabilize again (Montecinos in [155]).

The highest density thus far estimated is for the population at the Tamango National Reserve which was determined to have 66 individuals during the 1996 survey with a density of 6 individuals/ km². This population has been monitored since the 1988 census which revealed 9 individuals. Since then there was continuous growth until apparent stabilization in 1994 at around 60 individuals (Lopez in [155], Velasquez in [2]).

For populations monitored over several years, the growth rate of the population can be evaluated by calculating the finite rate of increase (lambda=8). Using the data from the surveys of the Tamango population for the years 1985 and 1995, a lambda of 1.21 is calculated. This figure is reasonable for cervid species with 1 offspring per year. The highest figures for lambda encountered in the literature were 8=1.34 [197] and 8=1.35 [27] for populations of red deer under good conditions. As the red deer is also a cervid who gives birth to only a single young each year, one can extrapolate from these results that lambda could be higher for the Tamango population. The lower lambda might be due to mortality factors such as predation or different age structure of the female population.

It has to be pointed out that these population sizes reflect the actual circumstances for most subpopulations; they are very small (<20) and isolated from other populations.

### *Sex and Age Structure*

Sex and age structure of a population can relay important information about the status of a population and environmental and sociobiological influences [167]. Long term data on sex and age structure can reveal trends in population dynamics. In a 4 year study period of black-tailed deer of the Cow Creek deer herd in California, Flueck and I determined that 68 radio-collared females averaged 8.3 ± 4.9 years of age during a period of high population densities. However in the summer following a major die-off, the average age for 59 sampled females dropped down to 4.5 ± 2.5 years [72]. Ages of cervids in a population are best determined through analysis of the dentition. Therefore, one must have their hands on either a live individual, as during a capture operation, or on a dead specimen. As so few huemul remain, it is unlikely enough live individuals will ever be handled at any one time in a population to determine the age structure. The only known case where a crude age structure could be determined through carcasses was for a population in southern Chubut province in Argentina [245]. Bones and carcasses from 15 different individuals were found and collected along an approximate 20 km transect (see Photo 14). Sex was determined for 8 adults of which 50% were females and 50% males. Of the 7

individuals with unknown sex, 4 were fawns. The age of 12 individuals was identified (see Figure 4). Of the 15 dead animals, 4 were fawns, 2 were yearlings, and 9 were adults of more than 2 years. Of the 8 aged adults, all were under 4.5 years of age (mean = 2.9). Such an observation is rare as mortality is usually higher in the older-aged groups than with young adults. This data indicates that individuals may rarely reach old age in this population.

Although age structure is not easily obtainable for huemul populations, censuses along transects can be conducted to determine the sex and age classes in a population through direct visual observations. Age classes are generally broken down into fawns of the year, yearlings, adults, and individuals unable to be classified. These categories are further divided into the two sexes whenever possible. A healthy population should have close to a 1:1 ratio of the two sexes. Drouilly [51] observed a ratio of 82 males per 100 females for the Aysén population in Chile. In comparison, when pooling results of the well-conducted surveys of the Tamango population from 1985-1997, we obtain a ratio of 91 adult males to100 females (see Table 4). When doing this calculation, one makes the assumption that environmental conditions were fairly similar from one year to the next, meaning that the extrinsic influences are minimal in affecting the herd composition. Thus, variation between survey results are most likely due to actual population dynamics and/or to sampling error. In contrast, some other populations have shown very high buck:doe ratios. In April of 1949, Grosse [94] recorded 46 huemul, of which 30 had antlers in the valley of the Rio Huemul in the region of Aysen, Chile. Povilitis [188] recorded 17 males and 6 females during a survey conducted with the aid of Earth Watch participants on the Río Claro population of Chile. It can be assumed that both of these data are reliable representations of those herds at that point in time. Then why, might we ask, are the buck to doe ratios so high for some populations? For one, Grosse's observations in April could have been influenced by the social organization of the sexes as related to breeding behavior at that time of the year. Stress could also have affected these ratios. For white-tailed

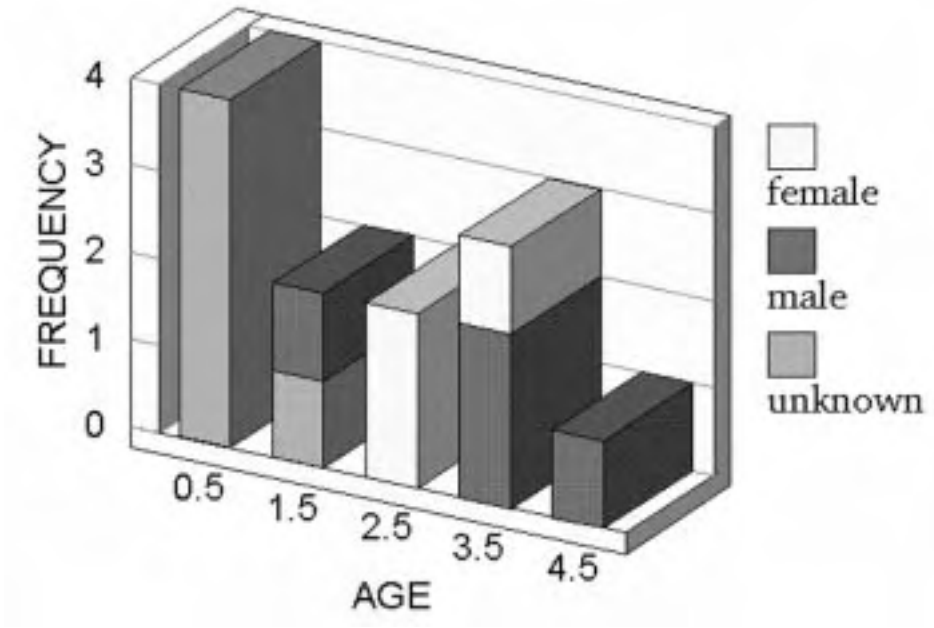


**Fig. 4.** Approximate age and sex structure of a huemul population in southern Chubut, Argentina as determined from carcasses (Smith-Flueck and Flueck 1996 [245]).

deer, male fawns predominate during nutritionally stressed periods. Well-fed does, in contrast, produce an even sex ratio or have more females [262-264]. In one study on penned deer, males comprised 70% of the births from undernourished adult females does, whereas males constituted 46.7% of the offspring conceived by well-fed does [262]. Regardless of the nutritional state of the does, for mule and black-tailed deer in the wild, the sexes of the fawns are often slightly biased toward male fawns [208,210,211].

**Table 4.** Sex and age structure of the population at Tamango National Reserve in Chile from censuses conducted 1986 to 1997 (Sandoval 1998 in [2])

| Year | Fawn | Yearling Female | Yearling Male | Adult Female | Adult Male | Unknown | Total | %.100& | Fawn: 100 & |
|---|---|---|---|---|---|---|---|---|---|
| 86 | 2 | | | 8 | 7 | | 17 | 88 | 25 |
| 87 | 2 | 2 | 1 | 10 | 11 | | 26 | 110 | 20 |
| 91 | 4 | 3 | | 7 | 7 | 2 | 23 | 100 | 57 |
| 93 | 3 | 6 | 6 | 9 | 7 | | 31 | 78 | 33 |
| 94 | 13 | 7 | 7 | 22 | 13 | | 62 | 59 | 59 |
| 95 | 8 | 2 | 3 | 23 | 24 | | 60 | 104 | 35 |
| 96 | 12 | | 4 | 27 | 23 | | 66 | 85 | 44 |
| 3/97 | 4 | 5 | 2 | 21 | 15 | | 47 | 71 | 19 |
| 10/97 | 7 | | | 22 | 28 | | 57 | 127 | 32 |
| **total** | **55** | **25** | **23** | **149** | **135** | **2** | **389** | **91** | **37** |

The sex of the offspring can also be a function of the timing of mating during the estrus cycle. Adult females mating toward the end of their estrus cycle conceive a disproportionate number of males [266]. Age and social status can be important factors affecting the timing of estrus. This was observed in a study of penned white-tailed deer [167,179] where late breeding females were the subordinate two-year old does. Thus, the age structure of the adult females in a population can influence which sex predominates among fawns. As with white-tailed deer, young red deer adult females (first and second time breeders) have also been observed to be prone to having more male fetuses whereas prime age females tend to predominantly give birth to female fawns (Flueck unpublished data). One must also consider that a higher number of male fawns could also be due to a higher mortality of female fetuses during the gestation or higher mortality of females after they are born.

The fawn to doe ratio required to keep a population stable or increasing will depend on mortality factors which will differ from one population to another. The data obtained from the censuses at Tamango from 1995 to 1997 [2] can be used to determine what a healthy fawn to doe ratio might be for this particular population. With fawn to doe ratios averaging 37:100 (Table 4), we can stipulate that the Tamango population will remain stable or increase as long as the ratio remains at this level and mortality factors do not change. For another reliable census taken in Bernardo O'Higgins National Park in 1995 [80], the fawn to female ratio was 31:100 (Table 6); this may also indicate a healthy population. The results of the other censuses need to be dealt with cautiously as either the total numbers were very low, there were too many unclassified deer, no yearlings were identified and/or the surveys were based on tracks and not actual sightings (Tables 5 and 6).

**Table 5.** Census data of various populations in Chile and Argentina between 1988-1999. BONP=Bernardo O'Higgins National Park in Chile; Manso=El Manso in Río Negro Province, Argentina ; LGNP=Los Glaciares National Park in Argentina; PMNP=Perito Moreno National Park in Argentina. This table doesn't include results of Tamango National Reserve in Chile which are in Table 4.

| Date Reference | Fawn | Yearling | Yearling & | Yearling % | Adult & | Adult % | Unknown Adult | Total | Place | |
|---|---|---|---|---|---|---|---|---|---|---|
| 11/90 | 2 | | 2 | 2 | 6 | 10 | | 22 | BONP | 78 |
| 11/99 | 2 | | 5 | 3 | 26 | 21 | | 57 | BONP | 80 |
| 2/92 | 2 | | | | 3 | 2 | | 11 | Manso | 247 |
| 1/92 | 3 | 2 | | | 5 | 5 | 3 | 18 | LGNP | 234 |
| 1/96 | 1 | | | 1 | 2 | 4 | 2 | 10 | LGNP | 236 |
| 1/97 | 3 | | 1 | 1 | 3 | 3 | | 11 | LGNP | 237 |
| 1/88 | 0 | 2 | | | 1 | 1 | 2 | 6 | PMNP | 238 |
| 1/1998 | 1 | 5 | | | 6 | 9 | | 21 | PMNP | 238 |

**Table 6.** Male to female ratios and fawn to female ratios for censuses conducted in Chile and Argentina 1988-1999. This table doesn't include data of Tamango National Reserve in Chile which are in Table 4.

| Date | Fawn | %:100& | Sample Size | Fawns: 100& | Sample Size | Reference |
|---|---|---|---|---|---|---|
| 11/90 | Bernardo O'Higgins NP, CL | 167 | 16 | 33 | 8 | Frid 1994 78 |
| 11/99 | Bernardo O'Higgins NP, CL | 81 | 47 | 31 | 28 | Frid 1999 80 |
| 2/92 | El Manso, AR | 67 | 5 | 67 | 5 | Smith-Flueck and Flueck 1997 247 |
| 1/92 | Los Glaciares NP, AR | 100 | 10 | 60 | 8 | Serret 1995 234 |
| 1/96 | Los Glaciares NP, AR | 200 | 6 | 50 | 3 | Serret and Borghiani 1996 236 |
| 1/97 | Los Glaciares NP, AR | 120 | 6 | 60 | 6 | Serret and Borghiani 1997 237 |
| 1/88 | Perito Moreno NP, AR | 100 | 2 | 0 | 1 | Serret and Borghiani 1998 238 |
| 1/98 | Perito Moreno NP, AR | 150 | 15 | 17 | 7 | Serret and Borghiani 1998 238 |

## HOME RANGE AND MOVEMENT PATTERNS

For home range, the scarce information available has been obtained from field observations of individuals. Although use of radio telemetry produces the most accurate picture of an animal's movement patterns and habitat use, it has only ever been part of a research project on huemul at the Tamango National Reserve in Chile, with only one annual home range estimated from a radio-collared individual. More telemetry studies should be encouraged, using exact location of individuals recorded over a period of time to determine home range and movement patterns during different seasons of the year.

At Tamango reserve, a radio collared animal was found to have an annual home range of 300 ha (Bahamonde in [155]). From direct observations of 5 individuals at Rio Clara in Chile, Povilitis calculated home ranges from 36 to 73 ha between 1 March to 2 May, 1982 (0=60 ha, n=4) and from 46 to 82 ha between 11 February and 7 April, 1983 (0=62 ha, n=3) [190]. The small size of these home ranges may reflect the time of year of the study which coincided with the breeding season; they would most likely

not be the same during the winter or summer seasons. Drouilly roughly estimated a home range area of 300 and 700 ha for huemul in Aysen and Río Chillán, respectively [51]. His explanation for the large home range size in Río Chillán was the disturbance created from human activities in the area.

Movement patterns of huemul are basically unknown. Drouilly found some individuals to move as much as 3 km within a 7 hour time period, apparently affected by human disturbance [51]. Rau reported on movements of a doe and her fawn of approximately 2 months of age in Torres del Paines National Park during an 18 day period of the summer [200]. Their movement averaged 3.85 km per day. As this female was reintroduced 4 months earlier to the area, her movement might not be indicative for huemul raised in a certain area. Serret [234] observed a male and female pair two days in a row in Los Glaciares National Park. On the second day they were more than 1,000 meters from the site of the previous day. Mobility can be affected by landscape, availability of food, snow cover, and disturbance. In Missouri's Ashland Wildlife Research Refuge, a study showed dogs chased white-tailed deer long distances and sometimes away from their home range; the known route of one chase extended about 5.5 air-line km in about ½ hour [195]. The deer who regularly had to flee from dogs in this study area, especially during the hunting season, occasionally lost the dogs by taking to water.

Seasonal migrations over larger distances are a predictable and common evolutionary trait in herbivores which follow the seasonal phenology of the plants [9,171,249]. Up to now, the only study conducted on radio-collared huemul, revealed short-distance seasonal movements of roughly between 2-3 km between summer and winter range at the Tamango Reserve in Chile (Bahamondes in [155]). However, long-distance migration should have occurred as well with huemul at one time, due to the strong seasonal patterns of plant growth which is further intensified by the mountainous topography. There are some indications of the existence of migration in the past, for instance, in the river valley of Río Manso, Argentina. One of the first settlers told me how he found several shed antlers near the river about 50 years ago. He also said that the huemul were a pest to other early settlers, competing with livestock, and many were killed in those years. However, of the many inhabitants I've interviewed, no one has ever seen a huemul in this valley. This is understandable since today, the valley is intensely farmed, with lots of livestock and dogs, etc. Similar accounts for other valleys are common.

For migratory deer, there is usually a certain percentage of the population which remains on the winter range all year; these are resident deer. The rest will migrate into higher elevations until the snow brings them back down. Flueck and I made a drastic observation studying several populations of black-tailed deer in the state of California in the U.S.A. One population had both ample winter and summer habitat, enough for about 5,000 deer. For several reasons, this population grew to 10,000 individuals, producing a lot of damage to the vegetation and eventually a population crash through a major die-off [72]. In another area of summer range, we noted all the same plant species, but absolutely no signs of feeding, tracks or pellets. Bushes were lush and large, whereas in the other study area they were stunted from repeated feeding by deer. We then learned that the winter range of this locally extinct population had been virtually eliminated for the deer after being subdivided and filled in with homes on small tracks of land; most people had dogs, a horse and other pets. Years later we learned that in such winter areas, California now established a law restricting the minimum size lot to $40 ha in order to secure survival of the deer population. From this experience, I'm inclined to believe that the loss of winter range may play an important role for many huemul populations in determining whether they will be extant or extinct. The winter range most likely is also a crucial factor limiting the quantity of huemul as in most areas where huemul still exist today, it has been greatly reduced and is much smaller in area than the summer range.

Several factors can influence migratory behavior, including the habitat type, density of the popu-

lation, and disturbance patterns. For instance, red deer reestablishing themselves in the Swiss National Park and those introduced to Nahuel Huapi National Park in Argentina did not exhibit migratory behavior in the early years until their population densities reached a certain level. Now animals in both populations migrate annually and over many kilometers.

## FOOD HABITS

The huemul, as are all other cervids, is a ruminant with a four-chambered stomach, including a rumen, reticulum, omasum and abomasum. The ingested food initially goes into the first chamber of the stomach and is stored. Later in order to be digested, it is regurgitated and chewed upon extensively before swallowing a second time. This process, known as ruminating or chewing the cud, occurs between feeding bouts while the animal rests (see Photos 3 and 15). After ruminating, the food passes to the remaining stomach compartments for further digestion.

The feeding habits of deer can be classified into three categories: 1) concentrate-selectors, 2) intermediate and, 3) bulk feeders [107,108]. The concentrate-selectors feed on smaller morsels of plants that are more nutritious and clustered in space than the bulk feeders who consume high quantities of food of less nutritious quality. In a comparative study with 74 species of African ungulates, Jarman [124] found that the ungulate species with smaller bodies lived in smaller group sizes and were more selective in food consumed than larger species. These smaller built ungulates need to select high quality patches of food such as berries and shoots because of their higher metabolic requirement per unit weight than a larger animal (see Table 1). From preliminary results of a diet study on the huemul, it appears it can be classified as an concentrate-selector (Smith-Flueck, unpublished data).

A relationship between the difference in food selectivity among the various deer species and the morphology and physiology of the four-chambered stomach has been demonstrated. Hofmann [108] showed that one can determine the feeding style of any deer species from its gut structure. Comparisons of gut structure and feeding habits of various deer species revealed that both anatomical and physiological variations of the stomach are in accord with the particular type of diet of each species. These morphological and physiological variations which can be viewed as adaptations to the animal's feeding habit include: the size and relative proportion of the rumen and reticulum, and their relative size compared with the omasum and abomasum; the fine structure of the lining of the stomach and intestinal tract; the species composition of the symbiotic micro-organisms within the rumen; and the retention time of the food in the gut [196]. A more primitive deer such as the roe deer has a less well-developed rumen-reticular complex than some of the other species and is therefore more of a concentrate-selector [196].

Gut structure is not the only thing to change with diet. Deer species which tend to feed more selectively have narrower muzzles than intermediate or bulk feeder with similar body size. The shape of the incisor arcade (bite shape) also correlates with feeding style (Gordon and Illius 1988 in [196]). The red deer, an intermediate feeder, has a muzzle intermediate in width between the domestic cow, a bulk feeder, and the white-tailed deer, a concentrate-selector. In accordance with preliminary results of a comparative diet study I am conducting on the huemul and red deer, which shows the huemul to be the more selective species, the muzzle of the huemul is also narrower than that of the red deer. Although the red deer has been identified anatomically as an intermediate feeder [108], the huemul's gut structure has never been studied. Considering that the white- and black-tailed deer, both concentrate selectors, have a similar muzzle shape and body size to the huemul, we might also predict the huemul to be a concentrate-selector. It is probable that we will discover that the structure of its digestive tract is similar to the white-

and black-tailed deer.

To determine into which feeding category to classify a deer species, diet studies must be conducted. There are various methods accepted for studying the diet of an ungulate. An accurate one is to collect fresh samples from the rumen content, however, with an endangered species this method is not feasible as the animal must be killed. There is one method known as fistulation where one collects recently consumed material by reaching through an opening to the esophagus or rumen but it requires surgery and a tame animal. Direct observations of individuals feeding (see Photo 16) or indirect observations of plants with browsing signs can provide information about plants consumed in their diet but not about preference and which plant species are the most important. The most common method for studying herbivore diets is the microhistological fecal analysis. For this type of study, fresh fecal droppings are collected and dried and microscopic slides are prepared of the contents. Each plant species has its own characteristic cell appearance by which they are identified and their frequency of observations per slide are recorded. Information about the diet of the huemul is crucial for captive breeding programs and habitat management plans for protected areas.

In Chile, a total of 45 plant species have been identified as consumed by huemul through microhistological fecal analysis and direct feeding behavioral observations [4,38,78]. In a study of the El Manso huemul population, Flueck and I found 4 additional species to add to this list by indirect observations [247]. Since the European hare was the only other herbivore besides the huemul at the upper elevations, we were able to distinguish their browsing signs from those of the huemul whose cut is much more ragged than the straight even-edged one made by the hare's sharp teeth. The huemul, as other cervids, lacks upper incisors and thus uses its bottom incisors pressed against the palate to tear the edible parts from the plant. Huemul tracks leading to these same plants also confirmed their consumption by huemul.

*Maytenus* species (maiten) appear to be very important to the huemul from results obtained of the few microhistological fecal studies conducted. For the lake population in southern Chubut province, I found *Maytenus disticha* constituted 74%, 60%, 54% of the total autumn, spring and summer diet, respectively. For all seasons combined, it made up 60% of the huemul's diet. For the Los Nevados de Chillán population, Colomes found that *Maytenus sp.* was the principal species consumed from April through November and was the plant most frequently consumed all year with 11% of the total annual diet [38]. The next most important were *Alstroemeria sp.* (9%), *Chlorea viridiflora* (8%), *Geranium sp.* (5%), *Schinus sp.* (5%). In feces analyzed by Merinos from Los Glariares National Park, *Maytenus sp.* also predominated [234]. These fecal pellets had been collected in January of 1995. During the summer of 1997 in Los Glaciares National Park, *Maytenus magellanica* was the most highly consumed species of 5 woody plants being recorded during direct observations of feeding behavior of 8 individual huemul [237]. Unfortunately the young seedlings of the tree *Maytenus boaria* are also eaten by cattle and red deer whose high densities and impact on the habitat make rejuvenation of this plant impossible in many areas of its distribution. One can hypothesize that the huemul no longer inhabits areas where the maiten was once the common forage plant, as an important staple food no longer exists.

For the autumn diet of the lake population in southern Chubut province, species in the Rosaceae family were also important at 10% of the total diet. The next in importance were *Myoschilos oblongum, Adenocaulon chilensis*, and *Osmorhiza chilensis* at 5, 4, and 4% respectively. In the spring, species in the Rosaceae family totaled 26% (this includes *Rubus geoides*) and *Osmorhiza chilensis* was found at 8%. In Los Glaciares National Park in Argentina, the most highly consumed plants of 33 species eaten by the huemul included *Maytenus sp., Berberis buxifolia, Embotrium coccineum, Pernettya mucronata,*

and *Stipa speciosa*[234]. The main species in the summer diet in Colomes' study population was *Alstroemeria sp.* (liuto) and *Geranium sp.* whereas *Alstroemeria sp.* and *Chlorea viridiflora* (orchid) predominated the autumn diet [38].

When combining Colomes' samples for all 12 months of the year, the diet was comprised of 46% forbs and 31% woody plants. When regarding only the 6 months from spring to fall (November through April) the percentage of forbs in the diet increased while woody plants decreased. For Los Glaciares National Park, forbs comprised 50% of the summer diet while woody plants and grasses comprised 38% and 12%, respectively [234]. In contrast for my study population, woody plants at 72% were preferred over forbs at 27% for the spring, summer and fall seasons combined (Figure 7). During the spring, forbs and woody plants constituted 31% and 69% of the diet, respectively. This ratio remained nearly the same for the summer diet at 27% and 72%, for forbs and woody plants, respectively. In the autumn, forbs decreased to 18% while the woody plants increased to 81% (Figure 7). Thus forbs were more important in the spring and summer time when in flower than in the fall after seed formation. This reflects a decline in nutritional quality due to an increase in the proportion of lignified structural tissue [257]. The results of my study demonstrate that the composition of the huemul's diet can vary substantially from one population to another and most likely reflects the food availability.

From observations made of feeding behavior, it was noted for several populations in the Aisén region of Chile that huemul were often seen browsing on *Ribes sp.* in October, and *Fuchsia magellanica* (chilco) in November [4]. In Tamango National Reserve where chilco is rare, *Anemona multifida* (field anemone) was frequently seen to be consumed. In winter, evergreen plants were notably consumed such as *Embothrium coccineum* (ciruelillo), *Chusquea sp.* (chaura), *Escallonia rubra* (siete camisas), and *Nothofagus dombeyi* (coihue). *Escallonia rubra* was not noted in the microhistological analysis of summer fecal pellets collected from Los Glaciares Park [234] yet, in January of 1997, six of eight individual huemul were observed eating this plant [237]. For the periglacial population, huemul were observed feeding on 11 different plants, but while on bluffs, grassland or grassland-forest edge they fed mainly on the perennial herb *Gunnera magellanica* [78].

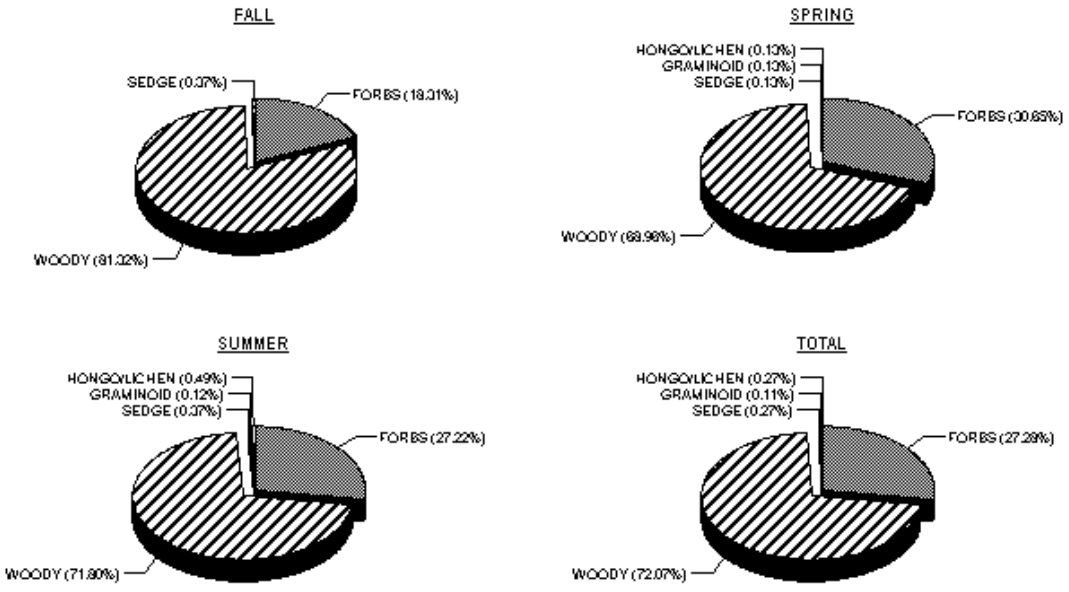


**Figure 7.** Composition of the huemul's diet during three seasons in southern Chubut Province, Argentina.

In a captive group of huemul, 36 plants were eaten of 48 different plant species offered, however only 22% of these were highly accepted [51]. The young leaves and branches of *Salix chilensis* (willow) was the species most preferred. Others highly preferred included *Acaena pinnata* (cadillo), *Vicia sp.* (arvejilla) and *Chlorea sp.* (orchid). It is interesting to note that two of the highly preferred species in the fecal diet studies, *Maytenus sp.* and *Alstroemeria sp.*, were only accepted on a medium and low level, respectively when fed to the captive huemul. This shows that the huemul can be flexible in its diet. They were found to really like apples which is a fruit I have seen red deer and black-tailed deer fight to eat. That they preferred willow above all other species might suggest that it once was a main part of their winter diet when they were able to live in the river valleys before the arrival of settlers.

## THREATS TO THE HUEMUL

By developing an annual monitoring program, consistent in its methodology from year to year, population trends can be determined. Of the protected Chilean populations being monitored, only the Tamango reserve population is not declining and has remained stable over the past 5 years. Meanwhile, a monitoring program has yet to be established anywhere in Argentina. It is particularly relevant to determine population trends before developing conscientious multi-use management plans. Additionally, once a population is realized to be on the decline, one must determine the influential negative factors. The actual cause of the present decline has never been defined in any population through scientific studies though the factors having a negative influence may be multiple and most likely vary for each of the remaining populations. Factors that are causing declines in Chile may not exist or have the same impact in the Argentine populations. Although human hunting may have had a substantial local impact in the past [47,228], the stronger influences over present declines may actually be from habitat change or reduction, diseases, nutritional deficiencies, introduced animals, human disturbance and genetic isolation [3,189,244].

Any factors which can negatively affect the huemul are particularly important to identify and avoid due to the extremely reduced numbers of surviving huemul (ie. 600-700 in Argentina). It is necessary to avoid activities and constructions of any sort in the few places where there still remain populations of huemul; this necessity is illustrated by what happened in the Ñuble Reserve in Chile (see below).

### *Hunting*

Human hunting had a stronger influence in the past, when it was not illegal to hunt huemul, than it does today. Regardless of the laws, illegal poaching continues to occur for several reasons. Either the animal is hunted by local ranch hands who simply desire meat or a trophy for their home or it is hunted by the wealthy collectors who pay large sums of money to obtain a trophy of an endangered male specimen. It is interesting to note that in the eyes of humans, collected species become more valuable and more sought after as they become rarer [13]. One hunting guide who was operating illegally within the Argentine National Park was asking $20,000 per huemul shot. Through connections, he had obtained blank legal papers from different branches of the government on which he forged signatures so that the foreign hunters could pass customs at country borders without being interrogated or arrested. These hunters were able to bring an endangered species across international borders, defying international laws established by CITES (Convention on International Trade of Endangered Species). This hunting

guide and an affiliate, a lawyer who worked for the Argentine government, were discovered to have organized the take of a mature male in 1990 but neither have ever been convicted (Serret in [155]).

When the opportunity arises while working in the upper elevations during the summer, some ranch hands will kill a huemul. Generally, they are opportunists and kill the animal for their own personal use but will also work as hunting guides to locate huemul for rich hunters, many of whom are foreigners. Through their summer work in the upper mountainous slopes, these ranch hands acquire basic knowledge about the huemul's use of the habitat.

Part of the field work of Flueck and I has included many long hours of conversations while sharing in the ritual of sipping yerba mate (herbal tea) with congenial country folks who are familiar with the huemul in their area. On several occasions we found people who outright admitted to wanting to kill a huemul to obtain a trophy, just like the one their brother or neighbor had. These are people who are yet uninformed of the animal's precarious position and once informed, convincingly remark that they do not wish to add to its downfall. They hold a love for nature but incorrectly believe there are still plenty of huemul remaining. It is doubtful that many are even aware of the laws which exist prohibiting the killing of huemul, as it is very weakly enforced.

Frid [80] learned of one local hunter who claims to kill 10-14 huemul per year in the Bernard O'Higgins National Park, always using dogs to corner the hunted individual. He also was informed that a hunter with his dog was in his study area shortly before his arrival. In another study area within the same national park, Frid was able to approach the animals to within 5 meters in 1990 but found them wary and approachable only up to 200 meters in 1995 (Frid, pers. com.). The change in behavior could be explained by the introduction of cattle in 1991 which increased human activity in the area, very likely increasing hunting pressure on the local huemul population.

The Department of Fauna of the province of Chubut recently declared the entire watershed of one of their southern lakes open for hunting red deer (Bol. Of. Chubut, Jan 25, 1999: 5-7). Although red deer are found on the eastern portion of the lake, the majority of the area is inhabited by huemul (Smith-Flueck and Flueck, unpublished data). This legal permission to hunt in the entire region, irrespective of whether there are red deer or not, will give illegal game hunters even easier access to the huemul. The Argentine Wildlife Foundation (FVSA) and members from the Technical Delegation of the National Parks presented their arguments against this plan before this decision was made. Regardless, their legitimate concerns apparently went unnoticed by the law makers of the province of Chubut.

### *Habitat Modification*

Modification of natural habitat, most likely, is a principal factor affecting huemul in both Argentina and Chile. Changes can come about directly as through man's intervention and manipulation of the landscape or in an indirect manner when, for instance, their introduced cattle overgraze a habitat causing irreversible changes to the vegetational community. Introduced herbivores at high densities can affect regeneration of forests, structure of plant communities, and be responsible for soil erosion. Exotic species found in some huemul areas include red deer [71], European hare (*Lepus europaeus*), wild boar, and domestic cattle, sheep, horses and goats. Modifications in regeneration and composition of forest species due to exotic animals [259,260] may negatively impact remnant huemul populations.

Human practices capable of modifying huemul habitat include cattle and sheep ranching, silviculture, large scale constructions, roads, mining and recreational adventure tourism. Burning extensive areas to create pastures by removal of native brush and trees has been a common practice in the cordillera (Laclau in [149]). Many of the lower, more accessible slopes in the southern Andes, particularly on the

Chilean side [188], have been burned. The consequent soil erosion has left a barren terrain which can support few animals, be they domestic or wild. A higher percentage of virgin sub-antarctic false-beech forests may remain in Argentina but these too are disappearing at an alarming rate. In the past three La Niña years, with below average precipitation and above average summer temperatures in the southern Andes, numerous large fires- many of them arson fires- have plagued forests from the province of Neuquen to Santa Cruz in the south. Although much of these false-beech forests are within the extensive national parks area and thus protected from logging, fires still can take their toll.

Subsequent to fires, additional changes occur when cattle are allowed to over-graze areas. Damaging forestry practices include irrational exploitation of native forests or replacement of native species with plantations of exotic pines. Drastic changes in vegetation and soil structure resulting from past burning programs, overgrazing by livestock, and increased removal of biomass (eg. cattle, wood) can cause nutritional deficiencies [64]. Large scale construction such as road development, oil and gas pipelines, hydroelectric plants or tourist centers should all be avoided if development interferes with one of these last remaining huemul populations. Loss of valuable habitat in lower elevations where human settlements have been established may be devastating to small populations during severe winters when they need to descend for food.

The isolated population of the Nevados de Chillán is the only remaining huemul population in central Chile and the northern most population of the entire present day distribution (see map, Figure 1). This region was declared a Protected Area (Area de Protección) by the Ministry of Agriculture in 1978 through Supreme Decree Number 384 with the main objective to protect the watershed (Verdugo in [155]). It includes the Nuble National Reserve of 55,948 ha plus another 4,000 ha under the protection of CODEFF since 1994/95 (Manzur in [155]). No other population has been studied as extensively. Regardless, it is still declining and in at least 7 areas the huemul have even disappeared [193] (Povilitis pers. com.). The various factors contributing to this decline include construction of roads, logging of native forests, lumber mills, construction of housing, intense recreational activity, construction of hydro electrical centers, cattle and dogs (López in [155]). Tourism is further encouraged to the local region by way of the Termas (hot baths) de Chillán. Captive breeding of red deer has also been permitted in the area and there have already been escapees (Maldonado pers. com.). Then, in 1992 the governments of Chile and Argentina agreed to the construction of oil and gas pipelines crossing the Andes which today pass through the Nuble National Reserve, directly cutting through prime huemul habitat (Verdugo op. cit.). The reserve is an important summer habitat for approximately 19 huemul. Unfortunately, legislation did not exist in Chile which would require an Environmental Impact Statement before the execution of such a large scale construction. Results from the surveys conducted this January 1999 in the Nevados de Chillan show that the situation is deteriorating. The population continues to decline and the gas and oil pipelines has caused a lot more damage to huemul habitat than anyone had anticipated (Povilitis pers. com.). As pipelines appear incompatible with huemul, construction sites should be placed through one of the many regions where huemul no longer exist.

Concerning forestry practices, in 1940 it was estimated that the native forests in Chile covered 15,000,000 ha [102]. It took only half a century to destroy nearly half of these forest lands to where the remaining native forests today only constitute a total surface area of 7,616,500 ha [118]. From this, the average annual rate of loss can be calculated to be 1.6% which, if allowed to continue, would mean the disappearance of the Chilean native forests in 62.5 years [154]. This reduction of the native forests in Chile has mainly been due to irrational exploitation (64%) which include replacement of native species with exotic species such as Pinus radiata and Eucalyptus sp. and fires (10%) [34,39]. Modifying land use for agriculture practices and cattle practice has also involved removal of native forests [39].

Under the National System of Protected Wilderness Areas (SNASPE), 16.6% of the surface area of the total native forests of Chile are managed [49]. Even though there are 3 types of protected areas under the jurisdiction of SNASPE- National Park, National Reserve, and National Monument- the native forests within National Reserves can be exploited. This signifies that complete protection only exists for 7.3% of the Chilean native forests under SNASPE [154].

In the VIII Region of Chile- the region with the greatest diversity of tree species in Chile- approximately 60% of the native forests have been replaced by plantations. [7]. Each year, an average of 1.44% of the remaining native forests are being destroyed in this region to be replaced by plantations [139]. Meanwhile only 3.5% of all the native forests of this region are under protection [154]. As long as the native forests are exploited, the huemul populations will continue to suffer, for most of those remaining today occupy these native forest habitats.

Old-growth forests are an important winter habitat for many species of deer, as they provide more thermal protection, more abundant food in the understory and better cover to intercept snow accumulation than forests stands of only younger trees resulting from logging practices [220,221]. Black-tailed deer from the coast of southeast Alaska, for instance, increase their use of the forest as snow accumulation increases [129]. In openings created from fallen large old trees, sunlight can penetrate, allowing for more plants such as saplings to grow in the understory which then provide more browse for the deer. The harsh winter climate and habitat types available to huemul, suggest that they may also be forest-dependent during the winter [78,79].

Hand in hand with deforestation comes skid roads plus the even more destructive logging roads. These roads cause a cascade of damaging effects to an ecosystem, including fragmentation of wildlife habitat, erosion of soil, diminished water quality and change in the structure of the plant community through increases of invasive plant species along the roads. In Idaho state of the Pacific Northwest in the USA, heavy winter storms of 1995-1996 caused 422 landslides of which 70% were associated with Forest Service logging roads [88].

Exotic tree plantations, on the other hand, may influence the rapid spread of red deer in Patagonia [73]. Although there are some plantations with native species in Argentina, mainly exotic species from the northern hemisphere have been planted because they tend to grow faster [48]. Plantations are often found in zones that apparently have not supported native trees historically, and such habitat changes may facilitate the advancement of red deer into huemul country.

### *Human Activities*

We can reasonably assume that the huemul have been greatly affected by the advancement of humans into their habitat if we note that during the past century, the size of the distributional range of huemul has declined in the same places where man's presence has made itself known. Considering this, further development infringing on habitats of huemul populations, particularly those relatively undisturbed, should be carefully evaluated and curtailed as much as possible.

One of our study sites, an unprotected area barely touched by man in the past century, still contains an apparently healthy huemul population in southern Argentina [245,246]. For the entire watershed surrounding our study area, a multi-use management plan is currently being developed by the province to include silviculture, hunting, livestock, fishing, mining, and tourism. Although selective logging of the native lenga tree took place at some scattered, lower-elevation locations nearly 50 years ago, much of the forest is still in pristine condition. Selective logging commenced again in the area in the early 1990's but the practice has fortunately been contained within a region just outside of the range of the

current huemul distribution. Unfortunately, the area containing huemul is also being considered for mining of precious metals and additional logging. The implications of logging and mining exploitation within the huemul habitat are disturbing, particularly if it involves the construction of new access roads. This area may possibly contain one of the larger viable populations of huemul remaining and disturbance of any kind into this region could bring a devastating blow to the apparent viability of this population.

Human intrusion into relatively undisturbed regions should be kept to a minimum as we do not know the potential impact of human activities on the behavior of huemul. Research topics on the impact of recreational activities on huemul need to be addressed to determine what type and level of activity might be permissible. In the same study area mentioned above, the main disturbance to the region in recent years has been the sport fishermen-mainly fly fishermen- whose activities concentrate at the lakeshore; these people rarely venture inland. However, even at the shoreline they can have an impact by disturbing the occasional huemul who comes out of the forest to drink the lake water; it is not uncommon to find fresh hoof tracks in the sand of one or more individuals heading down the beach. Today in Argentina, outdoor recreation and tourism are becoming in vogue, bringing more and more fishermen, hikers, horseback riders, paragliders, cross-country skiers, and mountain and dirt bikers to the wilderness areas where huemul rarely encountered a human before. In one backcountry area, a French fisherman in a boat captured photos of a male huemul swimming across the lake, presumed to be fleeing from a mountain lion. Taking photographs of this wild buck was acceptable enough, however he also had to push his luck and proceeded to approach the frightened animal, rubbing his alien hand across its forehead. Such inexcusable behavior could have stressed that wild animal to the point where physical ailments could have been manifested, eventually leading to an untimely death.

The National Parks in Argentina containing huemul still do not receive, in general, a heavy impact from tourism. However tourism is on the rise and so is the expected impact from related disturbances [92,103,104]. Increased use of an area by hikers may force huemul to move out of an area. In Los Alerces National Park in Chubut, huemul were often sighted on 2 mountains within the park in the 1970's; in 1978 there were three observations alone in the month of December on Alto El Petiso. In recent summers, the 2 mountains have received a high number of visitors however no huemul have been sighted (Lema in [155]). An expected outcome of the rising popularity in eco-tourism, is an increase in direct encounters between humans and huemul. Recently, some trekkers in the Lago Puelo National Park came upon a bedded newborn fawn when their dog brought it to their attention. Believing it to be abandoned, they brought it home to raise as a pet. What they didn't know was that this fawn's mother was most probably off feeding somewhere in the local vicinity. Fawns are normally left for several hours while the mother feeds. The fawn during this time will remain quietly bedded until her return. During the first two weeks of life, it will lie still, camouflaged with its environment so as not to attract predators. If danger appears, it will immediately freeze, lying on the ground with its head placed between the two front legs. This is typical behavior among fawns who rely on cryptic coloration and reduced scent to avoid predation. Although these hikers had good intentions, they naively brought harm to the animal by taking it away from its mother. They also did not have a recipe for a milk formula and were unaware that the fawn needed stimulation of the anal region in order to defecate and urinate. A mother will lick the fawn in this region, most often while the fawn is nursing. This is a defense mechanism evolved to protect the fawn from predation. Otherwise the fawn would defecate in its bedding site and attract the predator with the odors.

Paragliding has grown in popularity in the Bariloche region over the past couple of years. Within the Nahuel Huapi National Park, paragliders take off from at least one site known to potentially be used

by huemul. Paragliders also use the slopes of Cerro Pirque within the Provincial Reserve where huemul presence has been confirmed and where plans are currently under way to hold the next International Paragliding Championship. The longer history of paragliding activities in regions of the Alps has already resulted in severe conflict with wildlife conservation. Studies have now clearly demonstrated the disturbance created by this sport on several large mountain-dwelling ungulates. A study on the influence of paragliding on the behavior of male ibexes in the Swiss pre-Alps [255] found that males fled when paragliders flew within 30 to 1200 m (median 650 m) of the animal. While fleeing, males changed their altitudinal position on the slope, ranging from a difference of 20 to 500 m in altitude (median 200 m) and many fled out of their home range. These males walked longer distances on days with paraglider activity than on days without activity. Another study lasting 3 years, evaluated the impact of paragliding on chamois in the Swiss Alps [219]. The chamois is a goat-like ungulate which compares to huemul in body size and stature, and habitat use in mountainous terrain. The data showed that paragliding can alter behavior, habitat use and body condition of chamois in a detrimental manner. Both research groups recommended regulating paragliding in some regions to protect these animals.

I once witnessed the effect of this kind of disturbance when paragliding about 400 meters above a small group of chamois feeding in a forest clearing in the Swiss Alps; their reaction to the paraglider was to run to the edge of cover, thus needlessly expending energy. Continued harassment could eventually cause them to avoid this open feeding area, at least during hours of paragliding activity as was observed by Haller [96] for other chamois groups. Similarly, a change in use of habitat can be assumed to occur with huemul after they are disturbed by paragliders (see Figure 5).

The current trend for "ecological adventure tourism" (i.e. helicopters, trekkers, bikers), needs particular attention due to its potentially significant impact on remote areas. Huemul will be affected by development of tourist areas for outdoor recreation if the human activities are not properly regulated. The few populations which exist today in relatively undisturbed areas need to be better protected by the law. The impact of human activities in these areas must be critically evaluated before formalizing any

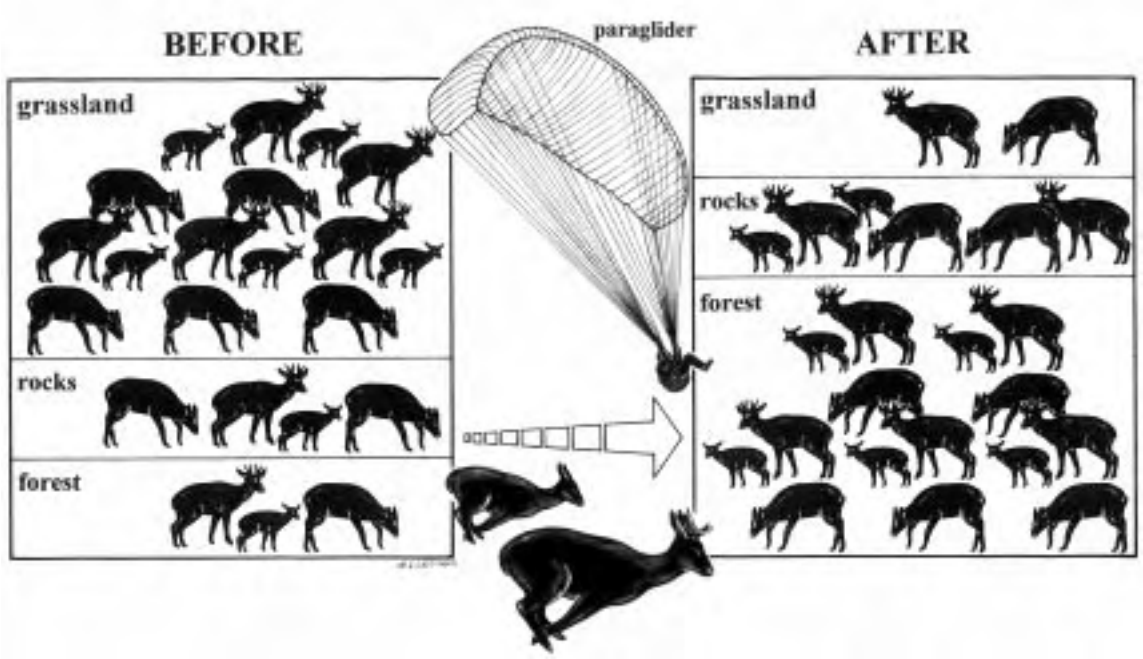


**Fig. 5.** Impact of paragliding on use of habitat by huemul.

multi-use management plans. Types and amount of activity to be permitted in wilderness areas need to be clearly defined within the framework of carefully designed plans. Finally, winter ranges of huemul need to be evaluated as huemul are vulnerable to human activities- for one, poaching- when they descend to the lower elevations occupied by human inhabitants.

Another serious issue which has developed recently involves the purchasing of large tracts of land, often by wealthy foreigners, in areas with or adjacent to huemul populations. Huemul are basically found today in only the most undisturbed, pristine areas. These same areas provide, unfortunately, the very landscape that these wealthy foreigners are interested in. A few of these landowners have shown outright disrespect for the natural resources in the local region. In Argentina, at least 4 foreigners have purchased land in areas by huemul populations having intentions to bring in exotic red deer. Two of these already have accomplished their goal. The first one brought in red deer without provincial permission and they escaped within the same year. The most recent episode involved Joe Lewis- who owns property around the Lake Escondido in Río Negro, comparable in scenery to the picturesque Yosemite National Park of the U.S.A.- who managed to obtain permission from the province to go ahead with a zoological collection. Red and fallow deer now live in an enclosure on his property. It is just a matter of time before they will escape and come into contact with the huemul of that zone. Flueck and I were initially asked by the manager of the property for advice on fauna. We wrote a proposal to study the situation of huemul in that area and to determine observation sites from where visitors could view huemul. The manager replied that they were more interested in having some animals in captivity close to the lodging facilities. He then wrote to ask us to work as consultants on a captive red deer project. We said that if legal permission could be obtained, we would assist in the design to guarantee that it was made a secure installation in strict compliance with provincial laws, however we also recommended that this zoological establishment preferably be limited to native species and recommended against the release of introduced animals into enclosures. Despite the promises by the manager, we never received replies to our correspondences. By placing these exotic ungulates in the heart of a huemul population, Lewis caused a reaction from Fundación Vida Silvestre Argentina, Sociedad Naturalista Andino Patagonica and the Universidad Nacional del Comahue, who have shown their concern for the exotic deer enclosure by writing a letter to the manager recommending that the deer be removed (FVSA in [2]). As far as we know today, they have not complied and the exotic red and fallow deer remain. Joe Lewis doesn't appear to be aware that he is playing Russian roulette with nature as in a recent interview with the Rio Negro newspaper (October 4, 1999 pages 28-29) he remarked that his longtime goal always was to have animals living free, with native fauna living together with exotics, which he would supply himself.

Besides ignoring the negative impact that they produce on the natural environment around their property, these "untouchable foreigners" are responsible for giving the rest of us foreigners living here a bad reputation. What we do know is that back home in our countries, they could never exercise so easily this form of environmental imperialism. Additionally, the desire of these people from abroad to purchase large tracts of pristine land in Patagonia has opened up a market which certain local real estate businesses are taking advantage of without regard for the heritage of their own country. Ironically, many countries would be proud to call a place so gorgeous as that which Lewis owns a national park, yet circumstances in Argentina allows private ownership and carelessness to rule over such areas. On the other hand it must be pointed out that several foreigners who own large tracts of land in Patagonia have espoused conservation ethics, and their support for the protection of the environment has actually been a substantial benefit to protecting the natural resources of the region.

***Predators***

Potential huemul predators include the mountain lion or puma, red fox *Pseudalopex culpaeus*, certain raptor species, the two wild cats, (*Oncifelis guigna*) and (*Oncifelis geoffroyi*), wild boar [122], and the domestic dog *(Canis domesticus*). Dogs are likely the most serious threat to huemul, because they kill young and in packs kill adult deer by chasing and surrounding an individual, sometimes force it into water. Feral dogs exist but more commonly herding dogs accompanying ranch hands kill huemul.

The huemul and puma have coexisted over many millennia implying a stable predator-prey relationship. One can assume that within the pristine old growth lenga forests, the huemul always lived at low densities due to the scattered patches of concentrated food. Mountain lions have never been shown to cause the extinction of any huemul population. At least within these virgin forests it is doubtful that they could extirpate every last huemul since the forest provides protective cover, making discovery and attack of the prey more difficult, and even more so when considering the small group sizes of the huemul. It is also clear from many studies on puma and deer in North America that they coexisted there all along.

Alternative prey, such as the introduced European hare and wild boar, may actually be beneficial to the survival of huemul. Most research investigating predation on ungulate populations has ignored the possible role of alternate prey in ameliorating the effects of predation [40]. The European hare was introduced to South America roughly 90 years ago [93] and definitely has been incorporated into the diet of the mountain lion. When results of 3 diet studies [120,202,278] of mountain lion in 2 regions of southern Chile were combined, Rau et al.[201] found that the hare constituted 54% of the prey occurrences. It is possible that the mountain lion has switched its diet predominately to the hare thereby reducing pressure on the huemul. In all areas where we have seen signs of huemul, we have also seen signs of the hare and often the wild boar. If an alternative prey is available then it is possible for the predator to reduce its pressure on the main prey. Rau et al. [201] reported that a decrease in the number of guanacos correlated with a strong decrease in mountain lion predation on them while simultaneously the consumption of the alternative prey (the hare) by the lions increased.

It is not surprising to find that the mountain lion feeds on the huemul; in most parts of its range in North America it feeds primarily on deer [40] with ungulates constituting almost 70% of their diet [119]. Rau et al. found that in southern and southernmost Chile, pudu and guanaco each constituted 15% of the mountain lion's diet [201]. Three mountain lion scats from an area in the province of Rio Negro contained huemul hair (W. Flueck and J. Smith-Flueck, unpubl. data) as determined microscopically [28]. Huemul carcasses with signs of mountain lion predation were found in Nahuel Huapi National Park (n=1), Perito Moreno National Park (n=2), and Glaciares National Park (n=1) [234] (Administración de Parques Nacionales Argentina, unpublished data). In another study to learn about mortality patterns in a population in southern Chubut, we collected remains of 15 carcasses found along a 20 km transect. Sixty percent of these individuals showed signs of predation by mountain lion [245,246,248].

The total predation found on the southern Chubut population occurred over a 4 year period and may not be significant as the huemul population there appears to be in good condition and with higher densities than in most other areas where we studied huemul. Some mortality by puma per year is to be expected. These puma may be limiting the population by keeping it below carrying capacity, but it is doubtful they could extirpate it. Rarely have predators been implicated as the sole direct cause of widespread decline of ungulate populations, except when man was one of the predators or when pristine ecosystem parameters were man-modified [40]. Severe winters, for example, may amplify mortality in prey populations. A series of harsh winters might explain the puma predation found in southern Chubut,

however, without data on the predator-prey density relationship we can not jump to conclusions about the impact.

The impact of large predators like puma on their prey depends on various factors. For one, the predator's attack success rate is generally low; the rates for lynx and wolves are 20% and 5%, respectively [117]. This results in a great opportunity for adaption by herbivores. Large predators can only regulate herbivores if the predator population is intrinsically regulated and if there is an alternative prey [56]. There are a variety of social mechanisms which keep large predators from reaching densities where they could deplete their prey. These include dispersal [161], intra- and interspecific killing of predators [110,135,153,217,242,253], reduced fecundity and territoriality. The social system of territoriality of large predators separates either individuals or social group units in time and space [91,127,215]. This has been shown for the puma [111,225,253]. Emigration of subadults also plays a major role [270]. Heavy fighting occurs when a new individual attempts to take over another's home range [14]. And as food supplies diminish, various types of aggressive behavior increase. Intraspecific killings have even been documented numerous times for puma, including killings within family units [6,146]. As determined by these various mechanisms, there is an intrinsic upper limit to puma density. Even an increase in herbivore densities will not elicit higher predator densities. Hence, the overall impact of the large predator on its prey population is kept in check by the ability of the large predator to intrinsically regulate its own population densities. Densities are never high in the first place due to little overlap between individual home ranges which are generally very large in size (see Table 7). Another mechanism resulting in decreased pressure on a major prey species is prey switching [1,11]. Thus when prey density reaches a lower limit, it becomes easier for the predator to switch to another prey species instead of increasing his efforts to find the few remaining individuals. In general, predators of large herbivores are not food limited to the point of compromising the existence of their prey species. As an example, in the Granite Mountains of the USA, puma predation reduced mountain sheep (*Ovis canadensis*) populations to a low density and held it at that level for 3 years, after which the predation abated and the population increased at 15% per year for the 3 remaining years of the study [271]. What we do know about predator impact on prey is that complex systems with large bodied predators and prey have existed for over 12 million years [156,258].

**Table 7.** Home range sizes ($km^2$) encountered for mountain lions.

| Male | Female | Reference |
|---|---|---|
| 221-938 | 98-574 | Anderson et al. 1992 [6] |
| 179-826 | 59-685 | 12 studies in Anderson et al. 1992 [6] |
| 453 | 173-306 | Seidensticker et al. 1973 [225] |

After humans, the domestic canine may be the huemul's worst enemy. Recently in a Chilean reserve established to protect the huemul, a local inhabitant decided to backpack into the area without permission during his vacation time. He disobeyed the park rules in the first place by camping in this area but he created worse havoc by bringing along his uncontrollable dog which attacked and maimed a mother huemul and her fawn. Such accounts are not unusual. In the same reserve some months earlier, another individual huemul was attacked by a dog and eventually died a slow death from its injuries.

Only last year, in another area closer to the northern border of the huemul distribution in Argentina, some local country folks looked on helplessly as their untrained dogs attacked and killed a young fawn of the season. On another occasion an owner of a fishing lodge in the Chubut province recounted how he witnessed some dogs chasing a huemul right into the water. This huemul escaped by swimming to another area. These dogs were seen with someone who was passing through the area on his horse and thus were not feral. These are but a few accounts of how domestic dogs can harm the huemul, killing them instinctively, not out of hunger.

Last winter in a lake region in southern Argentina, 2 adult huemul were discovered dead on a frozen lake, with their body collapsed over the ice and all 4 legs spread-eagled. Apparently they must have been disturbed to the point where they ran over the ice and slipped. One can speculate that they were fleeing a predator, possibly a dog. Once their legs were sprawled, they were unable to regain their footing to rise and were thereby confined to a slow death.

As mentioned earlier, fawns of the genus *Hippocamelus* do not have spots which is unusual among cervid species. Apparently the only other deer without spots is the Marsh deer [75]. On the other hand, the unspotted dark-grey coat of the taruca fawn is suited to its environment as these fawns are difficult to spot among rocks or rocky background [163]. The same may be true for the newborn huemul fawns as they too are found in rocky steep areas [78]. It is assumed that spots evolved as an anti-predatory response as they serve to camouflage the young one in forested habitat. One may therefore hypothesize that huemul fawns spend most their time outside of forest habitat, such as in above tree-line grasslands and rocky slopes.

### *Introduced Herbivores*

Introduced herbivores are often found in areas containing huemul. These include cattle, goats, sheep, horses and the European red deer, wild boar, hare, and rabbit (*Oryctolagus cuniculus*). Any of these herbivores in areas with huemul should be cause for major concern. Nonetheless, strict protection has not yet been provided for the huemul within the protected reserves and parks. Cattle, for instance, are found in many areas within the national parks and reserves in both countries.

All these introduced herbivores are capable of negatively impacting the remnant huemul populations. As invading exotic species, they can alter their new habitat in many ways including a substantial change to the composition and diversity of the native fauna and flora. Additionally, large invading herbivores can have detrimental effects on the soils and hydrology of an invaded area, thereby causing a decline in the general productivity of a region. Not only can an introduced species drive out native species by making a habitat unsuitable but also directly through competitive exclusion [13]. Furthermore, new diseases can be transmitted. Of all the exotic species, cattle and red deer are of the greatest concern. It has been assumed that they may compete with the huemul; however, no studies have yet substantiated this. Regardless, more efforts need to be taken to remove free-ranging livestock from protected areas and to manage the rapidly expanding red deer populations, especially in areas where they may come into contact with the huemul.

**Cattle.** The interaction of range cattle with different deer species has been a subject of interest for centuries [254]. It has been debated that the presence of cattle and the activities necessary for their management may have a negative impact on ungulates. Cattle may affect huemul directly by competing for a limiting resource such as food or by just simply being present in an area. The interference competition theory suggests that a species may be sociably intolerable of another and thereby avoid them [176]. This

however has never been demonstrated. On the other hand, increased interspecific encounters can disturb huemul to where they are displaced from parts of their habitat. Cattle may also indirectly affect huemul through the concomitant increased activities of man in the area, which can furthermore, increase exposure to hunting and dogs. Habitats may be damaged indirectly by increased soil erosion and alteration of the plant community structure [61]. Finally, cattle can act as carriers of infectious diseases and parasites to the huemul.

The only monitored population of huemul known to have remained stable in recent years is at the Tamango National Reserve in southern Chile. This reserve, protected by CONAF wardens, has gained the support of the local community through a successful environmental education program. Thus, poaching is not an issue, however, there is concern about the impact caused by grazing cattle within the reserve. Impact from disease transmission by these cattle should not be overlooked.

North American studies evaluating the social relationships between deer and cattle have revealed contradictory results. This discrepancy may be due in part to variation in environmental factors between study sites, time of year, study design, or intensity of cattle grazing. Many study designs dealing with deer-cattle social interactions have taken an indirect approach such as diet overlap or the occurrence of fecal pellet-groups, but clear conclusions have not been presented. In the forest and shrub habitat of California, USA, a positive correlation was found between the occurrence of cattle and deer droppings (Chapel cited in [173]). It was speculated that this was due to a preference by both species for the same habitat types. Meanwhile, in Arizona, USA, a negative correlation occurred between cattle and deer pellet-groups in one area; however, there was no correlation in another area [173].

Research on deer-cattle social interactions has included dietary overlap [25,52,98,99,126,160] but few studies have determined change in foraging behavior of deer due to cattle [10]. A review of published information revealed a low diet overlap between cattle and mule deer; cattle primarily ate graminoids while mule deer preferred browse and forbs [97]. Despite this, diet overlap and the potential for competition may increase in mutually preferred habitats in late summer when herbaceous forage has matured or been eaten. MacArthur and Pianka [152] theorized that if food resources become limiting, animals likely will respond by shifting to alternate habitats or by altering food choice.

A few studies have evaluated changes in habitat use by deer due to cattle pressure. While McMahan [159] and Ellisor [55] observed that deer tended to avoid cattle, Julander and Robinette found that deer preferred feeding sites heavily used by cattle [126]. On the other hand, Michael found that deer usually ignored cattle, but were sometimes displaced from good bedding sites [165]. Similarly, in Texas, white-tailed deer remained in pastures with free-ranging cattle and only dispersed when cowboys on horses disturbed the area while rounding up the cattle [109]. In another Texas-based study, cattle had little effect on the deer though deer were displaced by goat and sheep grazing at high densities [164]. From the literature it appears that the influence of cattle grazing on mule deer depends on the intensity of cattle grazing and the criteria used to assess deer response. When cattle levels are low, deer can coexist with them. In contrast, heavy cattle use causing severe vegetational degradation can significantly affect the area selected by mule deer as well as diet composition and percent dietary crude protein [10,147,180]. Although deer do not appear to completely abandon their home ranges subsequent to high stocking rates, they have been shown instead to sometimes change the center of their activity by moving to adjacent pastures as soon as cattle are introduced into an area [35]. Loft found that female mule deer home-range sizes were larger with cattle grazing and that they shifted habitat use by reducing their use of habitat preferred by cattle and increasing their use of habitats avoided by cattle [147]. Hiding cover for fawns was also reduced with intense cattle grazing [148]. Behavioral activity patterns may also be affected by cattle grazing. Kie et al. found that mule deer responded to increased cattle stocking rates by decreasing the length of their

resting bouts while increasing the number of feeding bouts each day and the total time spent feeding [128].

Cattle grazing may also have some positive aspects by increasing nutritional forage regrowth. Although heavy cattle grazing can reduce availability of herbaceous forage for deer [148], many studies have indicated that proper livestock grazing maintains or improves deer habitat [125,180,243,251]. On sagebrush range, Willms et al. found that pastures grazed heavily by cattle during the fall were more attractive to mule deer the following spring [275].

Similar to other deer species, observations of huemul-cattle habitat use have been contradictory from one surveyed area to another. Surveys of Cerro Castillo in Chile [213] and Glaciares National Park [234,236], identified a negative correlation between huemul and cattle fecal droppings. In the brush habitat of Glaciares National Park, signs of huemul and cattle were recorded 537 and 197 times, respectively. In comparison, on the grassland, 12 and 252 signs were registered for huemul and cattle, respectively. Interpretation of this negative correlation should be made cautiously as it may likely have nothing to do with huemul avoidance of cattle but rather a differential preference for habitat types. Considering that huemul are predominantly browsers (see section Food Habits, this chapter), as is common for medium-sized deer, it is reasonable to find them mainly in the brush habitat whereas the cattle's preferential use of the grassland habitat corresponds to their feeding habits as grazers. In the Nevados de Chillán, the huemul also mainly used the brush habitat [185]. Despite the negative relationship above, these data do show a strong overlap of habitat use in the brush by the two species. Other areas have also contained fresh huemul and cattle signs in the same place at the same time, indicating that the two species can be sympatric. A study I conducted will give you an idea of the cattle-huemul situation in a protected area. I recorded signs of cattle and huemul along 2 transects containing a total of 100 plots between the elevation of 950 meters to 1400 meters in the Cerro Pirque National Reserve. Plots were 50 paces apart and measured 5 meters in diameter. The transects, with slopes from 0 to 50º, crossed the various habitat types found at this elevation: dense bamboo (*Chusquea culeou*), small remnant stands of old-, mixed- and young-aged lenga, a brushy lenga stand, a burnt area which once was a lenga stand with many charred-fallen logs, open alpine meadows and open sandy-rocky terrain, often in a state of erosion. Cattle were more prevalent than huemul in this part of the reserve with 16 cow tracks compared to only 6 from huemul. Plots contained 32 cow droppings in total but not a single huemul fecal pellet group, though several huemul droppings were found along the transect outside of plots. Such results indicate low densities of huemul while there is very high use by cattle. There is no doubt, these huemul must interact with these cattle on occasion. When considering the steep bare sandy slopes suffering from heavy erosion, one can only speculate the occurrence of further environmental degradation to this area.

Cattle introduced in 1991 to Bernardo O'Higgins National Park in Chile may be influencing the habitat use by huemul. In the spring of 1990 before the cattle introduction, huemul were frequently observed on the grassland/forb habitat [78]. However on a return trip in early spring 5 years later, huemul were not seen in this same habitat. Results of fecal pellet transects indicated that winter use of the grassland/forb habitat was also reduced (Frid pers. com.). Besides cattle pressures, one must also consider that the possible shift in habitat use may have been due to multiple factors such as difference in snowfall between the 2 study years and the increase in human presence which could have helped to foster hunting activities (Frid, pers. com.).

None of these observations on huemul populations provide enough information to evaluate competition either through the interference competition theory or due to a limiting resource. One needs to be cautious when interpreting these data and not forget to consider the possible multiple causes [105]. Finding huemul droppings in areas where cattle use is low or completely absent doesn't signify that the huemul are necessarily avoiding cattle. Rather, they may have selected a preferred area which just happens not to

overlap with cattle habitat. To evaluate if avoidance is occurring, a study would have to be designed to include a control site where cattle are not included as a factor which could affect habitat use by the huemul.

There are additional problems with studies to date. For one, they were often of short duration such as two weeks. Future studies must consider these interspecific interactions during the course of all seasons and for extended amounts of time rather than short periods, as has been the case so far. Additionally, interpretation of results has to be made explicitly in relation to huemul and livestock densities. It is very common among cervids to completely change the habitat use pattern as a function of population density. Therefore, absence of use of a particular habitat type will be interpreted differently depending on huemul density. This also applies to migratory behavior. Similarly, results have to be interpreted explicitly in relation to the successional stage of the plant community of the study area. Early successional, post-fire habitat may be so attractive and provide large enough amounts of forage that deer will shift their habitat use. This would be a temporary response enduring until a late successional stage is reached again, but could be interpreted erroneously as avoidance of other habitat types. Lastly, due to an absence of studies based on marked animals, it is commonly assumed that the same individual huemul uses a particular site continuously, for example a north or a south slope. However, cervids commonly exploit habitats based on phenology of plants, weather and disturbance patterns. Therefore, it is a common observation that these herbivores change their use of slope exposure temporarily, visit a neighboring drainage, etc.; these are all behaviors expected to be part of the repertoire of huemul as well.

In general, results of studies on Odocoilid deer from North America suggest that competition for forage can be serious under conditions of heavy stocking, during periods of drought, or for short periods of the year when diet overlap is greatest such as late summer. The same could be found true when considering the interaction of the huemul with cattle, the European red deer or wild boar. If there are competitive effects for a limiting resource, niche dimensions most likely partitioned to minimize the competition are habitat type, food, and time of activity [222]. The relationship of huemul with other large herbivores still need to be determined. One would especially expect the dietary overlap between the huemul and red deer to be of significance, considering the biology of the red deer. A study evaluating the overlap of the food habits of the huemul and red deer is underway and aspects of the red deer impact on the huemul are discussed in the following section.

**European Red Deer.** The red deer is of particular concern to the condition of the huemul species. In the Andean-Patagonian region of Argentina and Chile, overabundance and continuing geographical expansion of introduced red deer across approximately 100,000 km$^2$ are responsible for many current problems in several national parks [199]. They occupy areas formerly used by huemul and preferentially select areas highly preferred by cattle due to the attractive forage base [68,74]. The ecological and economic impacts of this species on the ecosystems of the national parks and on the local forestry and cattle industries can no longer be ignored. They present a grave ecological threat, as has been experienced in New Zealand [113-116,207] where the native flora and fauna have been altered substantially. In Chile and Argentina, severe damage by red deer to the native flora has recently been documented in densely populated areas [101,260]. The extreme modification in the regeneration and composition of the forest species has created a concern about the potential impact the red deer may have over the last remaining populations of huemul [73], especially since they both tend to exist in similar habitats. Although red deer are assumed to be responsible in part for the recent decline of huemul in Argentina [42,142,277], this has never been documented.

There are several areas where red deer and huemul exist in close proximity [246] and, considering

the continual rapid expansion southward of red deer, many remaining huemul populations may eventually come into contact with them [73,244]. The introduction of the red deer into Argentina and Chile should be considered an ecologically serious situation. Besides the subsequent modified habitats and potential transmission of deadly diseases to other ungulate species, competitive behavioral interactions and competition for food with red deer may affect huemul negatively [244,246].

In 1972, Creswell noted that generally where the red deer is established there are no huemul. Twenty seven years later, the reason for this correlation has yet to be determined. Nonetheless there is at least one area confirmed where the two species currently overlap: within the Nahuel Huapi National Park in Argentina at 41ºS latitude. In the mid 1990's, red deer were released in an enclosure on private property, a few kilometers from the park's boundaries. Neither the park nor the province were involved in the operation. As a result of lack of experience, foresight and, careful planning of the facilities, snow accumulated to provide the means by which the deer readily escaped over the fenced enclosure during their first winter there. As this species was only recently liberated into this area, its numbers are few and thus its impact, directly or indirectly, on the huemul should so far be minimal. Moreover, the zone of overlap for the two species may still only lie at the periphery of this huemul population's distributional range, thereby producing only minor interspecific interactions. All it takes however is a mere single red deer individual to transmit a fatal disease which could wipe out the entire huemul subpopulation existing in this watershed. Thus far, preliminary surveys of this huemul subpopulation have indicated a minimum of only 6 animals making such a catastrophic scenario not so unrealistic.

The red deer were first introduced into Patagonia in the 1920's when 20 individuals were brought to San Martín de los Andes in the province of Neuquén in Argentina. By the 1940's, they were common throughout the western part of the province and the northwestern part of Río Negro. Then in 1979, a group of red deer in captivity, east of the National Park Los Alerces in Chubut, escaped when a fire broke out. These deer rapidly dispersed and inevitably came into contact-within the past 5 years-with the southward expanding Neuquén/Río Negro red deer population. In other words, the two populations are now one. Due to several other liberations- one in Chile close to the region of Lago Vintter in the province of Chubut and another one south of Lago Fontana in southern Chubut- the current distribution of red deer occurs between 39º and 45º south latitude (see map, Figure 6). One more established red deer population occurs at 55ºS indicating the capacity to invade Patagonia between 37º to 55ºS [157].

Several populations of red deer are found close to huemul populations between 40º to 45ºS (see map, Figure 6). Other than the population at 41ºS, there is very little information available to determine if there are other areas where the two species overlap. For the only other area studied with both species (45ºS), the two are in close proximity but as yet remain allopatric (Smith-Flueck and Flueck unpublished data). Regardless, it is just a matter of time before red deer from any of these populations invade the nearby areas currently occupied by huemul.

The rapid expansion of red deer throughout Patagonia has been facilitated not only by the additional focal red deer populations established along the cordillera but also by the lack of an intensive harvesting management program. These populations can reach dangerously high densities. Data which we obtained from permanent transects in the Nahuel Huapi National Park revealed densities of more than 100 animals per $km^2$ in the ecotone habitat (where the brush borders with the steppe) and more than 50 animals per $km^2$ in the steppe [74]. This suggests that red deer may affect not only the huemul in its habitat but also the guanaco in the steppe [67].

Dispersal rates for red deer introduced to New Zealand, during peak years of the expansion, averaged 11 linear kilometers per year [31]. These rates diminished once areas became saturated with deer. In Patagonia where ample space and suitable habitat remain for continued expansion, it is expected that

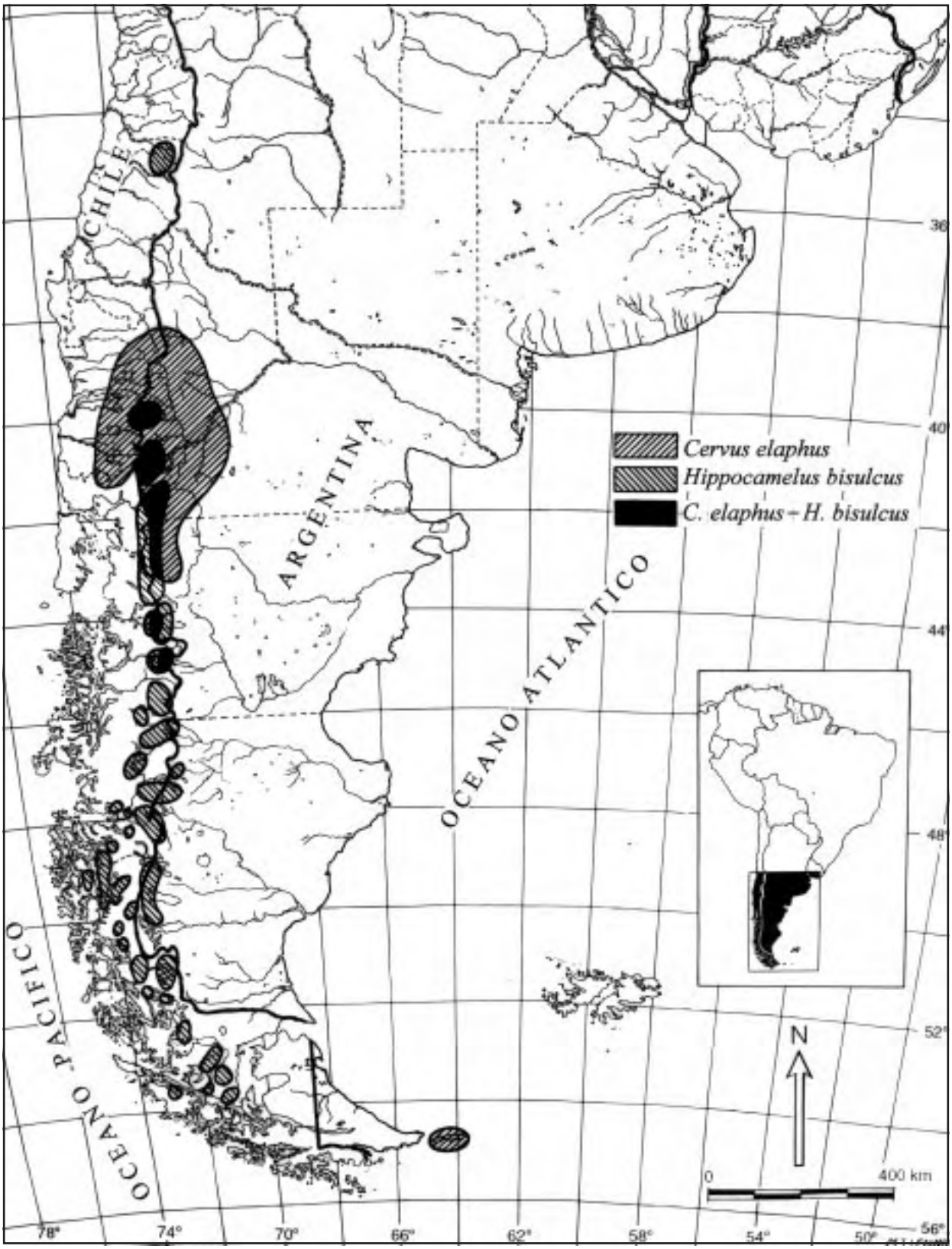


**Fig. 6.** Current distribution of red deer (Flueck et al. 1995, Smith-Flueck and Flueck unpublished data) and huemul (Serret 1992 and Lopez et al. 1998) for details of overlap see text)

the red deer will spread another 500 km north and south to the Straits of Magellan [73]. Considering the same dispersal rate of 11 kilometers per year, the Straits of Magellan could be reached in less than 50 years. The actual rate of dispersal will be influenced by topography, vegetation, population densities, additional introductions, and the intervention of man through a management program to control the expansion. Encouraging additional pine plantations will also facilitate the dispersal as we know the deer use these new environments as corridors.

The current interest in red deer farming and hunting, in and outside national parks, has resulted in uncontrolled translocations, both legal and illegal, and likely will determine future colonizations. Ignoring the red deer's capacity to destroy the environment, government officials continue to authorize the release of individuals into enclosures. Approval was recently given to include red deer in a private zoo being developed on property adjacent to the Río Azul-Lago Escondio Nature Reserve, both of which contain huemul. The enclosure is said to have fencing on three sides with the lake forming the final barrier. Somehow the fact was disregarded that red deer, as known swimmers, should be able to escape from this enclosure. There is no guarantee that individuals behind any enclosure will not escape someday, as has been demonstrated by the case where all the captive deer were able to jump the fence that proved too low once the snow accumulated and the incident where deer escaped because of a fire. New laws should be enacted which prohibit constructing enclosures for red deer in areas where this species is not yet free-ranging, particularly in regions close to the last remaining huemul habitat.

Then there is the dilemma of law enforcement. Although many laws exist concerning wildlife and animal health, they are rarely enforced. Even translocations across international borders (e.g. from Chile to Argentina), have been possible without any authoritative intervention [73] although laws do exist forbidding such action.

When the new habitat provides all essentials, deer numbers can increase rapidly to levels above ecological carrying capacity. Given proper planning and feasibility of controlling population spread, damages and conflicts can be minimized if effective management is initiated early after introduction [115,206]. It is clear that if red deer are further allowed to change this Patagonian ecosystem, the overall biodiversity and productivity of the area will decline. Considering the rapid expansion to the south of the red deer populations and interchange of individuals between Argentina and Chile, all the remaining populations of huemul could come into contact with this exotic species in the near future. The modified habitats with reduced nutritional quality, as well as competitive behavioral interactions with red deer leading to competitive exclusion, may force the huemul to occupy suboptimal habitat.

Classical ecological theory says that no niche can be occupied by two species simultaneously. The principle of competitive exclusion [100] states that such a situation simply cannot last and that two species cannot maintain the same niche indefinitely. As no two species interact with their environment in the same way, one will have a net advantage, no matter how slight. The theory is that, in time, the species with the advantage will replace the other species at least in their zone of overlap [267].

Preliminary results of a study I am conducting on the overlapping diet of the red deer and huemul shows that *Maytenus disticha* is a preferred food item of both. The percent of the autumn diet comprised of *Maytenus sp.* is 74% and 54% for the huemul and red deer, respectively. The overlap in the diet using the *Kulcyznski Index of Similarity* [280] was calculated to be 54%, 42% and 62% for spring, summer, and fall, respectively. This indicates a strong niche overlap between the 2 species and indicates that competition could have a negative impact when both are using the same area. The study area contains both cervid species although they are currently physically separated from one another by a mountain barrier which runs north to south. Vegetation on both sides of the barrier are similar with predominately old growth lenga forests, and some mixed-aged stands. Dominant species in the understory include *Maytenus*

*disticha*, *Gaultheria mucronata*, *Myoschilos oblongum* and *Berberis serrata-dentata*. The red deer consume a higher diversity of species (n$19) than the huemul (n$10). This agrees with the fact that the red deer is a generalist. In contrast, from these preliminary results, it appears the huemul is more selective in plants eaten and may thereby be considered more of a specialist in terms of its feeding habits. The spring and summer diet of the huemul also showed little variety with *Maytenus disticha* consumed 60% and 54% of the time, respectively.

A generalist is a species with broad food or habitat preferences, or both, [205] whereas a specialist has narrower tolerance limits for changes in its environment [267]. In terms of survival, the generalist is more flexible in its requirements than the specialist and will fare better in a changing environment; in other words, environmental deterioration is more detrimental to the specialist. The specialist may suffer when particular preferred food items are eliminated from its specialized diet and it may not be able to adjust to compensate for this loss. One specialist, the koala bear, depends entirely on eucalyptus leaves for its food source. Its digestive tract, feet, and food preferences evolved to utilize this available plant. If the eucalyptus groves are someday all replaced by pastures, the koalas would run into difficult times. When observing huemul on Isla Victoria with Franke, König [130] noted that they were very selective feeders, concentrating on brush species. He speculated that this might be the reason they had thus far been relatively unsuccessful in captivity.

The introduced species who are successful in their new environments are most likely to be generalists. The native species may find that the new additional member to its community occupies the same habitat and prefers many of the same food items that it eats. An herbivore specialist is in trouble once most of the plants of its short list of preferred forage items are gone from its environment. Its phenotypic plasticity is limited as it is not genetically adapted to switch so quickly. Physiologically, its body may not be able to properly digest and utilize efficiently other types of food. Meanwhile, the generalist, with the higher phenotypic plasticity, will adjust to the situation and change its diet to other available plant species in the community and thereby come out the survivor.

When a new species joins a community, the niches it seeks may already be filled by other species. In this scenario, if the productivity of the habitat can not be increased, then the added species would reduce the success of the other species in the community [205]. The degree of resource overlap may increase between species depending on resources available. Thus, the addition of red deer to the huemul's community may not only make the habitat unsuitable to where critical resources become rare for various native species but may force the huemul to share its critical resources with this exotic animal. In the diet study being conducted, this hypothesis is being evaluated so as to determine how the two species overlap in their use of the resources. According to the principle of competitive exclusion, evidence of strong overlap means that one species will eventually come to replace the other through competitive interaction. One is prone to assume that the red deer will be the aggressor and thereby out-compete the huemul. However, without actual studies we can never know for certain. In one area in Czechoslovakia, Bartos et al. [12] observed the smaller fallow deer adapting to the presence of the larger red deer. The fallow deer displayed aggressive behavior toward the red deer and became the dominant species at the feeding sites, causing the red deer to use the area less. Bearing this in mind, one can not ignore that huemul and red deer could also display similar interspecific behavior.

Another important consideration is the quantitative removal of forage by each species. Huemul commonly occurs at 1-2 deer/km$^2$ whereas red deer have reached densities up to 100/km$^2$ further north [74]. Moreover, while a huemul may weigh 40-100 kg, red deer further north have been weighed at 100-145 kg for females and 220-300 kg for males. Therefore, the biomass of red deer will be higher by 1 to 2 orders of magnitude over huemul biomass and they will consume proportionally more forage.

***Disease***

Health problems could be another factor driving the huemul numbers down. Anthropogenic modifications often change nutrient cycles such that they result in nutritional deficiencies which can directly affect an animal's health, resulting in stress which leaves the individual more susceptible to debilitating diseases. Diseases of exotic herbivores can also be transmissible to the huemul. Some of these diseases may only produce mild clinical symptoms, if any, in their original host species but on the contrary can result in severe sickness, even death, when present in the huemul. Three huemul died in captivity from exposure to coccidiosis when penned in an area previously used by infected sheep [256]. Unfortunately, failure to realize the potential of disease transmission from livestock to huemul may have been the reason why the few attempts to raise huemul in captivity have not succeeded.

Domesticated livestock (cattle, sheep and goats) and wildlife (red deer and European boars) introduced to new areas can transmit both infectious and parasitic diseases to the huemul. Those diseases that we know already can infect the huemul include foot-and-mouth disease [130,181,186]; brucellosis [51]; coccidiosis from sheep and *Taenia sp.*. [256], *Moniezia sp.* [46]; *Cysticercus tenuicollis, Ostertagia sp.*, *Strongylus, Fasciola sp.*, and *Bovicola caprae* [51]. In Table 8 below is a list of diseases which could be transmitted from livestock to the huemul.

**Table 8.** Diseases important to deer and livestock when using the same range (Flueck, unpublished)

| |
|---|
| Actinomycosis |
| Anaplasmosis |
| Anthrax |
| Arboviruses, minimum 9 types |
| Babesiosis |
| Besnoitiosis |
| Bluetongue |
| Bovine virus diarrhea |
| Brucellosis |
| Cervid spongiform encephalopathy |
| *Chlamydia* spp. |
| Contagious ecthyma |
| Coxiellosis |
| Dermatophilosis |
| Elaeophorosis |
| *Elaphostrongylus cervi* |
| Fascioliasis |
| Fascioloidiasis |
| Foot and mouth disease (aftosa) |
| *Haemophilus somnus* |
| Hydatidosis |
| Infectious bovine rhinotracheitis |
| Leptospirosis |
| Listeriosis |
| Lyme borreliosis |

Malignant catarrhal fever
Malignant edema
Necrobacillosis
Partuberculosis
*Parelaphostrongylus tenuis*
Pseudotuberculosis
Psoroptic mange
Rinderpest
Sarcoptic mange
Stomach worms: *Hemonchus contortus, Apteragia odociolei, A. Pursglovei, Ostertagia mossi, O. dikmansi, O. ostertagi, Trichostrongylus axei, T. askivaii, T. dosteri*
*Toxoplasma gondii*
Tuberculosis: minimum of 36 strains identified
Tularemia
Yersiniosis

---

Some diseases which leave no clinical symptoms in one species may be devastating to another. In this way, a group of apparently healthy European red deer moving into huemul habitat may introduce pathogens and parasites that are detrimental to the huemul's health. Brainworm, for instance, is tolerated by white-tailed deer but is pathogenic to mule deer [16]. In North America, liver flukes are tolerated well by white-tailed deer, but are not tolerated by reindeer, caribou, mule deer nor axis deer (*Axis axis*) [16]. Ovine herpes virus is a normal commensal of domestic sheep in which infection is prevalent but with no clinical signs. Transmission of this virus to at least 13 species of deer and other ruminants (such as cattle), however, results in the fatal disease of malignant catarrhal fever [204]. Not every disease has the same potential to affect the huemul, but a population under stress is probably predisposed to be affected by most of them. Other factors important to the potential of disease transmission to the huemul will be the density and herd health condition of sympatric wild and domestic herbivores.

In the literature, I have found no examples of any wild huemul suffering from malnutrition. From my work with W. Flueck in southern Chile and Argentina, individuals observed (n=14) in different areas of southern Chile and Argentina have all appeared to be of good weight and in a healthy condition. To evaluate how mechanisms such as nutrition, disease and predation might influence the dynamics of huemul populations, we analyzed huemul carcasses and bones from one subpopulation [245]. Samples were discovered from 19 individuals along a 20 km transect within 30 meters of a lakeshore. An analysis of bone marrow revealed a high fat content (between 88 and 98%), indicating a healthy population. Only one huemul in our collection, an adult male, had apparent health problems with an acute infection in the upper jaw bone, the maxilla. The results from this study indicate that the principle cause of death was not disease but predation (see Predation, this chapter). Another skull from an adult male collected from Los Alerces National Park in Argentina, also showed signs of possibly having had some type of periodontal bacterial infection with severe bone reabsorption in the upper and lower jaw [166]. Texera [256] recorded malformations in the mandibula of a male and female huemul in captivity who had died from unrelated causes. The bone was reabsorbed in the molar region, exposing the roots of the teeth. Similar observations of bone reabsorption have been seen in pudu and guanaco (Ramilo pers. com.). The actual causal agent was never determined in these cases however it could possibly have been

actinomycosis, norcardia, necrobacillosis or actinobacillus. Actinomyces, for example, normally occurs in the mouth and after an intraoral bacterial infection or other trauma and then may be able to invade soft tissue, later spreading to the bone. Norcardia is a similar organism and could be part of a cross diagnosis. Knowledge about mortality patterns in huemul populations will benefit conservation efforts to preserve this highly endangered species.

The most difficult to diagnose are subclinical problems. The increased removal and export of biomass for instance, can result in lowering of essential trace minerals important for the health of animals. One such example of this phenomenon occurred in northern California, USA. The first indications were a reduction of the reproductive rate in livestock grazing fiscal lands and forests which in some regions dropped to zero. At the end of the 1970's it was discovered that the problem was related to a deficiency in selenium, and the treatment of livestock with selenium brought reproductive levels back to normal. It has to be emphasized that livestock were first introduced during the Gold Rush during the middle of the nineteenth century and reached substantial numbers by the beginning of the next century. It was towards the end of this past century when reproductive problems were first exhibited. Livestock were partially responsible for the decline of selenium in the ecosystem. Continued removal of biomass containing selenium without replacement acts as a selenium drain. In the same area, a very low reproductive rates in black-tailed deer had been noted and based on the hypothesis that selenium deficiency also affected the deer, an experimental study was initiated in 1983. Wild adult females (n=60) were treated with selenium so that blood concentrations were elevated to normal levels during the gestation and lactation periods. The proportion of fawns/adult females increased to 0.83 for treated females whereas it remained at a low 0.32 in the untreated population (n=1551) [64,66]. During the four year study, no deer were ever encountered with clinical symptoms of selenium deficiency; that is, the effect of the deficiency at the level of the individual was imperceptible while at the level of the population it could be demonstrated by increasing the recruitment rate. Only the analysis of blood indicated the very low concentrations of selenium and allowed the deduction that there might be a subclinical problem, particularly after demonstrating the relevant connection between blood selenium levels and biochemical activity in deer [65]. Such drastic changes in mineral cycles are probably mostly related to various types of anthropogenic activities such as increased biomass export via livestock production [64,70].

### *Fragmented Populations: genetic variation*

Inbreeding is often an inevitable consequence of the severe reductions in population size experienced by endangered species. A crash in the population size, or "bottleneck" is assumed to result in loss of genetic variation due to the founder effect [177] which can consequently reduce fitness [50]. Populations which become fragmented through such factors as habitat destruction and human disturbances may have reduced genetic variation as there can no longer be gene flow between isolated populations. Concerning the geographically separate and apparently isolated subpopulations of huemul, one can hypothesize that there is little or no gene flow between these subpopulations. In a study I am currently conducting with support from the Scott Neotropic Fund, I expect to find significant genetic differentiation between study sites because of isolation but low genetic variability overall due to inbreeding in the small populations. In small isolated populations, mating between close relatives increases. This then increases the proportion of homozygosity in such offspring, thereby potentially leading to inbreeding depression. Although few data from natural populations are available, studies of captive and experimental animals consistently confirm the ubiquity and magnitude of the effects of inbreeding depression. The absence of genetic variation in some species such as the Père David's deer (*Elaphurus davidianus*)

shows that it is necessary to conserve genetic variation, particularly where population numbers and habitat are being reduced by human activity [50]. For such situations, it is particularly important to maintain genetic variation in captive or zoo populations through use of recently developed genetic techniques, such as mitochondrial DNA analysis and DNA fingerprinting. During the Genetics Workshop run by Dratch and Rhodes at the 1990 International Symposium on the Biology of Deer [50], it was agreed that application of conservation genetic principles becomes most critical in situations involving endangered species and translocation programs.

If after analyzing the genetic data sets, we discover bottlenecking is a problem in some subpopulations, all hope will not be lost as we will then have a strong argument with which to convince government officials to support programs in favor of managing and protecting these populations and more opportunities may materialize to receive financial support. There are several examples of species whose total population size fell to extremely low numbers but then were able to increase substantially through management. The Scandinavian roe deer was down to under 100 animals in the 1830s. The population began to increase again after strict hunting laws, removal of livestock from the forests, and extermination of the lynx and wolf. Today the population is estimated between one and two million animals [143]. Another example, the Tule elk, *Cervus elaphus nannodes*, found in the U.S.A. had only about 12 individuals remaining when the California Department of Fish and Game set up a reserve in Bakersfield to protect them. Once this group had increased to sufficient numbers, individuals were translocated to a second reserve. Individuals from both reserves were later used to reintroduce animals to various areas throughout California [69]. These operations produced successful breeding populations in the wild and the numbers are now well above 2,000 individuals and increasing. Bottlenecking can be reversed before it is too late if management includes reducing or removing the impact from factors bringing the population numbers down and taking the genetic variation of the population into account.

There are three types of genetic variation that can be managed [274]:

1. Heterozygosity- the genetic variability within an individual (this is lowest in inbred animals)
2. Gene diversity- a measure of the variation in allele frequencies in the population
3. Allelic diversity- a measure of the total number of different alleles at a locus in the living descendant population

Although all three types of manageable genetic variation are important, it is not possible to maximize retention of all three simultaneously [274]. In wild populations, measures obtained on heterozygosity can elucidate which management strategies are best to pursue [50]. For captive breeding programs, the conventional breeding strategies attempt to breed the most distantly related individuals and to balance the genetic representation of the founders in the descendent generations [162]. The Species Survival Plan of the American Association of Zoological Parks and Aquariums (AAZPA) recommends the strategy of "Mean kinship" which maximizes retention of gene diversity while also maintaining the three types of genetic variation over the long term [274].

"Mean kinship" is the average relatedness of an animal to all animals in the living descendant population. Individuals with low "mean kinships" have high breeding priority as they have genes that are on average under represented in the population. By pairing animals with similar "mean kinships", rare and common genes are not combined in a single animal. This is important as animals carrying both rare and common genes cannot be used to increase the frequency of rare genes in the population because the frequency of common genes would also increase when they produce offspring [274].

Most captive breeding strategies assume that the remnant population has already lost significant

amounts of genetic variation due to the founder effect [177]. However, a separate body of research dealing with speciation theory is operating under separate assumptions. A speciation process termed founder-flush speciation may actually increase genetic variation under certain circumstances. Recent experiments have yielded some definitive conclusions that founder flush events do not necessarily reduce genetic variation in complex traits [162]. However, maximizing genetic variation can be beneficial for traits with heterozygote advantages while detrimental to traits with simple dominance. In laboratory experiments supporting the founder flush speciation theory, the increased genetic variation was often associated with a reduction of overall fitness (ie., inbreeding depression), as would be expected for traits with deleterious recessive alleles [162]. Such consequences create new perspectives and challenges in the field of conservation genetics.

Thus far, a program to preserve the genetic variation of the huemul populations has not been initiated. Deer have been translocated from one region to another without the issue of genetics being addressed. The only genetic information available on huemul is on their karyotype [252]. We still do not know the situation of the genetic variation of the population as a whole nor of the fragmented subpopulations.

Maintenance of existing genetic variation remains an important priority for conservation programs because of the possibility of increased disease resistance in more variable populations and the chance that inbreeding depression may only be manifested under adverse environmental conditions. Inbreeding depression is often manifested as reduced fertility and/or poor juvenile survival in mammals [198]. Information on genetic variability and gene flow is also needed when evaluating the need for translocation projects and selecting individuals for the first captive breeding centers for huemul. If wild populations are founded from small numbers of breeding individuals, variation loss due to drift or inbreeding might be substantial enough to be followed by a concomitant loss of fitness [50]. On the other hand, founder events have sometimes been shown to produce robust populations. However, some founder events which increase variation can also be problematic in that the bottlenecks can further drive the increasing frequency and fixation of detrimental alleles [162]. All these consequences must be considered when managing a wild or captive population to maintain the existing genetic variation.

### *Natural Catastrophes*

Natural environmental perturbations can reduce population sizes to dangerously low levels. These can include harsh winters with high snow accumulation and natural disasters such as volcanic eruptions. Theoretically, once populations are reduced below a critical level, extinction can occur if by chance death rates are high or birth rates are low (ie. low rate of recruitment) over only a few generations [87]. Populations with large numbers of individuals are less apt to be affected by variation in recruitment rate which is assumed to be independent for each individual. According to population biology theory, small groups are not likely to persist for more than a few generations. Shaffer [241] calculated that population numbers below the range of 50 fall in danger of extinction by this chance variation in individual birth and death, coined by Gilpin and Soule in 1986 as “demographic stochasticity”.

Harsh winters with heavy snowfall may force animals to congregate at lower elevations. This could provide an increase in hunting success for the mountain lion. With inclement weather, huemul might even be forced to descend to areas now occupied by man in search of food and shelter. This could lead to an increase in opportunistic hunting by man and dogs alike.

Of all possible natural disasters to affect this region of the world, volcanoes and forest fires are the most likely to have an impact on huemul populations by completely destroying their habitat. The most recent volcano to erupt within Patagonia was Volcano Hudson- in XI Region of Chile at latitude 46º05’S

and longitude 72º55'W- which first erupted on 8 August 1991. Five days later it erupted again with such a force that the mass of the material spewed from it was estimated at 1,050,000 tons/km2 [90]. The volcanic ash and powder emitted were transported by the wind and deposited many kilometers away, even reaching into Argentina where it affected many thousands of sheep. The two eruptions affected a total area of approximately 1,120,069 ha.(SAG, Síntesis Global Impacto Ambiental Volcán Hudson, 1991, in Godoy [90]) with 250,000 ha. strongly impacted.

The area closest to the volcano which contained a small huemul population had ash covering the ground from 90-100 cm in depth. An estimated maximum population of 30 individuals which had inhabited this area before the eruptions were no longer observed and believed to have fled after the first eruption. In 1971 during a smaller eruption of the same volcano an established population in this area fled and was not observed to repopulate the area again until 1980 [90].

The huemul and their habitat were monitored in two reserves of the Corporacion Nacional Forestal (CONAF) during the three months following the eruption [90]. The one population in the Río Claro National Reserve was faced with 0.3-0.4 cm of ash cover. Neither the habitat nor the approximate 10 individuals of the population appeared to be impacted in any way from this deposition. It was in the Tamango National Reserve, where the deposited ash level fell between 3-4 cm in depth, that CONAF decided to execute an emergency plan of action to try and diminish the impact of the eruption on the species. It was feared that the ash, completely covering the leaves of the vegetation, would be consumed and cause illness and reproductive problems. It was documented that normal consumption of the vegetation was impeded, with huemul selecting clean leaves whenever available. A program was implemented to cleanse the vegetation by gently spraying water over the leaves; this process had to be carried out continually as strong winds soon bathed the leaves in more ash. Additionally, attendants cut, cleaned and placed branches of preferred species along trails for consumption. Some preferred plant species were temporarily affected: leaves of chaura (*Gaultheria mucronata*) turned a reddish-brown color while leaves of ciruelillo (*Embothrium coccineum*) dried out and developed spots. However, new growth sprouted as usual during the early days of spring.

Some huemul manifested temporary physical symptoms. Several were observed with conjunctivitis, lasting 5-7 days, with one eye completely closed. This was a reaction to ashes deposited either directly in the eye from the wind or from ash falling from vegetation when feeding or passing through the brush. The tear ducts also appeared temporarily affected with local swelling and a dryness of the eyes. These symptoms slowly began to disappear towards the end of October. A heavy loss of hair was also documented, mainly on the head, neck and feet with new growth being observed in early October. There was no known reproductive losses as two apparently normal fawns were conceived that spring.

Additionally there was a change in social behavior. During the first week following the eruption, the group size ranged from 10 to 18 individuals over a 2 ha area [90]. Normally individuals can be seen in groups up to 7 animals in this reserve (Smith-Flueck and Flueck personal data). As yet unexplained, immediately following the eruption until the end of October when observations ended, the males behaved as if the rut was in progress although the mating season is normally during the months of April and May. Possibly there were gases emitted which elicited this response by imitating some phermones.

## CAPTIVE BREEDING PROGRAM

During the 1990 International Symposium on the Biology of Deer, a workshop was held by Jacobsen and English on endangered species [123]. They were concerned that of the 39 endangered deer

species in the world, many have inadequate captive populations. South American cervids were considered the most vulnerable. There was general agreement that high priority was needed to insure that existing gene pools are preserved. Captive studies on reproductive biology and physiology were suggested as a priority for endangered species such as the huemul. The consensus reached was that the outlook for management of endangered deer worldwide is not encouraging. The pressures that cause extinction, principally habitat loss, poaching and other human disturbances are not likely to change in the near future; this provided the participants with a strong argument in favor of establishing captive populations. Although some participants stated concern that captivity might alter the ability of a species to later adapt back to the wild, they agreed this should not pose a problem as long as existing gene pools are maintained (see Fragmented Populations: genetic variation, this chapter).

The Policy Statement of the IUCN (International Union for the Conservation of Nature) on captive breeding recommends in general that the programs of captive propagation be a component of the conservation strategies for the taxa with populations less than 1,000 individuals. In the case of the huemul we do not know with certainty that there are less than 1,000 individuals but we have estimated about 1,500 ± 500. However, the huemul is classified as endangered according to IUCN (1998) because 1) the population is estimated at less than 2,500 mature individuals; 2) there is a decrease in number of mature individuals in the population; and 3) the population is severely fragmented.

Aside from the total size of the population, to determine the relevance of a breeding center it is also important to consider information about fragmentation and trends of the subpopulations and the habitat changes and stochasticity of the environment. All this is analyzed by the "Captive Breeding Specialist Group" in their evaluation of the taxa and their Conservation Assessment and Management Plans (CAMPs)[223,224]. Populations that are small and isolated have a high risk of extinction which is the situation with most huemul subpopulations. Intensive management becomes necessary to assure their survival and recuperation. This type of management includes habitat management and restoration, intensified data collection, and captive breeding. CAMPs provide the strategic direction for the application of intense management and the techniques to collect information on the threatened taxa. The Global Captive Action Plans (GCAPs), derived from the CAMPs, recommend which taxa are the most important ones to propagate in captivity.

Strategies and priorities for a captive breeding program should intend to maximize options and minimize risks. The captive populations are a support- not a substitute- for the wild populations. The populations in captivity should be treated like a metapopulation. A metapopulation describes the situation where the total population of a species is divided into a number of separate sub-populations [41]. It is recommended that a small captive population should be developed when the free ranging population is still categorized as vulnerable [223]. This captive population will need to be genetically assisted, and perhaps even with considerations of the demographics, from the wild population while the wild population is still large enough to meet this function without receiving significant harm. The worst-case scenario is to wait until the population is drastically reduced, as occurred with the black-footed ferret [36] and the California condor [37] in the USA. The few remaining individuals now have a very reduced genetic variability.

### *Past experiences*

Capturing and transporting huemul should be possible with little risk involved, if modern techniques are used. In undisturbed populations, the peculiar behavior of the huemul to be curious and to remain unwary in the presence of man should make it a fairly easy animal to capture with tranquilizers

by using dart rifles. In the past, animals were accidently killed when poor methods were used to capture them (see Díaz, chapter 1, for additional examples). One male, brought to Victoria Island in the Nahuel Huapi National Park, arrived with a broken hind leg and died two days later from internal hemorrhages [77]. During a first intent to reintroduce huemul to Torres del Paine National Park, four animals were brought to the Instituto de Patagonia in southern Chile in November of 1973, but a male died during transport due to injuries from the dogs used to capture the animals. Of the remaining three, however, only the female survived to later give birth to a fawn [256]. Drouilly [51] and Texera [256] recognized the technical problems of their era and recommended improving the capture and transportation techniques to reduce stress and injuries to a minimum. The following example further illustrates the problems that occurred when using the old capture methods. In 1968, there was a capture operation of Pampas deer to bring individuals to La Carona to breed [272]. From a population of 66 deer, 25 were captured by helicopter, but 16 of these died before reaching the enclosure. Of the 41 remaining in the population, 13 died from stress related to the capture operation. With modern methods and experienced personnel, a mortality number in such an operation today should be no more than 1 to 2 individuals.

Further problems in the past included lack of both sanitary conditions and awareness of the possibility to transmit diseases from other herbivores. The 3 animals who made it to the captive breeding center at the Instituto de Patagonia died several months later after being infected with coccidiosis from an enclosure contaminated from sheep.

One of these females gave birth to a fawn a few months after arriving at the center. However the young did not survive due to the mother's failure to produce sufficient milk. This could have been due to the stress of capture. The attendants at the center appeared to be very conscientious of the animals' health and yet they couldn't save them with the techniques available to them at the time. In the case of the fawn, they were giving it cow's milk instead of the special formulas used today. We can assume that they also didn't know how to induce defecation and urination in the fawn, the problem most frequently encountered when people try to save fawns found without their mothers in the wild. Furthermore, at death the adult females weighted 27 and 31 kg, and the adult male 36 kg [256], indicating that the animals had lost 50% or more of their normal body weight. As there existed no knowledge on feeding behavior at that time, these animals possibly did not receive adequate rations.

The subject of breeding huemul in captivity is a very sensitive issue for many Argentines and Chileans. Due to the past failed attempts, people are often of the opinion that this animal can not survive in captivity. The huemul may not exist today in any zoos or captive breeding centers, but this does not prove that their survival in captivity is a hopeless case. On the contrary, we can consider the few successful recorded cases of the huemul in captivity (see also Díaz, chapter 1, for additional examples). One such program, where huemul were maintained for several years during the 1930's, included the successful birth of a fawn as described by Franke on Victoria Island in Nahuel Huapi National Park in Argentina [77] (see Photo 19). Within days after their arrival, the huemul acclimated to both Franke and his dogs' presence and remained calm within the penned area (see Photos 20 and 21). Unfortunately, his detailed scientific notes from that experience in the 1930's are apparently lost. From the few other records, it is interesting to note that as early as 1830 a "Chilean deer" was brought as far as to the Gardens of the Zoological Society of London although it died 6 months later; its true species' identity however, was never verified [63]. The first definite record of this species being in the London Gardens is of a male huemul brought in December of 1881 from the Jardin d"Acclimatation of Paris. Unfortunately, there are no records for how many years he lived in captivity [63], however it shows that this huemul not only made it to the Garden in Paris, but survived a second trip to England. Translocations to Torres del Paine National Park have resulted in frequent subsequent observations of huemul and their signs in

**Photo 17.** Male fallow deer (right) with female huemul (left) in captive center at Isla Victoria, Nahuel Huapi National Park. This male mounted this female and ejaculated several times but did not produce any offspring (photo by F.R. Franke).

**Photo 18.** Female huemul approaching domestic cat. Once adjusted to the new environment, the huemul were not disturbed by caretaker Franke nor other animals (photo by F.R. Franke).

**Photo 20.** Huemul within pens adjacent to house at Isla Victoria in Nahuel Haupi National Park in Argentina. After release, they acclimated quickly to the facility (photo by F.R. Franke).

**Photo 19.** Huemul fawn successfully born and raised in captivity on Isla Victoria in Nahuel Huapi National Park, Argentine in the late 1930's . (photo by Franke).

**Photo 21.** Two undisturbed adult female huemul in captive center at Isla Victoria in Nahuel Huapi National Park in Argentina (photo by F.R. Franke).

certain sectors of the park (Rau, pers. comm.). This is indicative that huemul are able to withstand the stress involved in modern day translocations, just like other cervids.

If we evaluate other members of the Cervidae family, including the subfamily Odocoileinae, to which the huemul belongs, we find that there are various species successfully living in captivity. There are no obvious physiological and behavioral differences known for huemul which could give us reason to doubt that they should not respond similarly to a captive situation as long as precautions are taken to avoid the mistakes of the past. Notably, the huemul's closest relative, the taruca, has successfully been bred in European and North American zoos. Residing closer to accessible transportation routes and areas more densely populated by people, capture of the taruca was more common than with huemul. Consequently, there are more records of this animal being kept in zoos. In 1931, the Berlin zoo obtained a male and female. From this group, there were at least 12 registered births (records are incomplete) until the animals were destroyed during the bombing of the Second World War in 1944. One of these males holds the record for the longest known recorded time in captivity for the genus *Hippocamelus*, at 10 years, 7 months and 18 days. In the Bronx Zoo, a female taruca was held for 5½ years (1938-1943) [75]. Other records include the first male to go to the Berlin Zoo in 1889 as an adult, which lived for 3 more years. At least two other zoos in Germany received taruca.

Already in 1890, it was known that the taruca did not need anything special in its diet, doing well on the same food given to all other captive cervids in the Berlin Zoo [216]. Also, climatic influences were of no importance because the taruca was adapted to the heat as well as the cold, due to the climatic conditions of its native environment. One can assume the huemul would behave similarly. From his personal experience in the Berlin Zoo from 1930-1944, Frädrich confirmed that the taruca adapted well to captivity. He remarked that it has to be counted as one of the easier species to maintain in captivity [75,76].

By 1993, nineteen percent of all mammals in the world had already been bred successfully in captivity (data of the American Association of Zoological Parks and Aquariums). Still, no attempts have been made to breed the huemul in captivity since the last failed one of 1973. Since then, so much has been learned about cervids in terms of handling techniques during capture and transportation, and health and maintenance in captive facilities that one can expect positive results in future capture, translocation and breeding operations if safety procedures are taken well in advance and all precautions are met.

### *Precautions*

Some precautions to meet during captures, translocations and in breeding centers include:

1. Use of the most modern methods at all stages of the operation
2. Reduce or alleviate stress to the individuals at all stages
3. Avoid inflicting serious injuries
4. Avoid disease contamination by taking precautions with equipment used for the capture, the translocation, the enclosure, etc.
5. Maintain disturbance at a minimum within enclosures
6. Continual monitoring of diseases in captive individuals
7. A hired veterinarian experienced with cervids; or a large-animal veterinarian working closely with a deer biologist
8. Provision of a special diet for cervids, adjusted to seasonal needs
9. Milk formula for the fawns when the mothers can not nurse

10. Awareness of how to assist fawns to defecate and urinate
11. A protocol to do necropsies of dead individuals (see J. Zoo and Wildlife Medicine vol. 24, Number 3, 1993.)
12. Maintenance of the genetic variation; this is one of the most important goals of an organized captive breeding program [274] (see Fragmented Populations: genetic variation, this chapter)

***Benefits***

The benefits of a captive breeding center would outweigh the costs. It would not only provide a stock of individuals to be reinintroduced into the wild but would also provide the means to conduct controlled scientific research to answer some biological and ecological questions difficult or impossible to obtain in field studies alone of wild animals. The few studies from the wild should be complemented with captive studies [75], especially when collection of field data is hindered by factors such as low population densities and rugged topography limiting close access to make direct and repeated observations.

Some captive studies could include:

1. Obtaining basic data on morphometry, anatomy, physiology, reproduction, genetic makeup, social behavior, etc.
2. Monitoring annual biological cycles of males and females
3. Determining the rate of defecation per season for each age and sex class (this information is necessary when analyzing data collected on fecal pellet counts to determine population densities)
4. Food habit studies (besides controlled studies within the captive facilities, one could mimic, for example, the novel research experiment of Wölfel [276]; after having several red deer imprint on him, he brought them to different areas in the field to study their feeding habitats by observation and analyzed their intake by fistulation. This technique is only possible in tame deer as it involves reaching into a cavity, such as the stomach, of an individual to collect ingested matter. The opening is made surgically and has a closure which can be opened like a door to retrieve the food material)
5. Fawn development, including physical changes such as tooth eruption, skeletal growth and behavioral changes
6. Interactive studies with red deer, dogs, and various human activities [19,92,104,182,218,219,255]

## INVESTIGATIONS AND SURVEYS

The presence of huemul at several new sites in both Chile and Argentina have been confirmed through surveys conducted in the past few years. In Chile, CONAF has been collaborating with Raleigh International out of England to identify new areas with huemul and to start a monitoring program to learn about the state of the population at R.N. Lago Jeinimeni. The Comite Nacional Pro Defensa de la Fauna y Flora (CODEFF) has also been conducting surveys in several areas to locate huemul. Within the Argentine National Parks, the most systematic work has been provided by Fundación Vida Silvestre for Los Glaciares and Perito Moreno National Parks [232,234,236-239]. In 1992, the Argentina National Parks initiated the Huemul Program to learn more about this species in order to better protect it. A major objective was to determine current presence of huemul throughout the 6 parks known to potentially

contain the species. The few surveys conducted from 1996-98 alone within the Argentine National Parks were able to confirm current huemul use at 17 sites known to have contained huemul in the past, plus 13 new areas were identified to have contained huemul activity.

Surveys are also used to determine areas where huemul no longer exist. In Los Alerces National Park, several surveys have indicated that huemul are absent from certain locations in the park. They currently reside in a few sections on the eastern side, however, four areas surveyed to the west over a period of 23 days revealed only European rabbit and wild boar. Further surveys of unexplored areas plus studies of habitat use by huemul in this park might reveal why huemul are not present throughout more areas. A survey we conducted in the area bordering this park to the east revealed an absence of huemul, however I found a shed antler which was almost completely buried, attesting to former presence of the species. That same area, though, now harbors red deer which originally escaped from an enclosure in the region. In Lanín National Park where huemul presence has not been confirmed for over 50 years, a reconnaissance of one area in 1997 made some people optimistic from signs discovered suggesting huemul. However as the distribution of red deer in this region has yet to be studied, signs of any cervid species have to be dealt with cautiously and evaluated by trained park rangers and field biologists in order not to confuse the two species.

In Argentina, information is also available in a national park registry coordinated by the Delegation of the Patagonian Region (Delegación Regional Patagonia) which lists locations of reported observations of huemul signs or sightings. Actual sightings are rare, thus making records of observed signs even more valuable in evaluating the current status of the huemul populations.

For the 6 national parks, sightings are recorded as follows:

1. In Los Alcerces National Park there were 10 sightings of huemul groups from 1973 to 1990, no sightings from 1991 to 1993 and only 4 sightings of groups from 1995 to 1998;
2. In Nahuel Huapi National Park only 4 groups totaling 7 individuals have been sighted in 9 years of record keeping from 1990-1998;
3. In Los Glaciares National Park- In 1992, 1996 and 1997, group sightings totaled 1 (2 individuals), 15 (17 individuals), and 20, respectively. These groups were spotted during surveys conducted by the Argentine National Parks (1992-1997) and FVSA [234,236,237]. From reported observations outside surveys, the only recorded sightings since 1990 were 3 individuals seen together in 1996 and 1 individual in 1998;
4. In Perito Moreno a minimum of 5 groups totaling 10 animals have been recorded from 1990-1998;
5. In Lago Puelo National Park there have been only 2 sightings totaling 2 animals from 1990-1998;
6. In Lanín National Park the presence of huemul has not been confirmed in more than 50 years and they are feared to be extinct there.

When combining the registry notes from all the Argentine National Parks (ANP) with huemul, plus reports of FVSA since 1990, 74 individuals were seen in total, in groups ranging from 1 to 3 individuals. The data for Los Glaciares and Perito Moreno National Parks include the observations made by the ANP team in 1992 and by Serret and his team during their surveys in 1990, 1991, 1992, 1996, 1997, and 1998. Without these surveys, only 28 individuals would have been reported as sighted in this 9 year period.

A minimum of 12 partial and complete skeletons of huemul were recorded to have been found from 1990 through 1998 in the Argentine National Parks. Unfortunately few of these specimens were col-

lected. An organized national program for collecting and storing specimens for scientific purposes has not been established in either country, resulting in very few specimens available today for studies on morphology, genetics, and health. During the International Electronic Conference on Huemul, Flueck and I proposed to organize a data-base on existing huemul material so as to facilitate researchers in the future and to encourage the collection and storage of any discovered specimens and to provide advice about the preparation and storage of these valuable specimens. However, the success of such an endeavor depends exclusively on the active participation of people involved in huemul conservation. Unfortunately, so far nobody has provided any information.

Outside of the national parks, a study of habitat use by huemul has been conducted by Fundación Vida Silvestre on the population inside the Refugio de Vida Silvestre Esperanza in the province of Chubut [170]. Flueck and I surveyed 6 areas for a project supported by the Wildlife Conservation Society and World Nature Association (Flueck and Smith-Flueck, Final Report to WCS, 1993). Four of the 6 areas surveyed had huemul populations. The two areas (immediately outside the borders to the southeast of Nahuel Huapi and Los Alerces National Parks) which no longer had signs of huemul contained red deer at low densities. We have conducted additional surveys in several protected areas where we also prepared a list of plant species [248]. Currently we are conducting studies on the dietary overlap of the red deer and huemul and genetic diversity to determine the existence of gene flow between potentially fragmented populations.

The majority of studies conducted in Chile in the past 7 years since the first binational reunion have taken place in Region VIII. For the Chillán population, a monitoring program under Povilitis and CODEFF has been conducted annually with the support of Earth Watch volunteers. Additionally there have been several spring studies by Frid of 2 coastal populations in Region XII on habitat use, group structure, and activity patterns [78,80]. CODEFF and FVSA recently completed a mapping project funded by World Wide Fund on the distribution of current populations to determine how the remaining populations are spaced and to help clarify the level of fragmentation [149]. They are also implementing a geographical information system for the Niblinto population in Chile.

Some long-term studies on habitat use and movement are being conducted at Rio Simpson and Tamango National Reserves in Chile. An annual survey of the Tamango population since 1985 has shown it to be the only known stable population. It is possible that this population may even be expanding to new areas in the region. Studies have also been conducted on the impact of the construction of the Transandean Gas and Oil Lines being developed through the National Reserve (R.N.) Nuble. These lines are passing right through habitat where huemul use is concentrated.

In the field of genetics, a male huemul from Chile has been karyotyped [252]. The diploid number was 70 with 33 telocentric pairs of decreasing size. The total number of chromosome arms per cell (FN) was 74.

## EDUCATION

The huemul remains an unknown species to many Argentine citizens. In 4 highschool biology classes in Bariloche, a city surrounded by the Nahuel Huapi National Park where a few remnant populations of huemul still exist, I passed out a questionnaire to determine the children's background on environmental issues. To my surprise and chagrin, the students confused their precious autochthonous deer, the huemul, with the introduced European red deer (see red deer photos 10 and 11). At least they had heard the name 'huemul' before. Some even thought that the huemul was in fact the miniature deer, the

# Criarán ciervos en zonas bajo riego

El criadero de ciervos en chacras bajo riego que a fin de mes comenzaría a funcionar en chacras de Viedma será el primero del país. La carne -duplica el valor de la vacuna- se venderá a Buenos Aires, el cuero a las peleterías y los cuernos se exportarán a Asia. Piensan traer 600 animales.

Cerca de 600 ejemplares serán los que se utilizarán en un primer momento en el criadero de las chacras del Idevi. (Archivo)

VIEDMA (AV)- A fin de mes se iniciará en chacras del Idevi el proyecto de cría de ciervos en áreas bajo riego, el primero de este tipo en el país, que estará orientado a la exportación de los cuernos y a proveer con la apetecida carne a los grandes hoteles y restaurantes de Buenos Aires. El cuero, que al igual que la carne duplica en precio a la de los vacunos, se destinará a las peleterías para producir distintos artículos.

El productor ganadero Vicente Naim Pérez tendrá a su cargo el emprendimiento, y a su vez ostenta hoy el cargo de presidente de la Asociación de Criadores de Ciervos de la República Argentina.

La iniciativa a desarrollar en el Valle Inferior se denomina Ciervos Patagónicos y, pese a que existen ya 22 criaderos de ciervos en el país, es el primero que se realiza en chacras bajo riego.

El gerente general del Idevi, Guido Bergandi, destacó que el

**Foto 22**

El huemul, especie típica del bosque austral, uno de los más comprometidos.

# Especies con problemas en su hábitat

## Bosques, selvas y montes disminuyen en forma amenazante

BUENOS AIRES (Télam).- La caza y la modificación del hábitat por el hombre son las principales amenazas para la mayoría de las especies en riesgo de extinción que aún viven en la Argentina, advirtieron ayer fuentes de la Dirección de Fauna de la Nación.

Si bien son muchas las especies amenazadas en todo el territorio, ese organismo nacional está realizando un "estudio de sectorización" en todo el país para determinar con precisión cuáles corren peligro cierto de extinción.

Según datos científicos, "de los 105 millones de hectáreas de bosques, selvas y montes nativos pesentes a comienzos de siglo en Argentina, se han reducido hoy a 40 millones, es decir a un tercio de la superficie original".

Ese estudio también reveló que en el mismo lapso se duplicó la superficie de tierras cultivables, lo que provocó el desplazamiento de las actividades de cría de ganado hacia otras regiones.

Gustavo Poriní, técnico e investigador de la Dirección de Fauna, aseguró a Télam que "la modificación del hábitat donde viven los animales es el mayor y más grave de los problemas que deben enfrentar las distintas especies".

En la actualidad se instrumentó un estudio "que está en su fase inicial y que concluyó con la recategorización de los animales en la región Patagónica", donde se determinará qué especie está en peligro de extinción.

"La segunda parte, que se implementará en muy poco tiempo, continuará en Córdoba y en toda la zona centro del país", dijo.

Entre las especies más amenazadas de la Argentina figuran el ciervo de los pantanos, el venado de las pampas, el tatú carreta y el yaguareté.

El huemul (hippocamelus bisulcus), que vive en zonas muy especiales de las regiones de los Andes (Neuquén, Río Negro, Chubut y Santa Cruz), es también uno de los animales, según Poriní, "más comprometidos con la extinción".

En la Argentina existen ocho especies de ciervos, las que son muy perseguidas por los cazadores para tenerlas "como trofeos o simplemente para comerlos", dijo. Uno de los casos es el venado de las pampas (ozotoceros bezoarticus celer)

El huemul, una de las especies patagónicas en peligro de extinción

**Foto 23**

**Foto 24**

pudu, another native Andean deer which is the second smallest deer species in the world. This confusion is partially fueled by the media showing a photo of the wrong deer species when writing about another species (see Photos 22-24). It turns out that these students are much better informed about wildlife species from Africa, Alaska, the continental U.S.A. and Asia, from where many T.V. documentaries are presented on the Discovery Channel. When asked to select in order of importance which animal should be protected from a list of 10 endangered species, the majority placed the panda, manatee and jaguar at the top of the list. Less than 1% of the students placed the huemul as the number one species. A few better informed children gave all animals equal ratings and commented that all animals have the same right to live and should be equally protected.

By not providing environmental education to a community, people remain naive not only to the basic principles of ecology and the processes of nature but to simple facts such as the current situation of native animals in their own region. As long as naivete remains, hunting of endangered animals, apathy towards habitat destruction, and misunderstandings of the benefits of ecologically sound wildlife management programs will persist. At the start of my semester classes, none of the students understood the concept of harvesting animals to maintain a balanced ecosystem. The "Bambi syndrome", which has made the professional field of wildlife management very difficult to practice in Europe and the western U.S., has struck Patagonia. This syndrom refers to the negative, and often emotional response of a misinformed public to harvesting animals from wild populations for management purposes. However there is still time to educate the public about the benefits derived from a good management program. People need to understand that life and death are both integral to natural systems, that a hamburger once came from a live animal and that harvesting of animals has its place. They should come to appreciate the economic gains that can be made from harvesting an exotic species such as the red deer as a consequence of trying to protect the environment. An example of damage resulting unnecessarily because of naivete was the good intended "rescue" of the huemul fawn by those hikers this spring season near Lago Puelo National Park which ended in disaster. These people did not understand deer behavior enough to know that the fawn's mother had not abandoned her newborn and was surely not far away feeding. They were also not knowledgeable of techniques available for saving a motherless fawn. Thus, although one may have good intentions, ignorance of nature can lead to undesirable consequences. Considering the current trend of increased outdoor activities in Patagonia, the number of people entering the back country areas will likely continue to grow, making contact with huemul more probable. Thus, if people are not better informed about how to minimize their impact on nature, there are likely to be more unpleasant, environmentally destructive situations.

Environmental education is included in some of the schools' biology curriculums but only at a very basic level. Educational programs aimed at protecting the huemul began only recently in Argentina and have often been the work of concerned citizens in small communities living close to huemul habitat. The Argentine National Park Service and the Fundación Vida Silvestre have recently produced educational materials such as public brochures and fliers and learning activities for the children. They have both also collaborated on a workshop program to involve local citizens in the protection of this species. The Argentine National Park has also held several training courses for the park rangers to learn how to look for signs of huemul while out conducting routine fieldwork and to be able to identify huemul feces. Without prior knowledge, their feces can easily be confused with those of the European hare, wild boar, red deer, guanaco and domestic sheep, all of which are sympatric with the huemul in certain regions.

Meanwhile in Chile, where the huemul is nationally recognized on their national coat-of-arms, the citizens have been educated about the situation of this species for much a longer time. However, even this has not been enough as demonstrated by the ignorant person last December who entered a huemul

nature reserve next to his hometown without permission, bringing along his dogs which then seriously injured 2 huemul. Unfortunately, as important as education may be in influencing the condition of tomorrow's world and the future of all species on our planet, it has so far not proved to be enough to stop large corporations and wealthy individuals from continuing to destroy valuable ecological habitats, and in doing so, extirpating species from the face of the earth.

## INTERNATIONAL AGREEMENTS

There have been several international agreements drawn up in recent years which are directed towards protecting the natural resources of Chile and Argentina. Consequently, these favorably affect the protection of the huemul. By the Convention of CITES, the huemul is protected under Appendix I which signifies that the international trafficking of this species is prohibited. From the Bonn Convention on the Conservation of Migratory Wildlife Species, the huemul was included in both Appendix I, which places it in the strictest category of protection of the convention, and in Resolution 5.1 (COP5) which grants access to special financial funds of this convention. Chile and Argentina signed treaties drawn at The BioDiversity Convention and The Washington Convention which were both convened to promote positive action toward the conservation of the natural resources.

The door lies open for Argentina and Chile to continue on the path of cooperating in regards to huemul conservation. Such advances and gains have also been abetted by the Treaty for Scientific and Technological Cooperation drawn up by the governments of these 2 countries in 1974. Efforts for cooperation are further supported by the Environmental Treaty of 1991 drawn up cooperatively by both countries.

The two major non-governmental organizations active in wildlife protection, CODEFF of Chile and FVSA of Argentina, have developed a joint project to survey 2 border areas which each contain a binational population of huemul.

## CURRENT LEGISLATION

The huemul is regarded as a national symbol in Chile, being represented on its national coat-of-arms since 1833 along with the Andean condor [175]. Chile has recognized the fragile predicament of this species by protecting it since 1929 under law No. 4,601 which prohibits the hunting, possession, transport or commercialization of this species. In 1993, the Supreme Law No. 133 was enacted which established a 20 year moratorium on hunting, capturing or maintaining in captivity any native vertebrate except for scientific purposes with authorization from SAG (Servicio Agrícola y Ganadero). Laws also exist in Chile to protect the national parks and nature reserves (Areas Silvestres Protegidas). These include law No. 18,348 created by CONAF (Corporación Nacional Forestal) and law No. 18,362 through SNASPE (Sistema Nacional de Area Sivestres Protegidas del Estado). Unfortunately enforcement of these laws is poor. It was agreed at the 2nd Binational Meeting on Conservation Strategies for Huemul that there exists legal gaps in regards to the conservation of the natural heritage of the country. The proceedings from this meeting state that the Chilean laws contain flaws, are inconsistent, and offend the integrity of SNASPE and therefore need to be corrected. As an example, the mining code under article No. 17 permits mining exploration and exploitation within the Protected Wilderness Areas. In addition to these inconsistencies, the Water Code deals with activities concerning waterways as separate from the

laws of the land.

All in all, the conservation of the huemul in protected areas in Chile is under the jurisdiction of CONAF, SAG and the recently established National Commission of the Environment (CONAMA), whose principle role is to coordinate environmental issues between the governmental Ministries and to run the program for evaluating environmental impact assessment. Reserves patrolled and managed by park wardens have been established by CONAF to specifically protect this species within protected areas. This provides opportunities for conducting some basic ecological research and monitoring of populations. Protected areas in Chile which have huemul populations include: the Laguna Parrillar Forest Reserve, the National Parks of Bernardo O'Higgins, Laguna San Rafael and Torres del Paine, the National Reserves of Alacalufes, Cerro Castillo, Cochrane-Tamango, Futaleufú, Jeinemeni, Lago Carlota, Lago las Torres, Mañihuales, Ñuble, Palena, Río Simpson and the Nature Sanctuary and National Reserve of Los Huemules del Niblinito [149].

Argentina has a long tradition of conservation laws with its first national park being created in 1902. However, even though the huemul has been listed for some time as an endangered species in the Chilean Red Book of Terrestrial Vertebrates compiled by CONAF, in Argentina the species had only been listed as vulnerable by the Secretary of Agriculture and Livestock (resolution 144/83) until recently when it was finally classified as endangered. On a national level, it has been classified as a Natural Monument (Law 24.702 of 1996). Also, the Huemul was listed as endangered in the 1997 Red Book of Argentina [81].Within the National Parks, it has been protected by law 22.351 since 1980. Provincial governments also possess legislative power and can thereby provide additional protection. Three of 4 provinces containing huemul have established laws recognizing the huemul as an endangered species, classifying it as a Provincial Natural Monument in the provinces of Río Negro (law 2.646/93), Chubut (law 3.381/89) and Santa Cruz. (law 2.103/89). Specifically, these laws provide special protection for huemul and its habitat, and prohibit hunting of the species; however infractors have never been prosecuted.

Although conservation efforts have been inadequate thus far in both countries, there has been growing interest in recent years to make significant changes. In 1991, the system of protected areas in Argentina included 121,359 km$^2$ or 4.35% of the total territory [20]. Although this included several national parks which provided protection to some huemul populations, only one provincial reserve of the more than 121 possibly even contained huemul: the Lago Epuyen Forestry Reserve with 20,000 ha created in 1964. Since the first Binational Meeting for Conservation Strategies for Huemul in 1992, some major steps have been taken toward creating more protected areas for this species in Argentina. Several new provincial reserves have been created which also protect the species in the provinces of Rio Negro, Chubut and Santa Cruz. These include the Cerro Pirque Provincial Park in the Chubut province, created in 1993 (law No. 2,334), Provincial Reserve San Lorenzo in the Santa Cruz Province in 1993 (law 2,334 with a total area of 24,000 ha.), Provincial Parks Laguna Bello (13,000 ha.) and Shoen (54,000 ha.) in 1994 (law No. 2,373 ), Natural Protected Area Río Azul-Lago Escondido in the province of Río Negro established in 1994 (law No. 2,833), and Provincial Multiuse Park and Reserve of Río Turbio in the Chubut province in 1995 (law No. 4,064). These nature reserves provide varying degrees of protection depending on the level of exploitation of the natural resources permitted within their borders. All this was decided upon and is regulated by the provincial governments in charge. In Argentina, huemul populations are also found within one private reserve, Refugio de Vida Silvestre Esperanza, created in 1991 under auspice of Fundación Vida Silvestre that borders Lago Puelo National Park. However a management and monitoring plan has yet to be developed for this population. The Argentine National Parks with huemul today include: Los Glaciares, Lago Puelo, Los Alerces, Nahuel Huapi, Perito Moreno and

possibly still Lanín.

The National Direction of Flora and Wildlife (Dirección Nacional de Flora y Fauna Silvestre) drafted a resolution in 1998 which, if passed, will prohibit the hunting of any wildlife species classified as endangered. This will include the huemul and will be a legal tool by which to prohibit the hunting, national marketing and exportation of products and byproducts of the species and will provide the maximum level of legal protection possible.

## CONSERVATION MEASURES

Initial steps toward conservation have been initiated and the movement to protect the species has grown, though rather slowly, in a positive direction since the first Argentine-Chilean Binational Meeting of Conservation Strategies for the Huemul in 1993. Still a long hard road remains ahead of us. We must be persistent if we wish to accomplish our goal to protect the remaining subpopulations of this species to insure that each one is viable with corridors providing exchange of genetic material. The biannual meetings have provided an important impetus to organize and perform conservation directed activities.

New posts for park wardens have been established, such as in Bernard O'Higgins National Park in Chile and in Nahuel Huapi National Park in Argentina, to protect key huemul populations. CODEFF and FVSA, the 2 main non-governmental organization (NGO) involved in huemul conservation, have increased their activities to protect the species and have begun to work cooperatively. For one, they have campaigned against several business projects in progress or being proposed which would disturb the fragile huemul population in the Nevados de Chillán. The NGO's have also organized several workshops for people in rural areas. Additionally, fliers and educational materials have been created by several groups and numerous talks have been presented to school and public audiences to increase awareness of this native species. In Chile in 1998, CODEFF and CONAF began developing a joint program called the National Program of Southern Huemul Conservation (Programa Nacional de Conservación del Huemul del Sur) which will be implemented to establish priorities for the recuperation of the species. CODEFF and CONAF have also worked together with the help of the scientific community to develop the Management Plan for the Nature Sanctuary of CODEFF and the Niblinto National Reserve of CONAF under which protection, investigation, and education are being prioritized. In Argentina, APN has created the Huemul Conservation Program.

Remaining huemul populations must be protected and managed more effectively to ensure survival of the species. Although legislative controls on hunting and habitat preservation and management provide important conservation measures to prevent extinction of a species, additional action is needed to understand and alleviate the causes for the population decline. Viable actions for Argentina and Chile can be performed in 4 areas: research, education, legislation and management.

### *Research*

Research should identify all remaining huemul populations and areas that should be declared as protected areas to preserve viable populations. Population censuses and evaluations of habitats should be conducted and basic ecological information collected to help determine the influence of potential negative factors. The impact from different intensities of livestock practice has to be evaluated to develop guidelines on land use and management. Considering the huemul's apparent sensitivity to anthro-

pogenic alterations and its significant role as the principle large herbivore at its trophic level, knowledge about the state of a huemul population may serve to indicate the condition of the corresponding ecosystem. Results should also enhance development and implementation of conservation strategies, particularly considering that past studies have been taken seriously by governmental agencies. Based on current knowledge and conservation needs, the following lines of research should have priority:

1. Age and sex distribution within subpopulations to evaluate population dynamics (yearly monitoring)
2. Lifetime reproductive success of wild individual females (by telemetry)
3. Hematological and clinical chemistry profiles of adult females and recently born young
4. Serological profile for looking at titers to determine disease exposure
5. seasonal movements (by telemetry)
6. Use of winter habitat range (by telemetry)
7. Population dynamics of puma and huemul in areas without cattle (by telemetry)
8. Population dynamics of red deer and huemul living close to one another or sympatric (by telemetry)
9. Direct interactions between red deer and huemul
10. Interactions of cattle and huemul (by telemetry)
11. interactions between dogs and huemul
12. Confirm the presence of huemul in potential areas
13. Determining which populations are isolated
14. Level of inbreeding in fragmented populations
15. Genetic variation of subpopulations
16. Level and incidence of congenital genetic anomalies within subpopulations
17. Interaction between forestry activities and huemul
18. Interaction between recreational activities like eco-tourism and huemul
19. Evaluation of the past and current winter habitat distribution of huemul
20. Importance of hunting pressure on remaining huemul populations

Some of these proposed topics could be studies most efficiently under controlled circumstances as would be provided in a captive situation.

***Education***

Time and money spent in educating people living a substantial distance from huemul populations would not be cost effective**.** Instead, education should focus predominantly on inhabitants residing close to huemul populations. They should be taught about the fragile status of the remaining huemul populations to cultivate a nurturing attitude and thereby, an interest to protect the species. They should know about the legal regulations and be made aware of the consequences to themselves and the species if these laws are broken. Strict enforcement alone of existing laws in and of itself would be the most effective educational tool for the local people.

The economy of the two countries hinders donations by the average citizen as is common practice in North America and western Europe for environmental causes. Most Chilean and Argentine citizens do not have the income with which to make generous donations to NGO's working to protect endangered species and their habitats, although NGO's do exist in both countries though they are few and with

little funds available. Citizen involvement in environmental organizations is also not as high as that in western Europe and North America mainly due to socio-economic factors. Thus, effective environmental education becomes a great burden for the NGO's.

### *Legislation*

Legislation reforms in Argentina should include implementing and regulating legislation which supports maximum, enforceable protection throughout the huemul's distribution, including private lands. The huemul's habitat is currently not protected under the law in regards to private property. Environmental impact statements, for a minimum, should be required in both countries before any commercial activities are permitted in areas containing huemul populations. Any activity that may have a negative impact over the huemul and its habitat needs to be regulated under the law and the precautionary principle must be applied. This is a fundamental principle of law and policy for the protection of the global environment [24] and also applies to wildlife issues [59]. In the context of wildlife, this principle demands that when the impact of a proposed action upon a species is not known, the benefit of the doubt should be given to the species and the action should not be undertaken until it can be shown that the action will not impose an unacceptable cost or loss to the species [59] (see also Management, this chapter).

Legal mechanisms for enforcing regulations need to be established, such as providing more personnel, funding, etc. New protected areas should be created with appropriate law enforcement and management staff and consideration of biological corridors. Where huemul populations cross the Argentine-Chilean border, the creation of lateral reserves should be attempted. Poaching and other infractions of the law should be dealt with by stricter and better enforced penalties. A legal framework should be initiated to impede expanding populations of exotic species, in particular red deer, and with urgency policies should be created to prohibit future introductions. Governmental agencies also need to enact stricter policies for exploitation of natural resources with consideration for local inhabitants. Managing the system on a sustainable basis will have positive implications for huemul, other native species, as well as the local human population.

### *Management*

Management should begin by developing an annual monitoring program of key subpopulations to understand basic biological trends. This can include annual pellet counts or direct visual surveys along permanent transects. Unfortunately, the outlook for management of the huemul, as with many other endangered species, is rather glum. The factors responsible for the declining numbers are not likely to disappear in the foreseeable future and the situation could easily worsen considering the exponential growth of the human population, making a strong case in point for establishment of a captive breeding program. It has been calculated that a minimum of 50 to 500 individuals would be required to maintain genetically viable populations of deer depending on the social makeup of the species with the more social species likely to require more individuals than solitary species [123]. Existing gene pools must be preserved. The question no longer is, *should we* manage for genetic variation; instead, we immediately need to set up guidelines for how we should best manage genetic variation, routinely and economically [50]. Management programs should focus on retaining heterozygosity, gene diversity, and allelic diversity (see Fragmented Populations: genetic variation, this chapter). Some of the recommendations established at the International Symposium of Deer in 1990 for maintenance of genetic variation can be directly used or slightly modified to apply toward huemul conservation [50]. These include:

1. genetic survey data and knowledge of species breeding structure should be used to develop management plans that do not reduce gene flow and which maximize breeding opportunities among individuals;
2. prolonged breeding bottlenecks should be prevented and large effective population sizes maintained whenever possible in natural and reintroduced populations. Reintroductions may be necessary to maintain viable populations;
3. natural variation and genetic drift should be left to maintain variation within and between breeding units by maintaining habitats of sufficient size and preserving dispersal corridors between locally distinct breeding groups;
4. whenever huemul are tranquilized or their carcasses are discovered, biologists should be prepared to collect and preserve blood and/or tissue samples for subsequent genetic analysis. Such samples can provide a genetic baseline that will be useful in management. Samples can be used to determine if there are significant genetic differences between populations, which can aid in management decisions such as translocation projects. They can also contribute basic forensic data to assist in the prosecution of poachers.

Outdoor recreation and eco-tourism have been promoted throughout Patagonia in recent years. Subsequently, there has been an increased involvement in a variety of outdoor activities in back country areas by both local inhabitants and tourists. Areas containing huemul are no exception. Additionally, logging and mining in these pristine areas are currently being evaluated. It shouldn't be overlooked that as the prices of precious metals appreciate on the international stock market, mining in Patagonia could become highly attractive, making it a serious threat to the huemul. Concerned individuals are eager to develop multi-use management plans now for remote unscathed regions as a means to divide natural resources between the various interest groups. Careful planning is essential at this stage as these plans can either work in favor of protecting the huemul or aid in its demise. To protect the huemul, no activity which may be detrimental to the survival of the species should be permitted. This is a case where the precautionary principle should be applied (see Management, this chapter). Thus, development of any human activities in a region with huemul should be restricted until it can be shown not to pose a risk to the continued biological and ecological viability of the species. Permits for such projects should not be issued until after the results of a scientific study prove the proposed activity to be harmless. The burden of proof should be left up to the intended developer. It can not be emphasized enough, in the absence of scientific information, the best cautionary procedure is to prohibit development of any kind in huemul country. Short-term economic gain does not warrant destroying one of the few remnant populations of our beloved endangered Patagonian huemul.

As a last recapitulation, it is essential that we consider all factors which may have an impact on the huemul in a given area and evaluate the options to ameliorate the situation immediately. Whenever possible, all negative factors should be annihilated, or at the very least, managed so that their impact is substantially reduced. Populations which are small and isolated will require intensive management as recommended in the Conservation Assessment and Management Plans (CAMPs) developed by the Captive Breeding Specialist Group [223]. To avoid the extinction of these endangered populations, management will have to include habitat management and restoration, intensified monitoring and data collection, management of introduced wild herbivores and livestock, legal control of human activities, management of the genetic variation and a well-designed captive breeding program.

The fate of our mysterious huemul may essentially depend as much - if not more - on its economic

value as its esthetic one. Despite our aspirations, only by raising public and political concern for this species and its habitat can we ever expect to save it from the brink of extinction. Lamentably, knowledge of what essentially needs to be done and interest alone will not be enough. Appropriate management policy can only be implemented with the backing of a stable financial support system which must be formally constructed with a firm foundation and legally put into place.

## EPILOGUE

The following excerpt from my journal, of a brief encounter I had with an undisturbed and curious-type huemul protected within a Chilean National Reserve, highlights the importance of protecting this beautiful Andean creature:

*Some time ago, as the last of the evening dusk was fading into a starry lit night, I was truly the happy-go-lucky wildlife biologist as I sauntered through the brush, back to the warmth of the rustic park cabin after a rewarding day of huemul observations. Suddenly I was startled by a dark figure leaping straight up in front of me. I had nearly treaded on this peacefully bedded animal in my half-blinded descent down the darkened slope. The image I beheld in awe, was that of an adult female huemul who just stood quietly, gazing at me with twinkling eyes in the dark stillness of the night; only 2 meters stood between us. We were eye to eye and one to one. The air undeniably filled with magic. Catching my breath I wondered, was I back in the Garden of Eden? Or was this some alien creature come down to whisk me away to some distant star? We goggled at each other, all of 5 ecstatic minutes, or was it a mere 5 seconds; time had no relevance in this fleeting glance at eternal bliss. The moment is forever etched in my mind. Eventually, she moved unhurriedly away, and commenced to munch on some favorable leaves which she so delicately selected from a nearby bush. The darkness veiled the plant's identity from me. Reluctantly, I left her to her paradise and moved on, relishing in my new-discovered joy.*

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