

Hippocamelus antisensis (Artiodactyla: Cervidae)

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Abstract: *Hippocamelus antisensis* (d'Orbigny, 1834) is a cervid commonly called taruca or taruka and is 1 of 2 species in the genus *Hippocamelus*. It is a medium-sized, dimorphic ungulate with characteristic facial markings. It lives at high altitude along steep slopes composed of rocky areas with sparse vegetation in the central Andes. It is widely distributed but limited in population size, considered “Vulnerable” by the International Union for Conservation of Nature and Natural Resources, and is represented poorly in zoos. It is illegally hunted throughout its distribution, and is affected by anthropogenic activities.

Key words: deer, ruminant, South America, taruca, taruka, ungulate

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Synonymies completed 10 January 2010
DOI: 10.1644/901.1

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Hippocamelus Leuckart, 1816

Equus: Molina, 1782:320. Not *Equus* Linnaeus, 1758.

Camelus: Treviranus, 1803:179. Not *Camelus* Linnaeus, 1758.

Hippocamelus Leuckart, 1816:23. Type species *Hippocamelus dubius* Leuckart, 1816 (= *Equus bisulcus* Molina, 1782), by monotypy.

Auchenia: Hamilton-Smith, 1827:300. Part, not *Auchenia* Illiger, 1811; preoccupied by *Auchenia* Thunberg, 1789 (coleopteran beetle).

Cervus: d'Orbigny in Geoffroy Saint-Hilaire and de Blainville, 1834:91, footnote. Not *Cervus* Linnaeus, 1758.

Corvequus Lesson, 1842:173. Type species *Cervus andicus* Lesson, 1842 (= *Equus bisulcus* Molina, 1782), by monotypy; proposed as a subgenus of *Cervus* Linnaeus, 1758.

Furcifer: Wagner, 1844:384. Type species *Cervus antisensis* Wagner, 1844 (= *Cervus antisensis* d'Orbigny in Geoffroy Saint-Hilaire and de Blainville, 1834:91, footnote); proposed as a subgenus of *Cervus* Linnaeus, 1758; preoccupied by *Furcifer* Fitzinger, 1843 (Chamaeleonidae).

Capreolus Gray, 1849:64. Part, not *Capreolus* Gray, 1821.

Furcifer: Gray, 1850:68. First use as genus.

Anomalocera: Gray, 1869a:385. Type species *Anomalocera huamel* Gray, 1869a; preoccupied by *Anomalocera* Templeton, 1837 (copepod crustacean).

Xenelaphus Gray, 1869b:498, figure. Replacement name for *Anomalocera* Gray, 1869a.

Huamela Gray, 1872b:445. Type species *Huamela leucotis* Gray, 1872b (= *Capreolus leucotis* Gray, 1849), by monotypy.

Creagroceros Fitzinger, 1874:348. Replacement name for *Furcifer* Wagner, 1844.

Cariacus: Brooke, 1878:923. Part, not *Cariacus* Lesson, 1842.

Mazama: Lydekker, 1898:243. Part, not *Mazama* Rafinesque, 1817:363.

Odocoileus: Dabbene, 1911:293. Part, not *Odocoileus* Rafinesque, 1832.



Fig. 1.—An adult male *Hippocamelus antisensis* after casting antlers, from 5 km ENE Putre, Chile, October 2010. Used with permission of the photographer G. Schreiber.

CONTEXT AND CONTENT. Order Artiodactyla, suborder Ruminantia, family Cervidae, subfamily Capreolinae. The genus *Hippocamelus* includes 2 species: *H. antisensis* and *H. bisulcus* (Grubb 2005).

Hippocamelus antisensis (d'Orbigny, 1834)

Taruca

Cervus Antisensis d'Orbigny in Geoffroy Saint-Hilaire and de Blainville, 1834:91, footnote. Type locality “versant oriental des Cordillères;” restricted to Andes near La Paz, Cochabamba and Chuquisaca, Bolivia, by d'Orbigny and Gervais (1847:28).

Cervus antisensis Pucheran, 1844:328. Incorrect subsequent spelling of *Cervus antisensis* d'Orbigny, 1834.

Cervus (Furcifer) antisensis: Wagner, 1844:384. Name combination and incorrect subsequent spelling of *Cervus antisensis* d'Orbigny, 1834.

Anomalocera huamel Gray, 1869a:384. Type locality “Tinta, South Peru.”

Xenelaphus huamel Gray, 1869b:498 (= *Anomalocera huamel*). Name combination on new genus.

Xenelaphus leucotis: Gray, 1872a:89. Part, not *Capreolus leucotis* Gray, 1849.

Xenelaphus anomalocera Gray, 1872b:445. Replacement name for *Xenelaphus leucotis* Gray, 1872a:89.

Xenelaphus chilensis: Gray, 1873b:161. Not *Cervus chilensis* Gay and Gervais, 1846.

Creagroceros antisensis: Fitzinger, 1874:358. Name combination and incorrect subsequent spelling of *Cervus antisensis* d'Orbigny, 1834.

Furcifer chilensis: Gray, 1874:332. Name combination. Not *Cervus chilensis* Gay and Gervais, 1846.

Cariacus antisensis: Brooke, 1878:924. Name combination and incorrect subsequent spelling of *Cervus antisensis* d'Orbigny, 1834.

Furcifer antisensis: Nehring, 1895:9. Name combination.

Mazama antisensis: Lydeker, 1898:295, plate 23. Name combination and incorrect subsequent spelling of *Cervus antisensis* d'Orbigny, 1834.

Hippocamelus antisensis: Elliot, 1907:52. Incorrect subsequent spelling of *Cervus antisensis* d'Orbigny, 1834.

Odocoileus antisensis: Dabbene, 1911:293. Name combination.

Hippocamelus antisensis: Lydekker, 1915:196. First use of current name combination.

CONTEXT AND CONTENT. Context as for genus, no subspecies are recognized.

NOMENCLATORIAL NOTES. The original and 1st mention of the species was done by Geoffroy Saint-Hilaire and de Blainville (1834) and not by d'Orbigny. In the publication they report d'Orbigny's voyage to South America and

credited d'Orbigny for the name in a footnote. The quote identifies the origin as “versant oriental des Cordillères” and superficially describes the hair. A comprehensive description was given subsequently by Pucheran (1844), who also credited d'Orbigny as the author. Based on Articles 23.1 and 50.1.1 of the *International Code of Zoological Nomenclature* (International Commission on Zoological Nomenclature 1999), I concur with the original authorship by d'Orbigny as commonly treated, not by Geoffroy Saint-Hilaire and de Blainville (1834) or by Pucheran (1844). However, the negligible note on the location and hair might exclude its availability under Article 12.3 of the *Code*, until the description by Pucheran (1844). If Pucheran (1844) is credited as the author based on his description, the species will be called *antisensis* and not *antisensis*.

Cervequus was mentioned as a group of *Cervus* by Lesson (1842), but for the purposes of synonymy it is assumed as a subgenus, as was treated by Cabrera (1961). The genus *Huamela* (Gray 1872b) was more extensively described in Gray (1873a), which was depicted in Cabrera (1961) as the description date. The genus *Xenelaphus* (Gray 1869b) was described as a replacement for *Anomalocera*, which was preoccupied, but the explanation for the replacement was not mentioned until 1872 (Gray 1872a). The species received 5 different names between 1869 and 1873 (Gray 1869a, 1869b, 1872a, 1872b, 1873b), despite it representing only the original *Cervus antisensis* (Sclater 1873). *Xenelaphus leucotis* included the 2 species of *Hippocamelus* in the species' account by Gray (1872a).

Preliminary genetic data on *Hippocamelus*, based on the cytochrome-*b* gene, separate the 2 species into different genera (Duarte et al. 2008; J. C. Marin, in litt.). If the split is definitive, the scientific name would become *Xenelaphus antisensis*.

DIAGNOSIS

The genus *Hippocamelus* can be distinguished from other South American deer species by the antlers, which divide only once, near the base. *Hippocamelus antisensis* (Fig. 1) differs from *H. bisulcus* (the guemal or huemul), with which it is allopatric, by a lighter and less-uniform coloration, white on the ventral surface of the neck, white on the inner side of the legs, a larger white area on the buttocks and tail, and a darker rump. Antler branching usually begins closer to the base of the antlers in *H. antisensis* than in *H. bisulcus*, and the black pattern on the face in most individuals is more conspicuous and there is a greater amount of white on the muzzle. *H. antisensis* can be distinguished from the sympatric *Odocoileus virginianus* (white-tailed deer) by the antlers, dark underside, and distinctive color characteristics described above. The white-tailed deer usually has light-colored oculars, which are lacking in *H. antisensis*.

GENERAL CHARACTERS

Hippocamelus antisensis is sexually dimorphic; head coloration and antlers only on males are the main differences. In general, *H. antisensis* is a medium-sized, heavy-built deer where males are larger than females and have thicker necks (see “Form and Function”) because of greater muscular development (Pearson 1951; Roe and Rees 1976; Barrio 2010). The pelage is coarse and the body coloration is mostly sandy-gray (Figs. 1 and 2; Barrio 2010). Antlers are bifurcated once near the base and the posterior tine is larger. Fawns are unspotted (Nowak 1991; Barrio 2010).

The face has distinctive black markings, which differ among individuals (Roe and Rees 1976; Merkt 1985; Nowak 1991; Barrio 1999, 2010). The black on the face of males usually includes a black area behind the narial patch and a distinctive Y or V on the forehead throughout the rostral band (Figs. 1 and 2). However, in some individuals the dark areas are minimal or are lacking (Barrio 2010). The extension of white and black on the muzzle is variable among individuals, but always includes a white narial patch that may extend as a band around the nose (Barrio 2010). Females tend to show a dark brown area on the forehead, and frequently have a black line at each side of it, above the eyes (Fig. 2; Barrio 2010). The underside of the head is white from the mental patch to the buccal patch (Barrio 2010). *H. antisensis* has a very large preorbital gland (Barrio 2010). Ears are long and pointed and similar in color to the back of the neck; the inside of the ears are grayish brown with buff, long hairs (Barrio 2010). *H. antisensis* is white on the ventral surface of the neck from the gular patch to the beginning of the chest, the front legs throughout the inner side, both sides at the distal area near the hooves, extensively on the ventral side of the rump patch, the underside and most of the tail, and the genital area (Fig. 1; Pucheran 1852; Roe and Rees 1976; Barrio 2010). The ventral portion of the thoracic–abdominal area is dark brown (Pucheran 1852; Barrio 2010). The dorsum is dark near the rump, and the upper side of the base of the tail varies from dark brown to black. *H. antisensis* has tarsal glands on the inner side of the legs, at the same height of the calcaneum.

The anterior part of the frontal of the skull is flat and almost in a single plane with the nasal bones (Fig. 3). Mean cranial measurements (mm; ranges and sample size in parentheses) of adult male *H. antisensis* were: maximum length 254.2 (248.1–263.6, $n = 4$); condylobasal length 234.9 (230.0–244.7, $n = 3$); condyle–premolar length 127.2 (118.0–137.8, $n = 7$); breadth of braincase 70.5 (68.1–75.6, $n = 11$); maximum zygomatic breadth 95.8 (89.7–102.6, $n = 11$). Cranial measurements of 1 adult female skull were: maximum length 243.1, condylobasal length 226.0; condyle–premolar length 124.4; breadth of braincase 68.8; maximum zygomatic breadth 94.8.



Fig. 2.—Male, female, and 5-month-old female fawn *Hippocamelus antisensis*, from a group of 11 individuals, in Huacullani, Puno, Peru, July 1997. *H. antisensis* is most commonly found in groups.

DISTRIBUTION

Hippocamelus antisensis is distributed along the high Andes, from west-central Peru southward to northwestern Argentina with a small distribution in northeastern Chile (Fig. 4; Grimwood 1969; Thornback and Jenkins 1982; Merkt 1985; Barrio 2010). Along the Andes, the distribution of *H. antisensis* displays a gradual decrease in elevation from north to south, because its habitat is located at lower elevations with increasing latitude. *H. antisensis* is found at elevations of 3,500–5,000 m in the highlands of Peru and Bolivia (Pearson 1951; Grimwood 1969; Jungius 1974; Roe and Rees 1976; Merkt 1985; Barrio 1999, 2010), at 2,500–4,000 m in northern Chile (Sielfeld et al. 1988), and at 2,000–3,000 m in the southern extreme of its distribution (Cajal 1983). The distribution in Peru and Chile is mostly continuous but limited to mountains with rocky areas, with some populations of *H. antisensis* occurring near areas of high human density (Barrio 2010). Populations are heavily fragmented throughout the high eastern Andes of Bolivia and northwestern Argentina (Barrio and Ferreyra 2008).

Hippocamelus antisensis has never occurred in Ecuador (Barrio 2010), even though Ecuador is mentioned in several publications as part of its former distribution (e.g., Pine et al. 1979; Geist 1998; Wemmer 1998; Grubb 2005). The presence of *H. antisensis* in Ecuador is based on questionable records. One specimen in Museo Argentino de Ciencias Naturales (MACN, Buenos Aires, Argentina) and another in Field Museum of Natural History (FMNH, Chicago, Illinois) were recorded as coming from Ecuador (Voss 2003), but both specimens have disappeared and it is not possible to verify the species identification. The specimen in MACN was a skull purchased along with a group of skins from other species and from multiple locations (Tirira 2007; Barrio 2010). Two specimens deposited in the Museo



Fig. 3.—Dorsal, ventral, and lateral views of skull and lateral view of mandible of adult female *Hippocamelus antisensis* (Museo Argentino de Ciencias Naturales, specimen 53.60). Greatest length of skull is 243 mm.

Nacional de Ciencias Naturales in Madrid, Spain, were authentic records from Ecuador, because the collector, the collection site, and the year were identified (Voss 2003); however, both specimens also were lost and there is no way to verify if the records actually corresponded to specimens of *H. antisensis*. Another record was an antler fragment

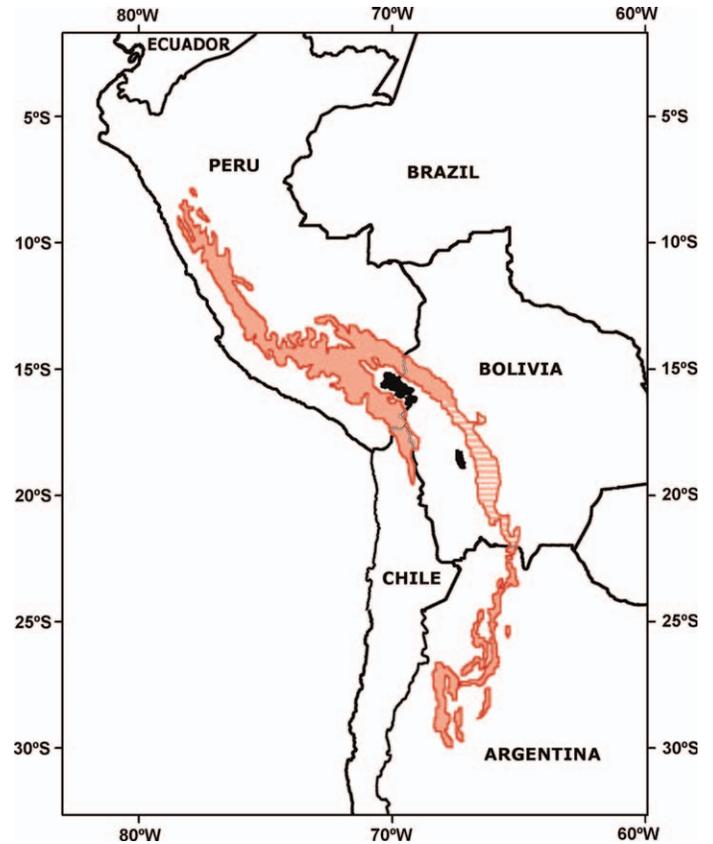


Fig. 4.—Distribution of *Hippocamelus antisensis* in South America. The striped area in Bolivia indicates an area where the distribution is assumed but has not been properly determined.

tentatively identified as *Hippocamelus* from the 3rd interglacial period from Punin, Ecuador (Hoffstetter 1986). However, all these records have been considered questionable or doubtful (Hoffstetter 1986; Tirira 2007; Barrio 2010).

FOSSIL RECORD

Fossil remains of the genus *Hippocamelus* have been excavated from the plains of Argentina, Uruguay, and southeastern Brazil (Castellanos 1944; de Paula Couto 1953, 1979; Rusconi 1967). The remains are from the Pleistocene, dating around 0.5–1.5 million years ago, and have been identified as *Hippocamelus sulcatus*. Fossils from Pernambuco, northeastern Brazil, were dated at around 1.8 million years ago; these fossils, however, may not actually belong to *Hippocamelus antisensis* (Magalhães et al. 1992). The fossils mentioned were found at lowlands and their assignment to the genus is based solely on the shape of the antlers, and may or may not correspond to the evolutionary line of the species. Fossils described as *H. percultus* from Tarija, southeastern Bolivian Andes, in layers placed at late Pleistocene around 20,000–40,000 years ago (Coltorti et al.

2007) are probably part of the evolutionary line of *H. antisensis* (Frailey et al. 1980; Hoffstetter 1986). The layers were wrongly dated in the 1980s as either 0.5–0.9 million years ago or 0.20–0.25 million years ago (Hoffstetter 1986). Fossil remains from *H. antisensis* have been recovered from caves inhabited by humans around 7,000 years ago in the central Andes of Peru (Wheeler et al. 1976; Wheeler 1984; Hoffstetter 1986). Fossils of *H. antisensis* have not been recovered from older layers (> 9,000 years ago) in the same caves, where the extinct genus *Agalmaceros* was found (Wheeler et al. 1976; Wheeler 1984; Hoffstetter 1986). It is possible that the more specialized *Agalmaceros* precluded *H. antisensis* from entering the high Andes until the former disappeared because of climate change alone or in combination with human actions.

FORM AND FUNCTION

Males are larger than females (Pearson 1951; Barrio 2010). Some males are clearly larger than others, a characteristic observed in mixed-sex groups that include several males (Pucheran 1852; Barrio 1999), and based on knowledge of other deer species it could be assumed that those males are older or are the ones that most likely sire most offspring (Clutton-Brock and Albon 1989; Kruuk et al. 1999; McElligott et al. 2001). The adult body mass is 46–60 kg and shoulder height is 69–80 cm, with the smaller heights and weights corresponding to females (Pearson 1951; Roe and Rees 1976; Barrio 2010). Other body measurements (cm) are head to body length: 138–146 for males ($n = 3$) and 128–130 for females ($n = 2$); tail length: 12.5–13.0 for males and 11.0–12.0 for females; ear length 15.0–16.5 for males and 14.0–15.0 for females (Pearson 1951).

The cover hairs throughout the body are hard, thick, and hollow, and are banded (Pucheran 1852; Barrio 2010). The 1st one-half to two-thirds toward the base of the hair is white, and the sequence of colors that follow in the distal one-half are brown, white, and dark brown on the tip (Pucheran 1844). The cover hair is all white in the white portions of the body (Pucheran 1844, 1852). The animal also has white curly wool hidden by the cover hairs (Barrio 2010).

The antlers are bifurcated near the base, with the tines of each antler placed one in front of the other (Pucheran 1852). The posterior branch grows almost straight upward after an initial bend and is usually longer than the front branch that curves backward. From the base of the pedicle to the apex of the posterior tine the antlers measure up to 33.5 cm (Samaniego 1988), with a mean of 27.4 cm ($n = 12$ [Pearson 1951; Samaniego 1988]; museum data gathered by the author) including only nondeformed antlers from adults. Dentition of adults is typical of Cervidae (i 0/3, c 0/1, p 3/3, m 3/3, total 32) except for the presence of upper canines in adult males and some females that results in a total of 34.

Most males have canines (Fig. 5), as corroborated by the type specimen (Pucheran 1852), 4 skulls examined from northern Argentina (Samaniego 1988), 1 museum specimen from MACN, 1 museum specimen from Museo de Historia Natural de la Universidad San Marcos (MUSM, Lima, Peru), and 2 specimens from FMNH. One aberrant male skull with 1-tine antlers and a long cranium, from FMNH, had no canines. The female skull examined at MACN lacked canines, as did the female skull revised by Pucheran (1852). However, 1 of 2 juvenile female skulls in FMNH has canines, and Roe and Rees (1976) reported canines were present in some females.

ONTOGENY AND REPRODUCTION

Reproduction of *Hippocamelus antisensis* is seasonal, with births occurring from January through March, peaking in February in the midst of the rainy season (Merkt 1985, 1987; Geist 1998; Barrio 1999, 2010), although April has been mentioned for the southern populations (N. Ferreyra, in litt.). Plant growth is at its maximum at the end of the rainy season in the Andes (Barrio 2010), so that reproductive seasonality appears to function so that parturition occurs close to the period of greatest food availability (Merkt 1987; Clutton-Brock and Albon 1989). Peak of the rutting season occurs in June at the middle of the dry season (Roe and Rees 1976; Merkt 1985; Sielfeld et al. 1988; Barrio 2010). Interactions between sexes are initiated by the male, and either the female retreats or the male mounts the female (Merkt 1987; Barrio 2010). Gestation period is around 240 days (Merkt 1987). A single fawn is usually born, which remains hidden inside rocky areas during its 1st month (Barrio 2010). Twins have been observed once in captivity and once in the wild in the humid puna of the highlands of the eastern Andes (Barrio 2006). Out-of-season fawns are occasionally seen (Merkt 1987; Barrio 1999), which is not that uncommon in deer displaying marked seasonal reproduction (Sadleir 1987).

The antler cycle is synchronized and seasonal (Merkt 1987). Most males drop their antlers around September, are in velvet by December (Merkt 1987; Sielfeld et al. 1988), and have clean antlers by February (Merkt 1987). A captive *H. antisensis* injured while growing its antlers ended up with deformed antlers; however, the same individual developed normal antlers the next year.

ECOLOGY

Population characteristics.—*Hippocamelus antisensis* is a gregarious species (Fig. 2), but solitary individuals are not uncommon. Observed group sizes vary widely among and within areas, and throughout the year, with the largest published group size being 31 individuals (Merkt 1987). The



Fig. 5.—Portion of a skull of a male *Hippocamelus antisensis* showing the canine fossa, without the tooth, on the joint between maxilla and premaxillary bones (Museo Argentino de Ciencias Naturales, specimen 53.62).

density of the species was estimated as 0.15 animals/km² in an area with a healthy population, considering all available habitats, and around 1 animals/km² when including only the area used by the species (Barrio 1999). Densities are much lower in human-modified and hunted areas or in the extreme southern or northern portions of the distribution (Barrio 2010).

Space use.—Across the distribution of *Hippocamelus antisensis*, the climate varies from wet on the eastern limit (Jungius 1974; Barrio 2004; Núñez 2005) to dry on the west (Sielfeld et al. 1988; Barrio 1999) and south of the range (Cajal 1983; Regidor and Rosati 2001). The main habitat type used is characterized by rock and cliff-like outcrops amid grassland vegetation on mountain slopes (Fig. 2), with sparse soft and leafy vegetation and nearby water sources (Jungius 1974; Roe and Rees 1976; Merkt 1985; Samaniego 1988; Barrio 1999, 2004, 2010). The species has been observed in dense shrubbery near rivers and inside high-altitude *Polylepis* forests (Barrio 2010). In several sections along its distribution, populations of *H. antisensis* live in fragmented portions of the range (Cajal 1983; Barrio 1999). *H. antisensis* typically remains close to the crops that it frequently consumes, resting on slopes in nearby mountains (Sielfeld et al. 1988).

Hippocamelus antisensis shares its habitat with white-tailed deer and domestic stock such as alpaca (*Vicugna pacos*), llamas (*Lama glama*), sheep (*Ovis aries*), and cattle (*Bos taurus*), which, especially the latter, might displace *H. antisensis* from areas outside rocky outcrops (Regidor and Rosati 2001; Barrio 2004, 2006). Based on habitat used by *H. antisensis* there seem to be large unoccupied available

areas, which would suggest that the distribution of *H. antisensis* might be linked to displacement by human activities (Barrio 1999). In a study in southern Peru, human activities only included alpaca grazing (Merkt 1987), which did not seem to influence space use by *H. antisensis*.

Hippocamelus antisensis occurs as dispersed populations with thin contact areas among them (Barrio 2010), a distribution explained by the specialized habitat it uses (Jungius 1974; Roe and Rees 1976; Merkt 1985; Barrio 1999, 2004). *H. antisensis* uses a determined space or home range, associating in groups in which home ranges of individuals periodically overlap (Merkt 1987; Barrio 2010) because of the nature of the large, loose group units (Barrio 1999). The groups may not be stable during daily activities, because groups may merge. The groups change composition over periods of a few days; however, because individuals maintain a stable home range, at least seasonally, the associations always occur with specific individuals so that on a larger scale they form cohesive population units (Merkt 1987; Barrio 1999). The area covered by those units ranged from 5.0 km² to 23.1 km² in a 900-km² study area (Barrio 1999). The groups move widely around their home ranges, disappearing from small areas for several days and even weeks (Sielfeld et al. 1988). Groups make elevational movements during the day, ascending in the late morning and descending in the late afternoon and night (Sielfeld et al. 1999); the author has observed elevation changes ranging from around 200 to 500 m.

Bedding areas and trails are well marked (Sielfeld et al. 1988; Barrio 2004). However, *H. antisensis* moves in a wide-open pattern when feeding, with individuals walking along different paths, almost in parallel (Barrio 2010). Groups have been observed eating while moving several kilometers (Sielfeld et al. 1988); females often lead groups (Roe and Rees 1976; Sielfeld et al. 1988; Barrio 1999), whereas males will be the last in the group (Sielfeld et al. 1988).

Diet.—*Hippocamelus antisensis* feeds primarily on small dicotyledon plants that grow near the ground instead of the abundant Andean bunch-grasses (Roe and Rees 1976; Asociación Peruana para la Conservación de la Naturaleza 1996; Barrio 1999; Gazzolo 2006). Primary species eaten at the northern extreme of the distribution were *Werneria nubigena* (Asteraceae), *Gentianella* (Gentianaceae), *Puya* (Bromeliaceae), *Ranunculus weberbaueri* and *R. aff. krapfia* (Ranunculaceae), *Valeriana pilosa* (Valerianaceae), and *Lycopodium* (Lycopodiaceae—Asociación Peruana para la Conservación de la Naturaleza 1996). In another study in the northern extreme of the distribution, 6 of 11 species being eaten by *H. antisensis* in Rio Abiseo National Park in 2001 were monocotyledons: 4 Poaceae (at least a *Calamagrostis*), 1 Juncaceae (*Luzula*), and 1 Iridaceae. Among dicotyledon species, 2 were the same as determined by Asociación Peruana para la Conservación de la Naturaleza (1996): *W. nubigena* and *V. pilosa*, the other

ones being *Lupinus* (Fabaceae), *Senecio* (Asteraceae), and 1 unidentified. Data from microhistological analysis revealed >20 plants are eaten by *H. antisensis* in Huascarán National Park, central Andes of Peru, of which grass species composed about 60% of the diet during the rainy season (Gazzolo 2006). Species that represented >4% of the fragments were *Poa gymnatha*, *Bromus villosissimus*, *Calamagrostis*, *Trisetum spicatum*, and *Poa spicigera* (Poaceae); *Luzula racemosa* and *Distichia muscoides* (Juncaceae); *W. nubigena* and *Senecio comosus* (Asteraceae); and *Ephedra americana* (Ephedraceae, a Gymnospermae—Gazzolo 2006). The percentage of grass species consumed was much lower during the dry season (<30%—C. Gazzolo, in litt.). In southern Peru, the only wild genus observed as being eaten was *Ephedra* (Ephedraceae: Gymnospermae—Barrio 1999).

Microhistological analyses identified 26 dicotyledon genera from Parinacota, northern Chile (Sielfeld et al. 1988). *H. antisensis* was observed feeding on *Balbisisa microphylla* (Ledocarpaceae); *Coreopsis suaveolens*, *Chersodoma jodopappa*, and *Ambrosia artemisioides* (Asteraceae); *Chenopodium petiolare* (Chenopodiaceae); and *Nasella pubiflora* (Gramineae: Poaceae) during April, after the rainy season (Sielfeld et al. 1988). Additionally, remains from Gramineae were identified only in pellets collected during the rainy season (Sielfeld et al. 1988). The species *Senna birostris* (Caesalpinaceae) and *Balbisisa microphylla* were identified as the wild species more often consumed by *H. antisensis* in northern Chile (Sielfeld et al. 1988). Another species widely consumed throughout the study area was alfalfa (*Medicago sativa*), a cultivated species (Sielfeld et al. 1988). Other cultivated species observed eaten by *H. antisensis* include sprouts of potato (*Solanum tuberosum*) and barley (*Hordeum vulgare*—Barrio 1999).

Interspecific interactions.—Individual *Hippocamelus antisensis* have been observed by the author at less than 200 m from alpaca herds, with no interactions between species. Moreover, *H. antisensis* seemed to avoid getting closer to the herd, regardless of the absence of herders or dogs nearby. No interactions have been recorded between *H. antisensis* and white-tailed deer, despite the fact that the white-tailed deer uses similar habitat in the northern one-half of the distribution of *H. antisensis*, which may be explained by differential use of elevation to avoid competition (Barrio 2004).

Miscellaneous.—The use of standard census techniques and estimates of population density are not easy given the rugged terrain that *Hippocamelus antisensis* inhabits. However, the open terrain makes possible the estimation of total numbers by direct observation, combined with some survey techniques such as the analysis of tracks and individual facial markings (Merkt 1987; Barrio 1999). All *H. antisensis* have unique facial patterns that allow for individual identification (Merkt 1985; Barrio 2010), which

can be used in either total counts or in a mark–recapture framework. In both techniques, observers have to be close enough for clear observation of individuals and their facial markings.

Breeding in captivity might not be difficult, because 12 births were recorded in the Berlin Zoo, Germany, from 1931 to 1941 (Frädriich 1987), and at least 4 births were recorded from 1995 to 1997 in a captive group, living freely in the gardens of the main hospital at Puno, Peru. The group started with 1 adult female and 1 adult male in 1994 (Barrio 2010).

BEHAVIOR

Grouping behavior.—*Hippocamelus antisensis* lives primarily in mixed groups most of the year (Merkt 1987; Fig. 2). Composition and size of the groups vary widely throughout the year, among groups, and even daily within a group, guided by a fission–fusion system (Merkt 1987; Barrio 2010). Larger groups, more than 30 individuals (Merkt 1987), are not common; however, observations by locals indicated that 30–50 individuals in a single group were frequent 50 years ago in Peru.

Mixed groups are the largest throughout the year, and usually are the most common group type (Merkt 1985). Mixed groups are composed of adult males and females, yearlings, and fawns, with small groups of 3 or 4 individuals usually containing 1 adult male (Merkt 1987; Barrio 1999). Larger groups include several adult males, some of them evidently larger than the others (Barrio 1999, 2010). There are also small all-male and all-female groups (Merkt 1987). Solitary individuals are found throughout the year and are mostly males, except for the fawning season, but are uncommon (Merkt 1987; Barrio 1999). Solitary individuals tend to be more common in areas with higher human influence, where solitary females also are frequently found.

Females segregate themselves when it is time to give birth, when they seek rocky outcrops (Merkt 1987). Parturition results in changes in the size of groups with groups being smaller during fawning months (i.e., January–April—Merkt 1987). From just before fawning through the fawn's 1st months, either male or female groups are most common (Merkt 1987). By the end of the rainy season (April–May) lactating females and their fawns return to mixed groups (Merkt 1987).

When a group flees, it either divides into smaller units or runs in single file (Barrio 2010); the last individual leaving the area seems to be a male (Barrio 2010). On the few occasions when fawns were in a large family group, they ran behind an adult male and in front of another adult male (Barrio 1999, 2010).

Reproductive behavior.—Large mixed-sex groups subdivide into smaller groups within the larger group from June to August, which is the primary breeding season (Merkt 1985;

Sielfeld et al. 1988). These smaller groups are composed of a male and several females, including juveniles of both sexes (Sielfeld et al. 1988). Males will defend females from other approaching males (Sielfeld et al. 1988). Courtship was observed as rutting activity from May to July (Merkt 1987; Sielfeld et al. 1988) and occurs just prior to copulation (Roe and Rees 1976; Merkt 1987; Sielfeld et al. 1988). Mounting occurred just after courtship, and only lasted a couple of seconds (Roe and Rees 1976). In the only detailed description of a sexual interaction, the male approached a resting female with his head low and penis semierect, nosed and licked the vulva, and heaved her hindquarters many times until the female stood up (Roe and Rees 1976). Subsequently, the female walked and urinated with her back arched and the male used flehmen and the vomeronasal organ to presumably detect chemical stimuli from pheromones in the urine. The male followed the female licking and nosing her vulva and lifting her hindquarters.

Communication.—Nothing has been written on vocal communication among individuals, or general vocalizations. Communication seems to rely on body language, like the previously described reproductive behavior and further detailed in Roe and Rees (1976), and on scent glands. Tarsal glands are used for communication through scent. It is unknown if the glands are only used during reproduction or throughout the year.

Adult males exhibit dominant behavior toward younger males. They show the white area on the underside of the head by lifting the head upward and backward with the chin pointing to the sky while standing (Roe and Rees 1976). Males may additionally nod their head and raise the forelegs 1 at a time, or point their antlers toward the juveniles, while the neck stays in line with the back, even slowly walking stiffly toward the juvenile (Roe and Rees 1976). This behavior might signify a threat for a possible strike with the forefeet while standing on the hind legs (Roe and Rees 1976). Dominant or threatening behavior occurred during the breeding season, and no similar observations have been reported from other times of the year.

GENETICS

A genetic analysis, including 1 *Hippocamelus antisensis* and 5 *H. bisulcus*, suggested that *Hippocamelus* does not form a monophyletic group and represents 2 separate radiations from unrelated lineages with high levels of molecular and cytogenetic divergence (Duarte et al. 2008). Other analyses, but still preliminary and with small sample sizes, are confusing because some corroborate that each of the species is more related to other South American species than to each other (e.g., J. C. Marin, in litt.), although 1 analysis indicates that both species are genetically closer to each other than to other species.

The karyotype of the species is unknown. The diploid number (2n) of the other species of the genus, *H. bisulcus*, is 70 (Spotorno et al. 1987); however, keep in mind that *H. antisensis* might belong to a separate genus.

CONSERVATION

Hippocamelus antisensis was considered as threatened by hunting as early as the late 1960s (Grimwood 1969). The International Union for Conservation of Nature and Natural Resources currently defines *H. antisensis* in its endangered species list as “Vulnerable,” based on International Union for Conservation of Nature and Natural Resources criteria C2a(i) E (Barrio and Ferreyra 2008). In addition, based on its threatened status, the Convention on International Trade in Endangered Species of Wild Fauna and Flora lists *H. antisensis* in Appendix I (Barrio and Ferreyra 2008), meaning that the international trade of specimens or parts is prohibited except when the purpose of the trade is not commercial.

Hippocamelus antisensis is considered to be “Vulnerable” because of small population size and ongoing decline estimated from hunting and inferred from reduction of habitat quality, and following a quantitative analysis on the extinction probability of 1 subpopulation, assumed as an indication of the scenario for the whole population (Barrio and Ferreyra 2008). Additionally, the cumulative population in a large portion of the existing range between Argentina and Bolivia possibly does not exceed 2,000 mature individuals (Barrio and Ferreyra 2008). A population viability analysis on a healthy population in southern Peru indicated a high probability of extinction in 100 years (Barrio 2008); therefore, populations in Bolivia and Argentina likely would face extinction. Threats to extinction include competition with domestic stock, habitat destruction, illegal trophy hunting, and predation by domestic dogs (Barrio 2006; Barrio and Ferreyra 2008).

Peru currently classifies *H. antisensis* as “Vulnerable” following an assessment based on International Union for Conservation of Nature and Natural Resources criteria (Ministerio de Agricultura, Perú 2004). In Bolivia, *H. antisensis* is protected by a hunting ban decree (Decreto de Veda General Indefinida) and it is classified as “Endangered” in the Bolivian *Red Book* of threatened vertebrates (Ministerio de Medio Ambiente y Agua, Bolivia 2009). Chile classifies *H. antisensis* as “Vulnerable” (Glade 1993; Galaz 1998) and it is protected by the general Hunting Law (Servicio Agrícola y Ganadero 2001). In Argentina, *H. antisensis* is currently classified as “Endangered” (Fernandez et al. 1997; Diaz and Ojeda 2000) and was declared a Natural Monument in 1996 by the Argentinean Congress (Fernandez et al. 1997).

Hippocamelus antisensis occurs in several protected areas throughout its range (see Barrio 2010 for details). However,

the size of most of the protected areas is not large enough to sustain a viable population, or the appropriate habitat is marginal and small, so that few of those areas actually harbor populations of *H. antisensis*. Most individual *H. antisensis* range outside protected areas (Barrio 2010). It is urgent that protected areas be established over what is left of the species total range.

Hippocamelus antisensis may be an economically valuable species for Andean communities but requires proper management for its conservation. *H. antisensis* is hunted for food by some local people; however, this pressure has never been measured. It also is hunted illegally by urban sport hunters and by the army and police. Proper management should consist of avoiding illegal practices for the benefit of both *H. antisensis* and local people. One of the major roles played by trophy hunting is related to improving the local economy while maintaining *H. antisensis*, its habitat, and other natural areas (Decker 1995; Morrill 1995). Hunting will offer economic incentives to local people as motivation to conserve certain wild species; the economic incentives from hunting have been successful in conserving wildlife and their habitats in many instances (Dickson 1992; Woolf and Roseberry 1998; Freeman and Wenzel 2006).

ACKNOWLEDGMENTS

I am grateful to J. Tello for photographing and sending copies of old journals from the American Museum of Natural History; the Library of the Zoological Society of London, which kindly provided copies of old journals; Internet Archive, which was invaluable when looking for rare and old journal articles; D. Flores, from the Museo Argentino de Ciencias Naturales “Bernardino Rivadavia,” for allowing me to photograph the female skull shown in the account; C. Gazzolo for unpublished material on feeding ecology and support throughout the writing process; N. Ferreyra for unpublished material on the Argentinean population and distribution; J. C. Marin for unpublished material on genetics; G. Schreiber for the photograph; W. Stanley from FMNH for the measurements of the skulls in FMNH; E. López and H. Zeballos from the Museo de la Universidad Nacional San Agustín, Arequipa, for allowing me to handle and measure the specimens under their supervision; and V. Pacheco from MUSM, for allowing me to handle and measure the specimens under his supervision.

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Associate Editor of this account was DAVID ZEGERS. Synonymies were reviewed by DAVID M. LESLIE, JR. Editor was MEREDITH J. HAMILTON.