Chinchilla laniger.

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Chinchilla Bennett, 1829

Mus: Molina, 1782:301. Part, not *Mus* Linnaeus, 1758.
Lemmus: Tiedemann, 1808:476. Part, not *Lemmus* Link, 1795.
Cricetus: È. Geoffroy St.-Hilaire, 1803:197. Part, not *Cricetus* Leske, 1779.
Chinchilla Bennett, 1829:1. Type species *Mus laniger* Molina, 1782, by monotypy.
Eriomys Lichtenstein, 1830:plate 28. Type species *Eriomys chinchilla* Lichtenstein, 1830, by monotypy.
Callomys d'Orbigny and I. Geoffroy Saint-Hilaire, 1830:289. Part, no type species selected.
Aulacodus: Kaup, 1832:column 1211. Not *Aulacodus* Temminck, 1827:245.
Lagostomus: Cuvier, 1830:plate 64. Not *Lagostomus* Brookes, 1828.

CONTEXT AND CONTENT. Order Rodentia, suborder Hystricognatha (Caviomorpha), superfamily Chinchilloidea, family Chinchillidae, subfamily Chinchillinae. Chilean chinchilla has been treated as 1 of 3 subspecies of *Chinchilla chinchilla* (e.g., Osgood 1943), but most recent authorities recognize 2 species of *Chinchilla*, *C. laniger* and *C. brevicaudata* (Cabrera 1961; Corbet and Hill 1980; Muñoz-Pedreros 2000; Woods 1993), a distinction that is congruent with recent molecular data (Spotorno et al. 2004). Valladares and Spotorno (2003) have submitted a petition to the International Commission on Zoological Nomenclature to conserve the specific names *Mus laniger* Molina, 1782, and *Eriomys chinchilla* Lichtenstein, 1830, for such 2 species but the petition is not yet published, and the Commission has not rendered an opinion.

Chinchilla laniger (Molina, 1782)

Chilean Chinchilla

Mus laniger Molina, 1782:301. Type locality "Provincie Boreali del Chili," [northern provinces of Chile]; given as "Coquimbo" by Osgood (1943:134).
Cricetus laniger: È. Geoffroy St.-Hilaire, 1803:197. Name combination.
L[emmus]. laniger: Tiedemann, 1808:476. Name combination.
C[ricetus]. chinchilla Fischer, 1814:55. Type locality "Chile borealibus," based on *Mus laniger* Molina, 1782.
Chinchilla lanigera Bennett, 1829:1. First use of current name combination and incorrect subsequent spelling of *Mus laniger* Molina, 1782.
Callomys laniger: d'Orbigny and I. Geoffroy Saint-Hilaire, 1830:289. Name combination.
Lagostomus laniger: Cuvier, 1830:plate 64. Name combination.
Aulacodus laniger: Kaup, 1832:column 1211. Name combination.
Chinchilla velligera Prell, 1934:100. Replacement name for *Mus laniger* Molina, 1782.

CONTEXT AND CONTENT. Context as for genus. *Chinchilla laniger* is monotypic.

DIAGNOSIS. Body size of *Chinchilla laniger* (Fig. 1) is smaller (<260 mm in length) than that of *Chinchilla brevicaudata* (>320 mm), with more rounded ears (>45 mm in length) and a longer (>130 mm) hairy tail (Redford and Eisenberg 1992) than those of *C. brevicaudata* (<32 mm and <100 mm, respectively). Number of caudal vertebrae is 23 in *C. laniger* and 20 in *C. brevicaudata* (Grau 1986).

GENERAL CHARACTERS. Wild Chilean chinchilla from Reserva Nacional Las Chinchillas in Aucó are smaller and less sexually dimorphic than domestic animals: males weigh (mean ± *SE* unless otherwise indicated) 412 ± 9 g (range, 369–493 g; $n = 15$) and females weigh 422 ± 7 g (range, 379–450 g; $n = 14$—Jiménez 1990a). Domestic females weigh up to 800 g, whereas males reach near 600 g (Neira et al. 1989).

Hair is 2–4 cm long, with gray, white, and black bands; it is silky, extremely soft, and firmly adhered to skin (Bennett 1835); thus, it is considered commercially valuable (Cortés et al. 2000; Seele 1968). Many hairs (50–75) emerge together from a single skin pore. Wool hairs, 5–11 μm in diameter, are grouped in 2 lateral clusters. A single guard hair, 10–15 μm in diameter, is located at center of each cluster. Vibrissae are abundant, strong, long (100–130 mm), and emerge from single follicles (Wilcox 1950).

General color of upper parts is bluish or silvery gray, under parts are yellowish white. Tail has long, coarse, gray and black hairs on its dorsal surface that are 30–40 mm long near the body, 50–60 mm long near the tip (Albert 1900), and form a bristly tuft that exceeds vertebrae by 50 mm (Bennett 1835).

Head is broad, with rounded large ears (range, 45–48 mm; mean, 46.7; $n = 3$) covered by tiny hairs. Skull (Fig. 2) has very expanded auditory bullae, which protrude over the upper plane. Forelimbs are much smaller in size than hind legs (Yarrell 1831). Tibia is longer than femur, and fibula is virtually nonexistent (Schaeffer and Donnelly 1997). Short forefeet have 5 digits, and narrow hind feet have 3 digits plus 1 rudimentary having stiff bristles surrounding a small and flat claw. Other claws present but very short.

DISTRIBUTION. Wild populations of *C. laniger* occur in Aucó, near Illapel, IV Región, Chile (31°38′S, 71°06′W), in Reserva Nacional Las Chinchillas (Fig. 3) and in La Higuera, ca. 100 km north of Coquimbo (29°33′S, 71°04′W—Jiménez 1996). Chilean chinchillas were reported from Talca (35°30′S), Chile, reaching north to Peru (Bennett 1835), and eastward from Chilean coastal

FIG. 1. Photograph of an adult male *Chinchilla laniger* from border of Reserva Nacional Las Chinchillas, Aucó, Illapel, IV Región, Chile (specimen Colección del Laboratorio de Citogenética, Facultad de Medicina, Universidad de Chile [LCM] 400). Photograph by A. Spotorno O. (1975).

FIG. 2. Dorsal, ventral, and lateral views of cranium and lateral view of mandible of an adult female *Chinchilla laniger* from Aucó, Illapel, IV Región, Chile (specimen Z65, Universidad de La Serena Collection, Chile). Greatest length of cranium is 59 mm.
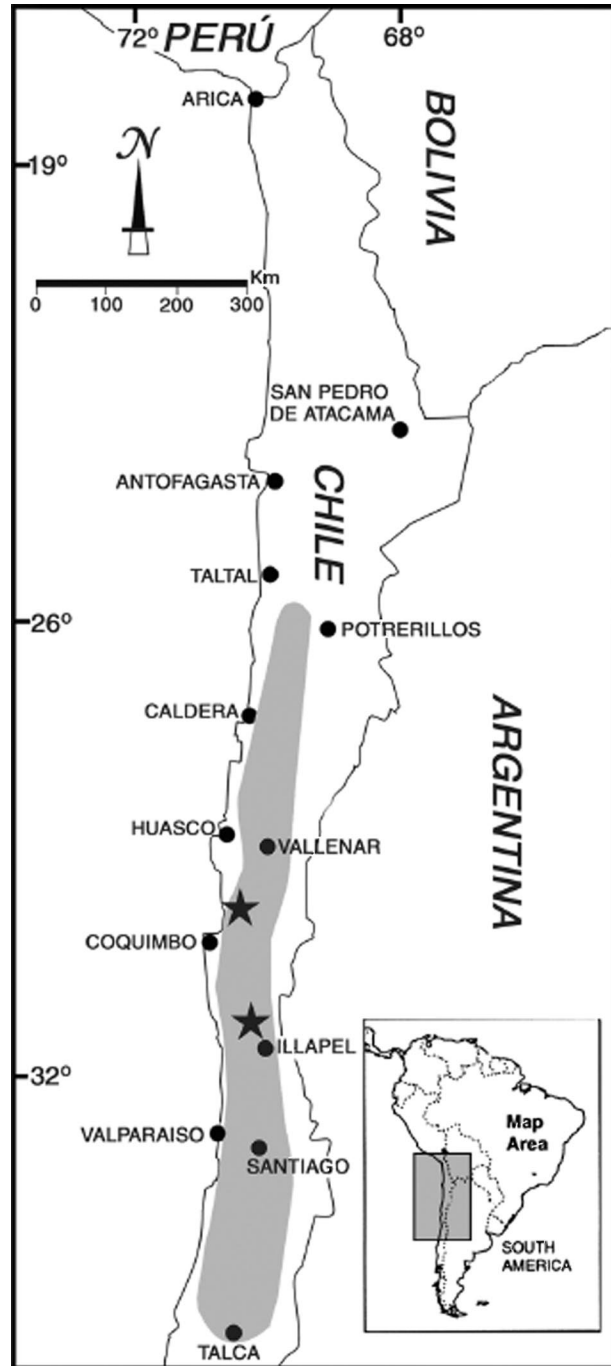

FIG. 3. Historic (ca. 18th century) geographic distribution of *Chinchilla laniger* (modified from Grau [1986]). Stars indicate sites of current wild populations (Jiménez 1996): La Higuera, Coquimbo, and Aucó, Illapel, Chile.

hills throughout low mountains. By the mid-19th century, Chilean chinchillas were not found south of the Choapa river (32°S—Gay 1847; Jiménez 1990a,b). They were mistakenly reported to occur far south, at 52°S (Walker 1968). No fossils are known.

FORM. Epidermis of domestic adults has 3 recognizable layers: a 2-cell-thick stratum germinativum, a single-cell stratum granulosum, and a thick stratum corneum. No stratum lucidum is found between last 2 (Wilcox 1950).

Each group of hairs has 1 arrector pili muscle. Guard hairs have their own sebaceous glands, whereas 3 or 4 other glands serve all hairs of a lateral group. Solitary hairs are found as vibrissae or on tail and pinnae. Follicular layering is found only in vibrissae (Wilcox 1950).

Females have 2 pairs of thoracic and 1 pair of inguinal mammae (Weir 1974), although latter are not visible in wild females. Area around mammae is devoid of fur during lactation.

Skull is relatively broad, with little or no ridging. Infraorbital canal is very large, without a distinct groove for nerve passage; at its front edge, lacrimal canal has large opening on rostrum side. Paroccipital process is short and attached to bulla. Jugal approachs lacrimal (Lawlor 1979). Encephalization quotient for domestic animals (ratio of observed versus expected brain mass for a defined body mass) is 1.342 (Eisenberg 1981). Pituitary is 3.46 mg/% of body weight in males and 4.02 mg/% in females (Asdell 1964).

Auditory bullae have 3 large vesicular protuberances; superior protuberance is nearly hemispherical, posterior is oblong, and inferior is pyriform (Bennett 1835). Mean total volume of middle ear is 1.52 ml $\pm$ 0.26 SD ($n = 9$—Vrettakos et al. 1988). Tympanic membrane is nearly parallel to medial wall of external meatus and anchored to bony annulus; maximum diameter is 8.53 mm $\pm$ 0.18 SD, and minimum diameter is 8.32 $\pm$ 0.27 mm ($n = 5$), with a circumference of 26.47 $\pm$ 0.65 mm, and a depth of its cone of 1.78

± 0.22 mm ($n = 5$). Tympanic flat area is 55.64 mm² ± 2.7 *SD*, but when its conical form is considered, average area increases 9%, to a mean of 60.44 ± 2.3 mm² ($n = 5$). In the ossicular chain, incudomalleolar joint is fused, and 2 ossicles form a curved bar that fit snugly in epitympanic recess. Malleus handle and posterior margin of incus long process are almost perpendicular to rotational axis. Footplate of stapes has a toe oriented posteriorly; crura of stapes are more central than in humans and mice. No stapedial artery occurs in adult Chilean chinchilla. Overall stapes height from footplate plate to incudostapedial joint is 1.78 mm, with mean mass 0.4 mg ± 0.3 *SD* ($n = 6$). Oval window has diameters of 2.19 and 0.78–0.93 mm. Round window is oval, with diameters of 1.40 and 0.95 mm. Ligamentous attachments occur between short process of incus and fossa incudis, as well as other 3 ossicular ones. Tensor tympani and stapedius muscles are well developed (Vrettakos et al. 1988).

Middle ear mucosa consist of columnar, cuboidal, and squamous epithelia. Lining epithelium of eustachian tube is ciliated pseudostratified columnar. Density of ciliated cells is highest in columnar epithelium area of transitional zone. Density of secretory cells is highest in pharyngeal orifice (Hanamure and Lim 1987).

Teeth are hypsodont and evergrowing (rootless). Upper toothrows are convergent anteriorly and crowns of cheekteeth flat, consisting of a series of transverse plates (Bennett 1835). Dental formula is i 1/1, c 0/0, p 1/1, m 3/3, total 20. Incisors grow 5–7.5 cm per year. Enamel is usually dark yellow in healthy animals (Hillyer et al. 1997); some inner radial enamel occurs close to dentin–enamel junction, as well as in portio externa (Von Koenigswald 1985).

Lower jaw has no ridge or groove on lateral surface; angular process is elongated and not deflected. Condyle is small and longitudinal, and glenoid cavity is superficial, permitting motion in anterior–posterior direction.

Vertebral formula is 7 C, 13 T, 6 L, 2 S, 23 Ca, total 51 (Bennett 1835), with 13 pairs of ribs (Yarrell 1831). Radius and ulna, although distinct, are so closely applied to each other at their carpal extremity that they appear anchylosed for half their length. Interarticular cartilage between clavicle and sternum is long, ca. 6 mm.

Masseter is divided in 3 portions. The superficial portion arises by a strong tendon from ventral side of zygoma below infraorbital foramen and inserts along ventral margin of angle of jaw. The lateral portion arises from zygoma and inserts on ventral part of masseteric fossa and ventral margin of mandible. The deep portion also is subdivided: anterior deep portion arises from dorsal part of maxillary portion of snout and passes backward and downward through a large infraorbital foramen; posterior deep portion arises from ventral surface of zygoma and inserts along dorsal half of masseteric fossa. Gluteus medius is enlarged. Temporalis is reduced and undifferentiated.

Hearts in domestic animals are more elongated and more rounded at apex than nearly quadrate heart of *Lagidium*. Internal carotid artery is absent and brain is supplied by vertebral–basilar artery system alone, whereas external carotid artery system has assumed entire stapedial area of supply by means of 3 anastomoses; internal ophthalmic artery aborts (Bugge 1984). Arterial irrigation of testicles and epididymis proceeds from testicular arteries, which emerge from renal arteries; accesorial sexual glands and ductus deferens irrigation is from external iliac artery (Adaro et al. 1998).

Lungs are asymmetric with 3 lobes in left and 4 in right; lower lobe is the largest, deeply bifid in latter. Trachea is transversely oval, with rings dorsally imperfect (Bennett 1835).

Vomeronasal organ is a pair of tubular structures, ca. 6 mm in length, situated bilaterally along base of nasal septum. Its sensory epithelium consists of sensory, supporting, and basal cells. Acinar cells of Jacobson organ in respiratory epithelium possess 2 types of secretory granules, 1 homogeneous and ca. 1,700 nm in diameter, and the other ca. 2,200 nm and varying in electron density (Oikawa et al. 1994).

Oral cavity is small and narrow. Oropharynx communicates with pharynx through palatal ostium (Hillyer et al. 1997). Stomach is pyriform, with a length of 63 mm, its greatest breadth on left is 44 mm and in middle is 25 mm (Bennett 1835). Esophagus enters near middle of cavity, and pyloric portion forms a curve upward, on which beginning of duodenum makes a sudden turn (Bennett 1835). Liver has 4 lobes, 2 large and 2 small (Yarrell 1831), with

both cystic and lobulus spigelii deeply cleft. Spleen is 25 mm in length, with a breadth of 22 mm at its lower extremity.

Small and large intestine in 1 adult domestic animal measured 350 cm (Hillyer et al. 1997). In a wild specimen with total length of nearly 21 cm, total length of small intestine was ca. 117 cm, and of large intestine, without cecum, was 145 cm. Duodenum, after descending to right lumbar region, turns upward, crosses spine, and then becomes free. A relatively large and coiled cecum (Hillyer et al. 1997) occupies left iliac region and has its blind extremity concealed behind 1st fold (Bennett 1835). Colon curves upward and toward left side, and then by a 2nd and very acute fold turns upon itself again and descends to hypogastrium. It reascends to hypochondrium, where it is attached to duodenum by peritoneum, and then returns on itself to descend in a long, loose, double fold, 23 cm in length. Formation of pellets begins at this long fold (Bennett 1835).

Kidneys are 19 mm long by 13 mm in breadth. Renal capsules are oblong white bodies, mesiad of upper part of kidney, and measure near 12 mm in length (Díaz and Cortés 2003).

Female reproductive system includes 2 uterine horns and 2 cervices (Weir 1970). Ovary is ovoid and suspended from dorsal wall of abdomen by mesovarium. Fallopian tubes are suspended by mesosalpinx mesenterium, which may partly invest ovary, forming a very thin and tenuous partial bursa ovarica. Fimbria are not prominent. Blood vessels and nerves enter ovary along cranial part of mesovarium, and hilum is well defined and extensive. Ovary surface is smooth and follicles may appear translucent but rarely project as domes on surface. Stigmata are not prominent and corpus lutea are not visible; therefore, ovulation is difficult to detect a few days later (Weir and Rowlands 1974). Polyovular follicles are particularly frequent at birth; 61% of animals had 0.4–19% of such follicles.

Testes are relatively large. Those from 4 wild mature males were 21–29 mm long (mean = 26.2), with mass of 3.0–5.1 g (mean = 4.3). *C. laniger* lacks a true scrotum; instead, testes are contained within inguinal canal, and caudal epididymis can drop into small moveable postanal sacs. Inguinal canal is open (Weir 1970).

Accesory reproductive glands of domestic males include large bulbourethral glands (mean diameter ± *SD* = 6.4 ± 0.16 mm; $n = 50$) that are surrounded by a capsule of dense connective tissue and striated muscles, with fibers arranged in 3 dimensions (Cepeda et al. 1999). Presence of prostate is variable (Adaro et al. 1999; Weir 1974). Large vesicular glands provide the bulk of accessory gland secretions, and this fluid gels to form a copulatory plug in females (Weir 1974).

Penis is separated from anus by bare skin (Weir 1974). Glans is partially covered with small simple spines directed toward body. A ventral 7-mm-deep sacculus urethralis or penian intromittent sac with small spines directed away from body occurs below meatus urinarium. Two large elastic bands connect to the internal part of sacculus bottom and, together with directions of spines, suggest that whole sacculus is everted during copulation. No spikes are present at external bottom of sacculus urethralis (Spotorno 1979).

Large black eyes have a vertical slit pupil (Walker 1968). Crystalline lens is large and convex.

FUNCTION. Middle ear conductive apparatus of domestic Chilean chinchilla is attached to surrounding cavity by suspensory ligaments, and thus is free to move independently. The single axis for the mobile middle ear of Chilean chinchilla passes through the center of gravity. When ossicles are in motion, no force is generated that would cause them to move out of axis. Bearings or suspensory ligaments, because they lie on axis, minimize resistance. Large mass of anterior process malleus also is distributed evenly, reducing moment of inertia, and probably contributing to high-frequency response (Vrettakos et al. 1988).

Basal metabolic rate of wild *C. laniger* ($n = 6$) averages 0.66 ml O_2 g⁻¹ h⁻¹, and skin thermal conductance is 0.0376 ml O_2 g⁻¹ h⁻¹ °C⁻¹. Thermal conductance in He-O_2 is 0.089 ml O_2 g⁻¹ h⁻¹ °C⁻¹. Thus, Chilean chinchilla has the highest thermal insulation (Cortés et al. 2000).

Evaporative water loss of wild Chilean chinchilla (mean ± *SD*, $n = 6$) is 0.58 ± 0.10 mg H_2O g⁻¹ h⁻¹ at ambient temperature ≤20°C. At temperatures of 25 and 30°C, evaporative water loss is 0.74 ± 0.09 and 0.89 ± 0.14 mg H_2O g⁻¹ h⁻¹, respectively (Cortés et al. 2000).

Chinchilla laniger produces concentrated urine. In 10 do-

mestic Chilean chinchillas deprived of water for up to 8 days, mean urine osmolality was 3.505 mOsm/kg (range, 2.345–7.599 mOsm/kg—Weisser et al. 1970). Chilean chinchilla shows elongated renal papilla and high renal indices, with relative medullary thickness of 6.7 ± 0.8 *SD*, and ratio of medulla to cortex of 5.6 ± 0.2 (Díaz and Cortés 2003). No reduction of urinary sodium concentration under food and water deprivation occurred (Gutman and Beyth 1970).

Feces size (mean = 8.6 by 3.9 mm) varies according to size of animal and is longer and narrower in males (Jiménez 1990a). Pellets are dark and can hardly be broken with bare hands. Freshly defecated feces feel dry to touch.

Rectal body temperature is 35.8°C in domestic males and 36.4°C in females (Kraft 1994). Body temperatures range from 38 to 39°C. Pulse is 100–150 beats/min, and respiratory rate is 40–80 breaths/min (Webb 1991).

Blood values in captive animals are: erythrocytes, 6.6–10.7 million/μl; hemoglobin, 11.7–13.5 g/dl; mean hematocrit, 38%; leucocytes, 7.6–11.5 × 10³/μl; monocytes, 1–4%; lymphocytes, 51–73%; neutrophils, 23–45%; eosinophils, 0.5–2.6%; and basophils 0–1%. Number of platelets is 254–298 × 10³/μl (Hillyer et al. 1997). Chilean chinchillas are as sensitive to ox insulin as they are to their own, and antigenic determinants and active sites are intermediate between ox and guinea pig insulins (Neville et al. 1974).

Accessory reproductive glands of domestic males throughout year follow concentration pattern of blood testosterone, which is highest between April and August, with a marked but brief descent in June (Orostegui et al. 1996). Mass and diameter of seminal vesicles of males is highest in austral autumn and winter (minimum mean mass $\pm$ *SD* in February: 0.32 ± 0.05 g; maximum mean mass $\pm$ *SD* in May: 1.4 ± 0.5 g; minimum mean diameter $\pm$ *SD* in January: $1,488 \pm 352.2$ mm; maximum mean diameter $\pm$ *SD* in June: $4,635.1 \pm 1,418.6$ mm; $n = 48$). Bulbo-urethral glands also vary (minimum mean mass $\pm$ *SD* in November: 0.11 ± 0.05 g; maximum mean mass $\pm$ *SD* in May: 0.4 ± 0.06 g; minimum mean diameter $\pm$ *SD* in February: 3.2 ± 0.52 mm; maximum mean diameter $\pm$ *SD* in June: 6.3 ± 0.19 mm; $n = 50$—Cepeda et al. 1999).

Semen ejaculate volume is 0.1–0.5 ml and contains 20–200 million sperm. Sperm can travel 25 mm in 4 min (Asdell 1964).

Follicles in pregnant domestic females are refractory to endogenous gonadotropin, but ovulation may occurs during anestrus. Ovulation can be induced if coitus occurs early enough to cause a premature surge of luteinizing hormone. Corpora lutea of pregnancy are about twice as big as those during nonreproductive cycles; they do not regress until ovulation recurs. Regressing corpora lutea may disappear quickly or remain for several cycles. Accessory corpora lutea are usually formed during pregnancy, but occur at infertile estrus in some females. Extensive remnants of mesonephric tubules and rete ovarii exist (Weir and Rowlands 1974). Pregnancy depends on a progressive increase of progesterone produced only by a complex ovary with accesory corpora lutea and interstitial tissue (Tam 1974).

ONTOGENY AND REPRODUCTION. Seven (<100 g) juveniles were caught in the wild between October and December without a 2nd litter (J. E. Jiménez, pers. comm.). Domestic *C. laniger* breed from May to November in the southern hemisphere (Neira et al. 1989), and from November to May in the northern hemisphere (Weir 1973). Usually 2 litters are produced annually.

Long estrous cycles are exhibited by domestic females (mean $\pm$ *SD*, 38.1 ± 0.7 days; $n = 323$; range, 16–69); estrus lasts 48 h. A postpartum estrus usually occurs at 57.4 ± 2.6 days, whether or not the litter is lost. Vaginal closure membrane of anestrus may open and close in 12 h, but usually takes 2–4 days; leucocytes are present when the membrane is open (Weir 1974). An open vulva, often with visible mucus, is an external indication of estrus. Vulvar swelling does not occur during estrus; rather, a change in perineal color from a dull pink color to a deep red occurs. Color of perineum increases dramatically at vaginal perforation and remains intense throughout most of luteal phase (Brookhyser and Aulerich 1980).

Ovulation in captivity is usually spontaneous, sometimes before vagina opens. A copulatory plug is usually visible after mating. Single-cell zygotes have been found in fallopian tubes 1–2 days postcoitum. Fertilization is difficult to detect because some eggs show no traces of polar bodies, sperm, or pronuclei, although some show a single polar body and sperm in zona pellucida, or a single polar body and 2nd maturation spindle at 2.5 days postcoitum (Roberts and Perry 1974). Polyspermy has not been observed. Pre-implantation blastocysts have been detected at 3.5 days postcoitum (Weir and Rowlands 1974).

Implantation occurs at 5.5 days postcoitum and is completely interstitial. Abembryonal pole of blastocyst is composed of ectoplacental trophoblast, which encloses an ectoplacental cavity frequently filled with extravasated maternal blood. The decidual cavity increases considerably in size, particularly in an antimemetrial region, where it expands and becomes dumbbell shaped by 10 days postcoitum. Amniotic cavity is formed at 15 days postcoitum, allantois at 25 days, and chorioallantoic placenta at 30 days after mating. In 400- to 700-g females, full-term placenta weighs 9 g with a diameter of 22 mm. Fetal growth rates in domestic Chilean chinchillas are the lowest observed among hystricomorphs, with a specific fetal growth velocity of 0.043 (Roberts and Perry 1974).

Hairs of 105-day-old fetus are single and independent. Transition to adult hair occurs in captivity before 2 months of age. Epidermis of fetus, newborn, and 2-month-old animals resembles that of adult, but stratum granulosum is quite prominent, and stratum corneum is somewhat thinner (Wilcox 1950).

Fetal reabsorption occurs frequently and may take place at any stage of pregnancy. Even in late stages, when skeletal tissue of fetus has formed, reabsortion rather than mummification or spontaneous abortion occurs. Neither placental nor fetal tissue can be recognized in the necrotic mass, but a central blood-filled cavity is usual (Roberts and Perry 1974).

Gestation in captivity is 111 days (range, 105–118 days). Parturition typically occurs early morning, and the placenta usually is eaten (Hillyer et al. 1997). Litter size is 1–6, usually 2 or 3 (mean, 1.75; $n = 273$ litters—Neira et al. 1989). Sex ratio at birth (male : female) was 1.19 (Galton 1968) in a Northern Hemisphere colony, and 1.10 in a Southern Hemisphere colony; at weaning in the latter sex ratio was 1.24 (Viñas 1997).

Mean neonatal mass in captivity is 52 g (range, 50–70, $n = 149$—Neira et al. 1989). Mean mass of newborn litter is 83.3 g ($n = 211$); individual mass is inversely related to litter size. Mean number born alive is 1.59 ($n = 273$), with 10.4% mortality at birth. Sometimes, 1 newborn is smaller than others from same litter. All neonates are precocious, fully furred, with erupted teeth, open eyes, and able to walk within an hour after birth. They begin to take solid foods at 1 week of age (Hillyer et al. 1997). Growth rate is 3.6 g/day during the 1st month, decreasing to 1.56 g/day from 2 to 6 months, and to 0.65 from 6 to 12 months (Neira et al. 1989).

Lactation normally lasts 6–8 weeks in captivity (mean = 54 days), and the minimal period of suckling necessary for survival is 25 days. Mean litter size at weaning is 1.31 ($n = 273$), and mean mass of litter at weaning is 342.9 g ($n = 193$). Mortality from birth to weaning is 21.3% (Neira et al. 1989).

Sexual maturity in both sexes occurs on average at 8 months, but may occur as early as 5.5 months (Weir 1974). In Southern Hemisphere captives, nonprimiparous females are most likely to become pregnant during summer and spring. Females have a 1st litter at a mean age of 459 days, with an interbirth interval of 214 days; they weigh 605 g at mating, 742 g at parturition, and 648 g postpartum (Neira et al. 1989).

Maximum recorded life span in the wild is 6 years (Jiménez 1990a). A few captives have lived >20, and some have bred at 15 years. Mean lifespan in zoos is 4 years (maximum = 7—Eisenberg 1981).

ECOLOGY. The natural habitat of Chilean chinchilla is the barren, arid, and rugged areas of transverse mountain chains in north-central Chile that connect the coastal mountain ranges to Andes with elevations from 400 to 1,650 m. Many intermittent streams occur. Channels are dry most of year, although some areas experience year-round flows. Average annual rainfall from 1974 through 1998 in that region was 165.4 mm ± 122.6 *SD* (Deane 1999). Maximum rainfall usually occurs May–August during austral winter (Waylen and Caviedes 1990). A prolonged dry season occurs October–April. Precipitation varies from 15.8 to 513.4 mm/year.

Typical habitat is rocky or sandy with a sparse cover of thorn shrubs, few herbs and forbs, scattered cacti, and patches of succulent bromeliads toward the coast. These plant communities are a mixture of species typical of xeric northern desert and mesic southern mediterranean zones (Sarmiento 1975). Chilean chinchillas

shelter in crevices, holes among or below rocks, or within large agavelike bromeliads (*Puya berteroniana*—Jiménez 1990a).

Chinchilla laniger is social. Colonies of ca. 100 individuals are usual (Albert 1900). Colonies are 1.5–113.5 ha in size, usually on equatorial slopes (Jiménez 1995). Two colonies had 450–500 individuals in 1990 (Jiménez 1990a). Isolated colonies form a metapopulation, with frequent local extinctions and colonizations of suitable habitat patches. Population density is 4.37 individuals/ha. Population size does not fluctuate between years of low and high rainfall (Jiménez et al. 1992). Predators include culpeo foxes (*Pseudalopex culpaeus*), which take both adults and juveniles, and Magellan-horned owls (*Bubo magellanicus*), which prey mainly on juveniles (Jiménez 1993).

Wild Chilean chinchilla feed on up to 24 plant species, mainly herbs and grasses. Diet changes between sites both seasonally (Serra 1979) and across years. They consume succulents in summer (Cortés et al. 2002). The primary native plant chosen in cafeteria tests during autumn and spring was *Nasella chilensis* (coironcillo—Pizarro 1988), which is also most frequent item in feces collected in wild (Cortés et al. 2002). Grass pasto rey (*Stipa plumosa*) is 2nd preference of *C. laniger* in same season. Chilean chinchillas choose plants with more fiber and less lignin content (Pizarro 1988). They appear to drink no water in the wild.

Among diseases, only Chagas disease, caused by spirochete *Trypanosoma cruzi* and transmitted by endemic hemipteran *Triatoma spinolai*, has been reported in wild Chilean chinchilla. At Aucó, percentages of infection were 20% of 35 individuals (Duran et al. 1989) and 40% of 20 animals (Jiménez and Lorca 1990). From 1939 to 1987, 29.4% of 53 animals were infected with *Trypanosoma* (Apt and Reyes 1990).

Bacterial flora is abundant in wild individuals. Most species found in digestive (53 individuals), respiratory (18 individuals), and male genital (33 individuals) systems are same as in domestic populations (Miller and Finegold 1967). Most common is *Listeria grayi*, a nonpathogenic bacteria (Mathieu 1980).

Small mammals that coexist with Chilean chinchillas in arid lands of north central Chile are a marsupial (*Thylamys elegans*), murid rodents (*Akodon olivaceus*, *A. longipilis*, and *Phyllotis darwini*), and hystricomorph rodents (*Abrocoma bennetti* and *Octodon degus*—Osgood 1943).

Chilean chinchillas are not trapped easily. The best trap for live capture is made of wire mesh (Jiménez 1987) and baited with rolled oats (Jiménez 1989). Pre-Columbian Amerindian hunted *C. laniger* for their wool, meat, and pelt (Molina 1782). The pelts reached high prices at international markets in the 19th century, and modern trappers harvested them almost to extinction (Jiménez 1994).

Domestication of *C. laniger* was initially for pelts, but now Chilean chinchillas are also raised as clean, odorless, and friendly pets (Webb 1991), and as laboratory animals. They are used for studies on hearing and behavior; they are easily trained, and they have a highly evolved middle ear (Vrettakos et al. 1988). Their middle ear and cochlea (Robles and Ruggero 2001) have easy access for recording electrodes. They are less subject to ear infections than laboratory rats, and their audibility curve is more like that of humans than common laboratory species (Heffner and Heffner 1991).

ANIMAL HUSBANDRY. *Chinchilla laniger* has been domesticated several times, but most if not all present captive colonies derive from 12 wild Chilean chinchillas captured around Potrerillos and taken to California by U.S. engineer Matthew Chapman in 1923 (Parker 1975). Some breeders refer to these domestic individuals as hybrids but this does not necessarily imply that they are true interspecific hybrids.

Chilean chinchillas are territorial and acrobatic animals. They need to be housed either as family units or individually in large spaces. Because they are nocturnal, cages should be placed in a draft-free area that permits daytime sleeping.

Individuals should be kept in cages no smaller than 0.0251 m³ in volume (0.35 m wide, 0.40–0.50 m long, and 0.30 m high). In breeding systems used in the pelt industry, with 1 male having access to various collared females maintained in separate cages, minimum cage size for reproductive females is 0.036 m³. For small colonies, cages no smaller than 1 m in length and 0.5 m high and wide should contain shelves, which allow for ample exercise. Tubes, 10–13 cm in diameter, hanging from top of cage, add locomotive

opportunities, and places to hide (Hillyer et al. 1997). Front, back, and top of cages should be wire mesh that allows fresh air to pass freely; suggested air change in large colonies are 8 volumes/h in winter and 15 volumes/h in summer (G. Lara, in litt.).

Temperatures in housing areas should be between 17 and 25°C (Grau 1986). Chilean chinchillas are prone to heat stroke, and should never be exposed to temperature above 30°C (Hillyer et al. 1997). Length and density of hair increases when maintained at 5–12°C (G. Lara, in litt.), and with a relative humidity under 50% (Webb 1991).

Commercial pellets for Chilean chinchillas are ideal food when available; accepted formula is 10–20% protein, 2–5% fat, and 15–35% bulk fiber (Webb 1991). Ca. 30 g of pellets should be given daily, along with a handful of dried timothy hay, which is preferred in the United States over higher protein content of alfalfa; the latter is preferred in South America. Dried apples, figs, grains, hazelnuts, raisins, and sunflower seeds should be limited to not >1 large spoon a day. Changes in diet should be gradual because abrupt dietary change can cause serious illnesses (Hillyer et al. 1997).

Individuals consume ca. 25–50 ml of water daily. Water bottles should be hung outside of cage, and they should be hard if made of plastic, with protection to prevent punctures. A metal wheel should be hung inside cage.

Because incisors are constantly growing, a piece of wood (not cedar) allows gnawing that results in trimming teeth. A clinical sign of malocclusion is excessive drooling with wet fur around chin, chest, and forepaws; roots of molars also begin to extend into orbit, causing lachrymation (Webb 1991).

Dust baths to remove moisture and oils from fur should be available daily, or at least several times per week. Sanitized chinchilla dust is available commercially; beach or playground sand is not suitable. Dust is placed at a depth of 2–3 cm in a pan that is large enough for the animal to roll around; dust should be kept clean and free of feces (Hillyer et al. 1997). Pets should be allowed to play nightly in an area that allows for jumping and running.

Although Chilean chinchillas are shy, handling is not difficult, particularly if they are habituated from early age. They may be held at shoulders, but grasping fur or rough handling will result in shedding fur patches. They also may be picked up by the base of tail; body is then supported by other hand (Webb 1991). Biting is rare, except in extreme distress.

A good indication of an animal's health is the state of its feces (Kluhner 1987). Firm, dark feces are ca. 1 cm in length. Wild individuals produce ca. 223 fecal pellets daily (Jiménez 1990a); domestic animals produce a mean of 209 pellets ($n = 8$—G. Lara, in litt). Chilean chinchillas practice coprophagy or reconsumption of fecal pellets; this aids in maintenance of microorganisms in digestive system. Thus, oral penicillin should not be administered.

Main reasons for culling in domestic colonies are infertility (44%), age (24%), illness (20%), and fights (12%—Neira et al. 1989). For 2 breeding colonies in Chile, general rate of natality is 69 per 100 chinchillas, and general fecundity rates are 3.06 newborns for every male and 1.73 for every female. Specific fecundity per age is highest at 1–6 years in females and 1–6.5 in males; then, fecundity decreases progressively. During reproductive life, a female produces a mean of 20.8 live newborns, and a male sires 51.1 (Viñas 1997).

Information on care and pathology (Bickel 1987), and on veterinary practices (Hillyer et al. 1997; Webb 1991) are available. Guidelines for adequate and humane animal husbandry of Chilean chinchillas, including a specific questionnaire for evaluation are available from Council of the Chinchilla Industry (1992), an organization that includes representatives from the pelt industry.

BEHAVIOR. Chilean chinchillas are quiet, shy, but active animals. They ricochet on their long hind legs across rocks in their usual habitat with remarkable agility. Animals are generally philopatric, remaining in a small area for as many as 6 years. They use conspicuous rocks for resting and observing their range. Chilean chinchillas urinate and defecate on rocks, forming latrines that advertise their presence (Jiménez 1990b). Domestic animals defecate between 0300 and 0600 h, and consume cecotropes between 0800 and 1400 h (Holtenius and Bjornhag 1985). When eating, Chilean chinchillas sit erect and hold food in their forepaws.

Infants often lie on their backs during suckling (Weir 1970). Fathers are tolerant and fairly friendly, sitting with mother and

young in a protective manner (Kleiman 1974). Mothers usually feed their young with small pieces of food (Albert 1900). Juveniles display frisky-hop playing, which includes vertical leaps, body twisting, head tossing, racing and pivoting, and prancing with kicking back of hind feet (Kleiman 1974).

When stressed, captive Chilean chinchillas shed fur. Females are very aggressive toward each other and toward males, even when in estrus. Threats are expressed by growling, chattering teeth, or urinating (only in captive, unreported in wild). Females are less aggressive at postpartum estrus than at other times (Healey and Weir 1970). Courtship rituals include mutual grooming and bipedal approach by males (Kleiman 1974). Copulatory patterns consist of multiple intromissions (median = 5) of 5 s each, and multiple ejaculations (range, 1 or 2), with ejaculatory intromissions lasting 8–10 s each. Thrusting occurs during intromission. Females remain receptive for several hours (Bignami and Beach 1968).

Individuals produce various sounds. When frightened or seized, an "eek-eek" is produced. Isolated males may produce a "nyak-nyak" call (Eisenberg 1974).

Small burrows are built by Chilean chinchillas under or among rocks. Below the entrance, a straight corridor runs and turns, opening into a wider room, which serves as a dormitory, and probably as a nest when covered by dried hay or soft materials. Astringent sheaths and sweet seeds of algarrobilla (*Balsamocarpon brevifolium*) may be stored (Albert 1900). Sometimes, watery fruits of cacti also are stored within burrows (Opazo 1911).

Chilean chinchillas clean their fine fur by sand or soil bathing (Stern and Merari 1969). In wild, they repeatedly bathe in the same place, thus leaving a barren circle of fine dust ca. 40 cm in diameter, near the entrance of their burrows.

GENETICS. All chromosomes of Chilean chinchilla are biarmed with $2n = 64$ (Hsu and Benirschke 1967) and $FN = 128$ (Makino 1953; Nes 1963). The metacentric X chromosome is the largest of complement at a 9% of the haploid autosome set (Galton et al. 1965); it is of a duplicated type (Ohno et al. 1964), with a large late replication region on its short arm (Galton et al. 1965) that corresponds to a large C-band in position and size. In addition to the duplicate X chromosome is a very small Y chromosome, which was misidentified as a large chromosome (Makino 1953). Association of X and Y chromosomes is always end-to-end in meiosis, denoting absence of complete synapsis. XX bivalents in females have 4 chiasmata (Galton et al. 1965). Nucleolar organizing region is on the secondary constriction of the long arm of a single submetacentric chromosome pair (George and Weir 1974). A single nucleolus occurs in the subcentral nuclear space of spermatocytes (Berríos et al. 2004).

Cytochrome-*b* gene sequences from mitochondrial DNA of wild and domestic *C. laniger* share 3 character states not present in other chinchillid species: a C base at site 11 (2nd codon position), a G at site 93, and a T at site 150. The 2 chinchilla species differ at 22 sites, among which 3 are 1st or 2nd codon positions, with Kimura 2-parameter genetic distances near 6% (Spotorno et al. 2004; Valladares 2002). All wild *C. laniger* have a characteristic A base at site 366 (Spotorno et al. 2004). Wild samples from Aucó have 4 characteristic bases at sites 47, 198, 234, and 495. A single specimen from La Higuera had 5 autoapomorph mutations at sites 147, 264, 265, 266, and 429. Five domestic *C. laniger* had 2 characteristic nucleotides: a T base at site 33, and A at site 85 (2nd codon position) and shared with the single wild specimen from La Higuera, Coquimbo, a unique silent G base at site 63, concordant with documented historical origin of present domestic *C. laniger* (Parker 1975). No traces of *C. brevicaudata* variants, wild or domestic, were found in any of 5 domestic *C. laniger* (Spotorno et al. 2004). Microsatellite DNA markers have been amplified from feces (Walker et al. 2000). Many mutations resulting in different pelage colors have been described in domestic colonies (Grau 1986).

Hybrids obtained from crosses with *C. brevicaudata* are intermediate in gestation length. Hybrid males are infertile. Hybrid females are fertile, but when backcrossed ca. two-thirds of the 2nd-generation hybrids are sterile (Grau 1986).

CONSERVATION STATUS. The Chilean chinchilla is endangered (Glade 1988; Thornback and Jenkins, 1982), with the 2nd highest conservation priority among Chilean mammals (Cofré and Marquet 1999). Wild populations are listed in CITES Appendix 1 (CITES 1991). As a result of overharvesting for its fur (Iriarte and Jaksic 1986), the entire species was almost extirpated during early 1900s (Jiménez 1994). Despite protection provided by an agreement signed between governments of Argentina, Bolivia, Chile, and Perú (Grau 1986), and under Chilean law since 1929 (Lagos and Valverde 1998), poaching continued. By 1950s, the Chilean chinchilla was considered extinct (Mann 1978). Wild populations were rediscovered in 1978, and in 1983 Reserva Nacional Las Chinchillas was created (Lagos and Valverde 1998). This reserve comprises 4,227 ha, of which 556 ha had colonies before 1983, but only 264 ha had colonies in 1989 (Jiménez 1990b). The former distribution has been reduced primarily to only 2 areas. Only 19 of 42 known colonies in Reserva Nacional Las Chinchillas currently are protected (Jiménez 1996). The total wild population is estimated as 2,500–11,700 individuals and is declining, as indicated by reduction in area covered by present colonies and their fragmentation (Jiménez 1993). Although protected inside the reserve from human activities since 1987, population size continues to decline (Jiménez 1996). A conservation plan has been in place since 1990 (Lagos and Valverde 1998), but no particular conservation action is being taken for the small genetically rich northern population of La Higuera.

REMARKS. Molina (1782:301) described "La Chinchilla, *Mus laniger* (I. Mus cauda mediocri, palmis tetradactylis, plantis pentadactilis, corpore cinereo lanato.) è unaltra sorta di sorcio campestre stimabili assai per la finissima lana, di cui è coperto in vece di pelo, la quale è tanto morbida, quanto la seta, che producono i ragni dei giardini: essa è di color cenerino, e assi lunga per potersi filari.". Bennett (1829) proposed the new generic name *Chinchilla* for such Molina's *Mus laniger*; he also emended *laniger* to feminine *lanigera*, assuming that *laniger* was an adjective. Subsequent authors have followed this action (Woods 1993), unaware that *laniger* is perfectly acceptable as a noun in apposition; others have retained original spelling (i.e., Gray 1830). Prell (1934) formally rejected Molina's description as ambiguous, unidentifiable, and even applicable to animals of genus *Abrocoma* undescribed in Molina's time. However, Molina (1782) described the tail as dressed with soft hair ("vestita di morbido pelo"), in contrast with the tail of *Abrocoma*, which has only very short hairs <1 mm long and looks naked. Also, Molina (1782) reported the color as "cenerino", which usually refers to a brilliant gray that is almost cold silver in appearance, unlike color of *Abrocoma bennetti* from central Chile, which is ashy gray mixed with warm brown (Spotorno et al. 1998). Molina (1782) noted that *Mus laniger* does not have a bad odor, whereas wild *Abrocoma* has a strong organic odor of plant oil. Prell's (1934) rejection of *laniger* led him to propose new specific name *velligera*, an action followed by Osgood (1941) 1st in conditional terms, and in formal terms (Osgood 1943). Prell's opinions were analyzed and found to be without serious basis (Cabrera 1960). The International Commission on Zoological Nomenclature has been requested to incorporate *C. laniger* to the official list of scientific names (Valladares and Spotorno 2003).

The common name, chinchilla, may derive from Quechua words *chin* meaning silent, *sinchi* meaning strong or courageous (Grau 1986), and a diminutive Quechua *lla*. Together, *chinchilla* would mean the strong, silent little (Aleandri 1998). The name *laniger* is from Latin, meaning woolly. The common name Chilean chinchilla was used by Osgood in 1941, and also in the 1st modern revision of Chilean mammals (Osgood 1943) for this Chilean endemic and most probable autochtonous species. Cabrera (1960:195) stated "Durante siglo y medio, *Mus laniger* Molina, 1782, fue universalmente identificado como la chinchilla chilena (o "costina", si se prefiere el calificativo adoptado en peletería) . . .)." [During a century and a half, *Mus laniger* Molina, 1782, was universally identified as the Chilean chinchilla (or "coastal", if the qualification adopted in the pelt industry is preferred . . .).] Other common names for this species are chinchilla, chinchilla chilena, coastal chinchilla, chinchilla costina, chinchilla velligera, chinchilla cola larga, long-tailed chinchilla, chinchilla chica, and small chinchilla.

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