

Spalacopus cyanus.

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Spalacopus Wagler, 1832

Spalacopus Wagler, 1832:1219. Type species *S. poeppigii* Wagler, 1832.

Poephagomys Cuvier, 1834:323. Type species *P. ater* Cuvier, 1834.

Psammorectes Poepig, 1835b:252. Type species *P. noctivagus* Poepig, 1835b.

CONTEXT AND CONTENT. Order Rodentia, Superfamily Octodontoidea, Family Octodontidae. *Spalacopus* includes one species, *Spalacopus cyanus* (Woods, 1993).

Spalacopus cyanus (Molina, 1782)

Cururo

Mus cyanus Molina, 1782:300. Type locality "Valparaíso," Chile by subsequent selection (Osgood, 1943:114).

Spalacopus poeppigii Wagler, 1832:1219. Type locality "foot of the Andes" in central Chile (erroneously fixed at coastal Quintero by Thomas, 1925).

Poephagomys ater Cuvier, 1834:323. Type locality "Coquimbo," Chile.

Psammorectes noctivagus Poepig, 1835a:166. Type locality "sand dunes near Concón," Valparaíso, Chile (not from coast of northern Chile as in Osgood (1943:114)).

Spalacopus tabanus Thomas, 1925:585. Type locality unknown, but in southern Chile.

Spalacopus cyanus Osgood, 1943:114. First use of current name combination and spelling.

CONTEXT AND CONTENT. Three subspecies currently are recognized (Tamayo and Frassinetti, 1980; Contreras et al., 1987).

S. c. cyanus (Molina, 1782), see above (*ater* Cuvier and *noctivagus* Poepig are synonyms).

S. c. poeppigii Wagler, 1832, see above (*tabanus* Thomas is a synonym).

S. c. maulinus Osgood, 1943:115. Type locality Quirihue, Ñuble, Chile.

DIAGNOSIS. *Spalacopus cyanus* is a burrowing rodent of moderate size, with a mass of <140 g, a short tail (41 mm), short ears (10 mm), and black in color (Fig. 1). Of all octodontids species,



FIG. 1. Male *Spalacopus cyanus* from Lagunillas, Andes of central Chile.

only *Aconaemys* is moderate sized with a short tail, but it is brownish and has larger ears. Chilean species of the fossorial genus *Ctenomys* (Ctenomyidae) are larger than 140 g and are brown in color. Upper incisors of *Spalacopus* are long and protrude forward; all other octodontids have orthodont or opisthodont incisors. Grinding teeth are quadrate with a single deep indentation on lingual and labial sides, separated in the middle by a slight space; in *Aconaemys* indentations meet in the middle.

GENERAL CHARACTERS. Adults range in mass from 80 to 120 g; those from low altitudes are smaller and show more sexual dimorphism than do those from high Andean localities (Contreras, 1986). Mean measurements (in mm, ranges in parenthesis) for males and females respectively, for *S. c. cyanus* ($n = 74$ and 72) are as follows: total length, 176 (155-205), 170 (142-204); length of tail, 41 (31-50), 39 (28-49); length of hindfoot, 28 (21-33), 28 (23-31); length of ear, 10 (8-12), 10 (8-12); mass (in g), 81 (53-105), 73 (43-119). The same measurements for *S. c. poeppigii* ($n = 30$ and 29) are as follows: total length, 188 (162-224), 190 (160-225); length of tail, 47 (39-55), 48 (39-57); length of hindfoot, 30 (27-34), 30 (24-37); length of ear, 11 (10-12), 11 (8-12); mass, 105 (68-151), 97 (60-163). Body measurements for *S. c. maulinus* ($n = 10$ and 10) are the following: total length, 172 (140-195), 167 (160-176); length of tail, 39 (30-43), 38 (35-43); length of hindfoot, 28 (26-34), 26 (25-28); length of ear, 10 (9-11), 11 (9-12); mass, 87 (64-130), 84 (71-102). The pelage is black, dense, and short (12 mm). Some specimens have white patches, especially in the ventral region. The eyes are small, usually 5.5 mm in diameter. The forefeet are strong, with long claws. The dental formula is $i\ 1/1, c\ 0/0, p\ 1/1, m\ 3/3$, total 20. The incisors are long and very procumbent with a Thomas angle (a measure of the degree of procumbency of upper incisors—Thomas, 1919) of 117° , similar to the 120° of *Heterocephalus* (Reig and Quintana, 1992). The alveoli of the upper incisors are large, extending to the second M1, a condition typical of tooth-diggers (Lessa and Thaler, 1989). As extensions of upper and lower lips are almost fused behind the I1, the mouth can be closed while digging with the teeth. The molariform teeth grow continuously and exhibit single indentations in the lingual and labial surfaces that produce a figure-eight shape typical of most octodontids (Fig. 2—Mann, 1978; Osgood, 1943).

DISTRIBUTION. The cururo occurs in Chile, in coastal regions from Caldera ($27^\circ 03'S$) to Quirihue ($36^\circ 17'S$), in the Andes up to 3,500 m, from Alicahue ($32^\circ 19'S$) to Los Cipreses ($34^\circ 01'S$), and at scattered localities on the slopes of the intervening Intermediate Depression (Fig. 3—Contreras et al., 1987). *S. c. maulinus* is found in Cauquenes and Quirihue, Ñuble Province (the two most southern localities in Fig. 3). *S. c. cyanus* occurs in central Chile, from Caldera ($27^\circ S$) to Curicó ($35^\circ S$), and from sea level to 1,000 m altitude; and *S. c. poeppigii* occurs in the Andes of central Chile, at elevations of 1,500-3,400 m above sea level. There are gaps in the known geographic distribution of *Spalacopus cyanus*, especially between 34° and $36^\circ S$, probably because of the lack of sampling effort rather than absence of the species.

FOSSIL RECORD. There is no fossil record of *Spalacopus*. Reig (1970) referred fossils of the fossorial octodontoids *Eucelophorus*, *Actenomys*, and *Xenodontomys* from Argentina to *Ctenomys* (Ctenomyidae, sensu Woods, 1982), rejecting a close relationship with *S. cyanus*. Reig (1970) suggested *S. cyanus* originated prior to (and independent of) *Ctenomys*. Contreras et al. (1987) suggested *Spalacopus* speciated in situ during the Pleistocene. The only subfossil record consists of Late Pleistocene remains found in archaeological excavations in Tagua-Tagua, Region VI (R. Feito, in litt.).

FORM AND FUNCTION. Fossorial adaptations of *S. cyanus*

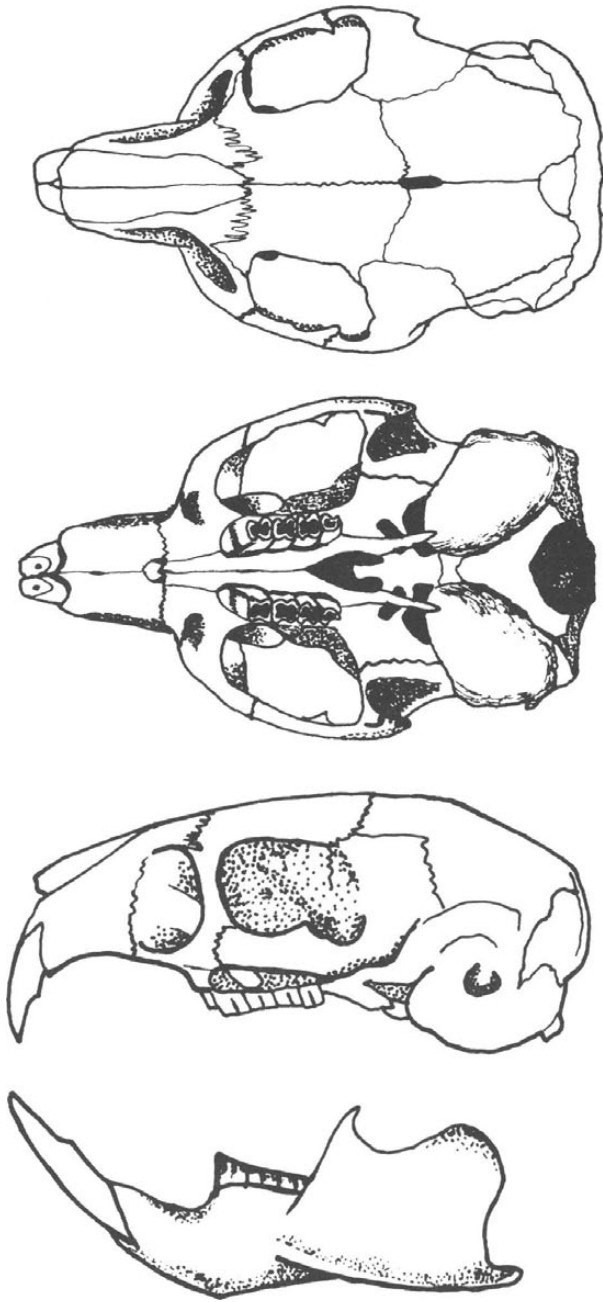


FIG. 2. Dorsal, ventral and lateral views of the skull and lateral view of mandible of *Spalacopus cyanus* from Perales, Vallenar, Chile (female, J. C. Torres-Mura number 601). Greatest length of cranium is 35.0 mm. Illustration by Marina Lemus.

are evident from its small thickset body, short tail, short ears, small dorsally situated eyes, short limbs, wide feet, and long claws. These features yield a Fossorial Index of 5.1, similar to that of *Ctenomys haigi* (Pearson, 1984). The skull is robust, short, wide, and flat, with highly procumbent upper incisors (Fig. 2). The nasal region is short. In contrast to *Ctenomys*, the auditory bullae of *Spalacopus* are small. The angular process of the mandible is large, as are the masseter muscles. As in *Octodon* and *Aconaemys*, the incus and malleus are not fused (Wood and Patterson, 1959). The tibia and fibula are fused proximally (Landry, 1957). A well-developed delto-crest of the humerus permits powerful movements of the forelimbs. The clavicle is wide distally and narrow and thin proximally. The femur has an enlarged third trochanter, as in *Octodon degus* (Mann, 1940). Lateral views of skull, mandible, and pelvis, and anterior and lateral views of humerus, femur, and tibia of *S. cyanus* are depicted in Reig and Quintana (1992) as part of a comparison with fossil ctenomyine *Euclaphorus*.

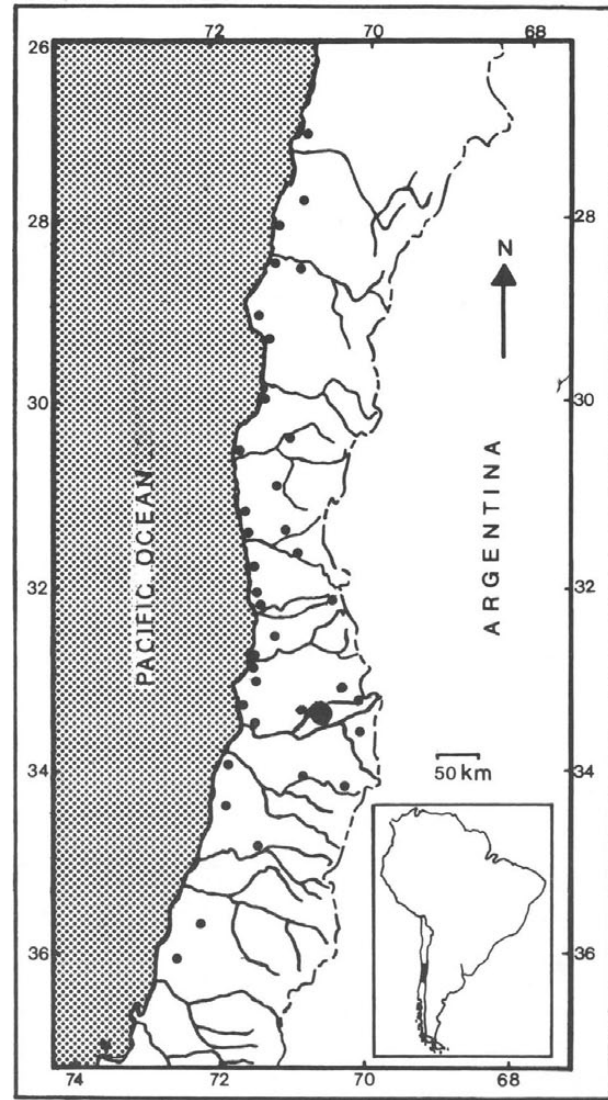


FIG. 3. Map of Central Chile showing the geographic distribution of *Spalacopus cyanus*. Large symbol indicates the position of Santiago, Chile (33°27'S, 70°38'W, 600 m). The two southernmost localities belong to *S. c. maulinus*. The five localities along the Andes and close to the Argentinian border belong to *S. c. poeppigii*. Other localities are for *S. c. cyanus*.

The stomach of *Spalacopus cyanus* is simple, with a large fundulus and a small and simple cecum. The simplicity of the digestive system reflects a diet low in cellulose and easily digested (Mann, 1940). The seminal vesicles are large and the testes are abdominal throughout the year. At the bottom of the intromittent sac of the glans penis there is a variable number of horny spicules that are smaller than in other octodontids (Contreras et al., 1993; Spotorno, 1979). The uterus is bicornate. Females have two pairs of abdominal and one pair of inguinal nipples (Mann, 1944, 1978).

Cururos are good thermoregulators between 2° and 30°C and maintain a body temperature of 36.5°C. Animals from the coast have a basal metabolic rate of 0.745 ml O₂ g⁻¹h⁻¹, whereas those from the Andes have a rate of 0.956 ml ml O₂ g⁻¹h⁻¹ (Contreras, 1986). These values are 85% and 74% lower, respectively, than expected based on body mass. Minimal thermal conductance is the same for individuals from both populations, representing ca. 85% of that expected based on mass. These values are in agreement with typical bioenergetic patterns of subterranean mammals (Contreras and McNab, 1990).

Kidneys of *S. c. cyanus* from the coast in north central Chile have a relative medullar thickness value of 4.9, and a percentage medullar thickness of 63.9%. These values are significantly lower than those from the Andes (*S. c. poeppigii*), with 6.0 and 68.4

respectively—reflecting a longer renal papilla in *S. c. poeppigii* (Cortés, 1985).

ONTOGENY AND REPRODUCTION. Gay (1847) and Molina (1782) stated that *Spalacopus cyanus* reproduces twice a year, with litters of up to six individuals. Examination of 75 animals, however, indicates an average litter size of 2.2 (range, 1–3—Lagos et al., 1989). According to Housse (1953), neonates are black and naked and open their eyes 10–12 days after birth. Our observations of two captive litters revealed they are haired and open their eyes at birth. Unda et al. (1980) found corpora lutea and germinative lines in all months sampled. They proposed the existence of a reproductive period from June to March in coastal populations and a shorter period in Andean populations. A male to female ratio of 1:0.88 was found for 224 specimens captured in various localities over the past 10 years (Lagos et al., 1989).

ECOLOGY. Habitats occupied by *S. cyanus* range from alpine grasslands in the Andes to acacia savanna in the Intermediate Depression and stabilized sand dunes and sandy grasslands on the coast. Shrub cover is <60%, with an herb stratum that contains geophytes and hemicryptophytes (Contreras et al., 1987).

Cururos maintain and expand an extensive system of tunnels ranging from 5 to 7 cm in diameter. The majority of these tunnels lie 10–12 cm below the surface and are used for feeding. These tunnels have numerous lateral tunnels opening to the surface. They are used for depositing soil on the surface, thereby forming conspicuous heaps, and also for feeding on vegetation around tunnel openings. Feeding tunnels undergo continuous modification. A second type of tunnel is found 40–60 cm below ground surface. These are shorter than feeding tunnels but are used for longer periods. Within these deep tunnels usually there is a nest chamber and a bolt hole (Reig, 1970; Torres-Mura, 1990). Nests are 20 cm in diameter, lined with grasses, and kept free of feces; however, they often also serve as homes for staphilinid coleopterans and isopods (Torres-Mura, 1990). Harvesting of geophytes through tunneling appears to be the primary mode of foraging throughout the year, as suggested by the volume of soil deposited in surface heaps. In arid mediterranean habitats of Chile, the monthly rate of mound production by one colony was variable, with an average of 64 ± 23 (mean \pm SD) heaps/month (range, 9–110). However, the volume of soil deposited on the surface was less variable and unrelated to precipitation. The cumulative volume of soil deposited on the surface was equal to 2.5 m³/year and the total soil mass equal to 3.22 metric tons/year, at a bulk density of 1.31 g/cm for mined soil. The surface area directly covered by heaps was 92.4 m²/year. At a density of 3 colonies/ha, this would equal about 10 tons/ha (Contreras et al., 1993).

Reig (1970) stated that this species is nocturnal, but Ipinza et al. (1971) considered it to be diurnal. Surface soil deposition and captures in traps only occur during the daytime, although continuous measurements of metabolic rate indicate no circadian or photoperiodic rhythm, a pattern typical of other subterranean mammals (Contreras, 1986).

According to Ipinza et al. (1971), the cururo is strictly herbivorous, feeding on tubers of iridaceas (e.g., *Libertia*, *Sisyrinchium*, *Alophia*). However, Reig (1970) reported that the cururo on the coastal dunes feeds exclusively on huilli (*Leucocoryne ixiooides*), consuming the stalk and underground tubers. Bulbs of *Rodophiala* were found in recent excavations of seven gallery systems in coastal dunes (Torres-Mura, 1990). Feeding usually takes place underground, with occasional feeding on aerial herbs around open tunnels at distances no greater than the animal's body length. Unlike some *Ctenomys*, they do not venture away from the entrance of their tunnels (Pearson et al., 1968). Many authors (Gay, 1847; Gigoux, 1945; Housse, 1953; Ipinza et al., 1971; Mann, 1944, 1978; Molina, 1782; Reed, 1892) state that this species stores geophytes underground and uses them as food reserves, especially in regions where the ground is covered by snow during winter. However, no substantiating data were included in any of these reports.

Predators of the cururo include snakes, buzzards (*Buteo*), Harris' hawks (*Parabuteo unicinctus*), American kestrels (*Falco sparverius*), great horned owls (*Bubo virginianus*), gray foxes (*Pseudalopex griseus*), grisons (*Galictis cuja*), and pampas cats (*Oncifelis colocolo*—Housse, 1953; Mann, 1978). Quantitative analysis of food habits for 10 common species of predators in central Chile indicated low predation pressure on the cururo (Jaksic et al., 1981).

The nematode *Graphidioides yanesi* specifically parasitizes the intestines of *Spalacopus* (Babero and Cattán, 1980). Similarly, the flea *Ectinorus cocyi* (Siphonaptera) is a specific parasite of *S. cyanus*, whereas other species of *Ectinorus* parasitize *Octodon degus* and other rodents (J. C. Beaucourou, in litt.).

Cururos cause damage in agricultural areas by burrowing and by consuming potatoes and other crops. The tunnels of this species are dangerous to horses and cattle, which may fall and break their legs when stepping into them (Housse 1953; Miller and Rottmann, 1976). Burrowing activities by *S. cyanus* have great impact on the biomass of herbaceous vegetation in coastal habitats. In areas with burrows, biomass was 60% higher than in areas without burrows, due mainly to a large increase of early successional herbs (Contreras and Gutiérrez, 1991). The biomass of geophytes which are eaten by *S. cyanus* does not differ between areas with or without burrows. However, in areas with burrows, geophytes are more numerous and smaller. Burrowing activities possibly facilitate the presence of new small bulbs by promoting seed germination. Species composition and diversity of herbs do not differ between areas with and without burrows (Contreras and Gutiérrez, 1991). Digging activities, as indicated by the rate of mound production, in coastal habitats are greater in the rainy season (austral winter) than during the summer dry season (Torres-Mura, 1990).

Home ranges of individual cururos are similar to the home range of the whole colony and have a mean of 40.3 m² (range, 24.3–61.8) based on the minimal convex polygon method. Home-range dimensions were determined by radioactive tagging and tunnel system excavation. These values are similar to those of other subterranean rodents with similar body size, such as *Thomomys bottae* and *Tachyoryctes splendens* (Torres-Mura, 1990).

BEHAVIOR. *Spalacopus cyanus* lives in colonies of as many as 15 individuals, consisting of a family group of one to several pairs and their young (Housse, 1953; Ipinza et al., 1971). Tactile communication in the form of nose-to-nose contact often is used in social interactions. This contact is followed by exploratory behavior including smelling the perineum, haunch, and neck (Kleiman, 1974). Urine possibly is used in intraspecific communication such as marking a territory (Torres-Mura, 1990). *S. cyanus* is one of the few caviomorphs that uses a specialized posture to urinate, raising a leg while urinating on vertical surfaces (Kleiman, 1974).

The most characteristic call of *S. cyanus* is a musical song with descending frequencies and duration of 300–8,000 msec, with audible frequencies of 0.9–1.2 kHz (Eisenberg, 1974). This vocalization is used as a warning call for colony members, and can be heard easily when their activities are disturbed in the field or laboratory. Tooth chattering frequently is produced by dominant individuals when an unfamiliar animal is introduced into an experimental arena (Torres-Mura, 1990). Colonies of *S. cyanus* exhibit a regular pattern of spatial distribution. This pattern, together with a high level of intercolonial aggressiveness, was interpreted as evidence of territorial behavior (Torres-Mura, 1990).

Cururos can swim short distances with no difficulty, using strong movements of hind and forelegs and with nose, eyes, and ears always above of water (Hickman, 1988; Reise and Gallardo, 1989a). Behavior upon encountering water differs between northern and southern populations. Water seems to be a strange element for northern cururos, but southern cururos have no difficulties entering water (Reise and Gallardo, 1989a).

GENETICS. The diploid (2n = 58) and fundamental numbers (FN = 116) are the same in five different populations of *S. cyanus* from the coast and the Andes (Reig et al., 1972). The diploid and fundamental numbers are the same as those of *Octodon degus* and *O. bridgesi* (Contreras et al., 1990, 1994). Further, the C- and G-banded karyotypes of coastal and mountain populations of *S. cyanus* are similar in most respects. *S. cyanus* differs from *O. degus* in exhibiting paracentromeric C-bands in the X chromosome and by the absence of an extra heterochromatic zone on pair 1 (Gallardo 1992; Zulch et al., 1982). Lack of species diversity in the genus *Spalacopus* has been attributed to enhanced gene flow among colonies as a result of searching for bulbs of geophytes (Reig, 1970; Reig et al., 1972). However, studies of home ranges by radioactive tagging indicate these colonies are relatively stable (Torres-Mura, 1990). Also, restricted swimming abilities of some populations may be a factor that hampers migration (Reise and Gallardo, 1989a). Data on karyology (Contreras et al., 1994) and morphology of the

glans penis (Contreras et al., 1993) demonstrate similarities between octodontid taxa inhabiting the southwestern Andes (*Aconaemys*, *Octodon*, *Spalacopus*) and suggest close evolutionary relationships among them, possibly as a result of isolation and radiation on the Chilean side.

CONSERVATION STATUS. In the Red List of Chilean Terrestrial Vertebrates, *S. c. maulinus* was qualified as "Endangered" (CONAF, 1993). Since the description of this subspecies by Osgood (1943), the only reports on its biology are those by Reise and Gallardo (1989a, 1989b).

REMARKS. The generic name *Spalacopus* is derived from the greek *spalax* meaning a mole and the greek *pous* (Jaeger, 1978) meaning a foot, in reference to adaptations of its feet for a fossorial life style. The specific name *cyanus* is derived from the greek *kyaneos* meaning a dark blue, although it refers to the cururo's shiny black pelage (Jaeger, 1978). The subspecies name *poepigii* is a patronymic of German naturalist Eduard Poeppig and *maulinus* to the Maule region, although at present the type locality of this subspecies is in the Ñuble region.

The name cururo seems to have a double meaning. It is an onomatopoeia of the most characteristic vocalization of the species and also is similar to the mapuche or araucarian (mapudungun) word *curi* or *curu*, meaning black. The name *cuyu* also is used in the southern end of its distribution and relates to the word *cuyul*, meaning charcoal. According to Molina (1782), the name *guanque* would apply to cururos, but this may be a mistake or confusion. Guanque is the common name of the bulbs of dioscoreaceas that cururos store in certain regions and that peasants obtain for food by digging out cururo galleries.

The best method to trap cururos alive is by use of thin wire snares placed at the entrance of their burrows. Snares must be checked frequently to avoid injuries. This work was supported by grants FONDECYT Chile 90/376, DIULS 120-3-35, and Dirección de Bibliotecas, Archivos y Museos 92/15.

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