Gerbillurus setzeri. By Edith R. Dempster, Michael R. Perrin, Colleen T. Downs, and Michael Griffin

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Gerbillurus setzeri Schlitter, 1973
Setzer’s Hairy-footed Gerbil

Gerbillurus (Gerbillurus) setzeri Schlitter, 1973:13. Type locality, “one mile east of the Namib Desert Research Station, Goba- beh, Namibia.”

CONTEXT AND CONTENT. Order Rodentia, Family Muridae, Subfamily Gerbillinae, Tribe Taterillini, Subtribe Gerbillurina, Genus Gerbillurus. Subgenus Gerbillurus. G. setzeri is monotypic (Meester et al., 1986); however, a distinctive gray form has been recognized from sites between the Swakop and Kunene rivers (Griffin, 1990). This is probably the form mentioned by Coetze (1969). G. setzeri was described in 1973 (Schlitter, 1973); in previous literature it was referred to as Gerbillurus (or Gerbillurus) vallinus (Coetze, 1969; Lundholm, 1955; Meester, 1963; Roberts, 1951).

DIAGNOSIS. Gerbillurus setzeri is similar in color to G. paeba where they coexist, but G. setzeri is distinguished from G. paeba by its larger size with adult mass ca. 30–40 g (20–30 g in G. paeba). The tail brush of G. setzeri is more pronounced than that of G. paeba (Fig. 1—Griffin, 1990). In areas where G. setzeri and G. paeba coexist, both species have a pale cinnamon coat color (Schlitter, 1973), but G. setzeri has longer and thicker fur than G. paeba (Schlitter et al., 1984).

Gerbillurus setzeri has the largest head and body length (105.7 mm) of all Gerbillurus species (Schlitter, 1973). Its tail is shorter relative to head and body length than either G. tytonius or G. vallinus (20%, 30%, 40%, respectively—Schlitter, 1973). Dorsal pelage of G. setzeri is paler in color than either G. tytonius or G. vallinus (Schlitter, 1973).

Cranially, G. setzeri is distinguished from other Gerbillurus species by having the greatest overall length (31.4 mm) and the greatest development of the bullae (oblique length 11.4 mm—Griffin, 1990; Schlitter, 1973). G. setzeri is further distinguished from G. tytonius by having longer palatal foramina (Schlitter, 1973).

GENERAL CHARACTERS. Setzer’s hairy-footed gerbil is a robust, hairy-footed gerbil with a long and bushy tail. Upper parts of the body are light brown or beige, never brown or red (Griffin, 1990). Areas around the mouth, dorsal surface of the limbs, and underparts are white. White supraorbital and postauricular spots are clearly defined (Skinner and Smithers, 1990). Colors of the upper and underparts are clearly demarcated. A bushy tip or brush is present on the tail, which is often silver gray on the dorsal surface.

Mean and range of external measurements (in mm) for G. setzeri are as follows: total length, 233.0 (217–263, n = 43); length of tail, 127.4 (113–145, n = 43); length of hind foot, 32.5 (30–35, n = 44); length of ear from notch, 13.9 (12–16, n = 43—Schlitter, 1973). Cranial measurements (mean and range) in mm for G. setzeri are: occipito-nasal length, 31.4 (29.5–32.6, n = 23); breadth across zygomatic arches, 16.6 (15.7–17.4, n = 29); greatest breadth of braincase, 14.9 (14.1–16.1, n = 31); least interorbital breadth, 5.6 (3.3–5.9, n = 35); breadth of rostrum, 4.1 (3.6–4.3, n = 33); greatest length of nasals, 12.3 (11.4–13.1, n = 29); breadth of auditory porion, 11.4 (10.6–12.4, n = 35); crown length of maxillary toothrow, 4.3 (4.1–4.6, n = 19); breadth of palate at M3, 5.1 (4.9–5.3, n = 7); length of posterior palatal foramina, 5.5 (5.0–6.1, n = 34); length of posterior palatal foramen, 2.3 (1.8–2.7, n = 36); greatest height of skull 13.2 (12.7–13.8, n = 22); breadth of auditory bulla, 9.0 (8.1–9.7, n = 35—Schlitter, 1973; Fig. 2). Mean body mass is 32.9 g (n = 16—Downs and Perrin, 1990a) and 36.6 g (n = 3 females—de Graaff, 1981).

DISTRIBUTION. Gerbillurus setzeri is endemic to the Namib Desert ranging northwards from the Kuiseb River to southern Angola (Fig. 3). Specimens have been trapped at Gobabeb on the gravel plains north of the Kuiseb River in the Namib Desert (Downs and Perrin, 1989; Schlitter, 1973). G. setzeri has also been trapped south of the Kuiseb River at Chare (M. Griffin, in litt.). Although specimens disperse from the gravel plains across the riverbed into adjacent red sand dunes (Schlitter, 1973), this is most likely a rare event (Boyer, 1987). The southern limit of distribution is the narrow gravel/sand plain corridor between the Gaub and Tsodub rivers (Griffin, 1990). G. setzeri has been recorded from Swartrank Mountain, Tumas Mountain near Swakopmund, at Goanikontes, and at Hope Mine (Schlitter, 1973). The distribution includes the Iona National Park in the northwestern Namib Desert of Angola (Skinner and Smithers, 1990). Distribution records of G. vallinus from central and northern Namibia, Damaraland, Kaokoland, and Angola (Crawford-Cabraal, 1986) almost certainly refer to G. setzeri. No fossils of G. setzeri are known.

FORM AND FUNCTION. Dental formula is i 1/1, c 0/0, p 0/0, m 3/3, total 16. Preferred ambient temperature is ca. 28°C. Thermal parameters are as follows: thermoneutral zone, 32.2°C; predicted lower critical temperature, 28.4°C; basal metabolic rate, 0.893 ml O2 g–1 h–1; minimal conductance, 0.125 ml O2 g–1 h–1 C–1 (Downs and Perrin, 1990b). Above ambient temperatures of 35°C, dry thermal conductance increases sharply, but hyperthermia may occur. G. setzeri salivates, wetting the neck region to aid cooling through evaporation, which is accompanied by peripheral vasodilation and piloerection (Downs and Perrin, 1990b). Exposure to ambient temperatures ≥40°C for periods ≥1 h results in death. Pulmocutaneous water loss is low below ambient temperatures of 35°C, but increases sharply thereafter. The small rate of increase of oxygen consumption and the sharp increase in thermal conductance at temperatures above the thermoneutral zone reflects an avoidance of evaporative water loss that reduces overheating. The relatively large size and thick pelage of G. setzeri (Schlitter et al., 1984) may facilitate thermal conductance (Downs and Perrin, 1990b). The large body size of G. setzeri for the genus Gerbillurus reduces the difference between total water loss and metabolic heat production. Gerbillurus setzeri has a daily energy expenditure slightly lower than predicted (93%) and lower water turnover rate than other species within the genus (Downs and Perrin, 1990b). Water turnover rate varies with protein and water content of the diet (Downs and...
Perrin, 1990c). On millet seed, sunflower seed, and mealworm diets (all diets without drinking water but supplemented with carrot) water turnover rate is 102.2, 113.6, and 200.5 ml kg⁻¹ day⁻¹, respectively. Field water turnover rate of G. setzeri, 76.9 ml kg⁻¹ day⁻¹, is lower than for G. paeba and G. tytonis and lower than rates in the laboratory (Downs and Perrin, 1990a).

Urine production in G. setzeri varies with diet from 0.76 ml/day on a diet of mealworms to 0.06 ml/day on a diet of sunflower seeds (each supplemented with carrots). Fecal water loss is 0.0869 and 0.0026 mg/l of body mass respectively. Mean urine osmolality (osmol/kg) was 2.04, 3.50, and 4.19 on diets of mealworms, sunflower seeds, and millet seeds (supplemented with carrot, no drinking water available), respectively. Mean urea concentration was higher on a diet of mealworms (2.32 mM/ml) than on a diet of sunflower seeds (1.67 mM/ml). Urinary concentrating ability is enhanced by the conversion of urea to allantoin (Downs and Perrin, 1991). G. setzeri has the greatest urine concentrating ability of all Gerbillus species. The high urine concentrating ability is confirmed by renal indices. G. setzeri has greater relative (Sperber, 1944) and percentage (Heisinger and Breitenbach, 1969) renal medullary thicknesses than other Gerbillus species (Downs and Perrin, 1991). The loop of Henle and papilla renal are unusually long, accounting for the remarkable urine concentrating ability (Downs and Perrin, 1991). Low water turnover rate, low fecal water loss, and high urinary concentrating ability enable G. setzeri to survive indefinitely in arid environments without free water (Downs and Perrin, 1990c, 1991).

**ONTOGENY AND REPRODUCTION.** Animals in reproduuctive condition may be present at any season (Griffin, 1990). Copulation was observed in one pair of G. setzeri in the laboratory (Dempster, 1990). G. setzeri exhibits an unusual copulatory pattern of a single ejaculation, lock and deposition of a copulatory plug. The male clapsed the female around the abdomen and lifted the female's abdomen while making pelvic thrusts; several deep thrusts indicated that intromission had occurred. Pelvic thrusting ceased once a lock had occurred. The single intromission led to a single ejaculation. A copulatory plug was visible in the vagina after copulation. The copulation observed resulted in pregnancy.

Gestation in G. setzeri is 21 days. Data on postnatal development and maternal behavior are available for only one litter (Dempster and Perrin, 1991a). The litter size of three was within the range of from one to six recorded for other Gerbillus species (Dempster and Perrin, 1989a). Individual young weighed an average 2.5 g at birth and grew at a rate of 0.7 g/day during the first 23 days of life. Nipple-slinging did not occur (Dempster and Perrin, 1991a). Neonates are altricial, and their eyes open at ca. 18 days of age. Weaning occurs between 23 and 28 days. Ultrasonic calling by young was recorded at frequencies between 45 and 53 kHz.

**ECOLOGY.** Gerbillus setzeri occurs in hot, dry areas where mean annual temperature is >18°C (Downs and Perrin, 1989). Burrows create a microenvironment that is buffered from extremes of temperature while humidity is elevated. Burrows of G. setzeri are often complex, 90% are branched, and they are longer (maximum, 214 mm) and deeper (maximum, 392 mm) than those of other Gerbillus species (Downs and Perrin, 1989). Burrows often occur in dry river washes where the substrate is loose and gravelly, although surface soil is compact and fine (Downs and Perrin, 1989).

Gerbillus setzeri prefers semi-compacted, gravel plains which lack vegetation (Griffin, 1990). Soils have been described as shallow and calcareous with a slight gypsum crust and a grit blanket (Scholtz, 1972). Occasionally G. setzeri colonize sand dunes during periods of high gerbil densities (Griffin, 1990; Schlitter, 1973). After rains, areas occupied predominantly by G. setzeri are colonized by other gerbils (Griffin, 1990). At low densities, G. setzeri and G. paeba occur sympatrically, but as population densities increase, one species migrates from the area. Segregation may be related to habitat change rather than displacement (Griffin, 1990). G. setzeri may co-occur with short-eared elephant shrews (Macroscelides proboscidus) on semi-compacted calcareous soils (Griffin, 1990).

Little information is available on the diet of G. setzeri. Stomach contents of five individuals collected in March 1988 from the gravel plains near Gobabeb comprised 50% arthropods, 40% plant material, and 10% seeds (Perrin et al., 1992). According to Griffin (1990), G. setzeri is primarily granivorous but regularly ingests arthropods and leafy material, although stomachs taken from a pop-
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ULATION at Donkerhoek contained only arthropod material. Caches from excavated burrows at Rossing in central Namibia contained leaves, flower heads, and the dry fruits of *Tetragonia repandula*; seeds, bracts, and twigs of *Blepharis grassi*; leaves, twigs, and seed pods of *Acacia reficiens*; chewed grass; sheaths of bulbs; insect cytra; and tenebrionid beetles (Downs and Perrin, 1989).

No detailed data are available on density, demography, or spatial use of *G. setzeri*. Trapping success in suitable habitat varies from 4% in wet years to 0.1% in drought years (Griffin, 1990). High trap success (9%) was recorded on the farm Donkerhoek during a 3-month period, and on the gravel plains north of the Kuseib River near Gebabeb during March 1988 (C. T. Downs, in litt.).

**BEHAVIOR.** When alarmed, *G. setzeri* put their hind feet on the substrate using very rapid alternate movements (Dempster and Perrin, 1990a). During sandbathing the animals roll rapidly from flank to dorsum with a flick in the sand. *G. setzeri* also performs a side rub which involves sliding the flank along the sand. Digging in the sand with the forepaws and kicking sand back with the hind feet occurs frequently. The primary form of locomotion is quadrupedal saltation. Nests are constructed of shredded grass and tusks of seeds; seeds are cached at specific sites (Dempster and Perrin, 1990a).

*Gerbillurus setzeri* is semi-tolerant of conspecifics and its behavior is intermediate between that of the aggressive and solitary *G. paeba* and *G. tytonia* and the tolerant *G. vallinus* (Dempster and Perrin, 1990a). The semi-tolerant behavior and complex burrows of *G. setzeri* suggest a degree of sociality not found in dune dwelling *G. paeba* or *G. tytonia*. *G. setzeri* inhabits more extreme environments than solitary *Gerbillurus* species.

Male-female interactions exhibit similar levels of agonistic behavior for each species (Dempster and Perrin, 1990). The behavior of *G. setzeri* in staged encounters with conspecifics is characterized by low levels of sexual and exploratory behavior and high levels of attentive behavior (Dempster et al. 1992). *G. setzeri* lacks the contact-promoting behavior of *G. vallinus*, and allo-grooming is not performed. Male-female aggression is more intense in *G. setzeri* than in *G. vallinus*; *G. setzeri* may be less colonial than *G. vallinus* (Dempster and Perrin, 1989c). *G. setzeri* does not identify conspecifics by deposited chemosignals (Dempster and Perrin, 1990b).

*Gerbillurus setzeri* vocalizes at ultrasonic frequencies by means of a strongly modulated call with a frequency sweep, which differs from congeners in duration and maximum and minimum frequency (Dempster and Perrin, 1991b). Only one call type was identified from *G. setzeri* a whistle which began at ca. 49 kHz and ended at ca. 39 kHz. Mean duration of a call was 117 msec (Dempster and Perrin, 1991b).

Vocalizations were positively associated with sexual and huddling behavior in *G. setzeri*, but vocal emissions were inhibited during aggressive and submissive bouts which entailed much physical activity (Dempster et al., 1991). Vocalizations preceded copulation but were undetected during and immediately after copulation.

**GENETICS.** The diploid chromosome number is 60 and the number of autosomal arms varies between 76 and 82 (Qumisiyeh et al., 1991; Schlitter et al., 1984). *G. setzeri* and *G. vallinus* share the same diploid number, but *G. vallinus* is variously reported as having 70-74 autosomal arms (Qumisiyeh et al., 1991) or 80 autosomal arms (Schlitter et al., 1984). Chromosomes include 20 pairs of acrocentrics and 9 pairs of metacentrics and submetacentrics (Schlitter et al., 1984). G- and C-banding of chromosomes of three individuals revealed that two specimens had 20 biarmed autosomes, while a third specimen from the same locality had 24 biarmed autosomes. *G. setzeri* has the following unique derived chromosomal characteristics: a centric fusion in 11/12 and translocations to 1, 7/8, 14, and 29 (Qumisiyeh et al., 1991).

**REMARKS.** The generic name is derived from the French *gerbille* meaning a small gerbil. The suffix *urus* denotes "as belonging to" (de Graaff, 1981). The species is named after Dr. H. W. Setzer in honor "of his efforts in African taxonomy and in particular for his interest in the taxonomy of desert rodents" (Schröter, 1973:17). Skulls in Fig. 2 were drawn by Karen Duxbury.

**LITERATURE CITED**


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