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A preliminary description of body maintenance behaviour of four *Gerbillurus* species

G. paeba paeba
G. p. exilis
G. tytonis
G. setzeri
G. vallinus

no dates
lab study

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ABSTRACT

The behaviour of captive solitary animals of the species *Gerbillurus paeba paeba, G. p. exilis, G. tytonis, G. setzeri* and *G. vallinus* is described. Few interspecific differences were found in locomotion, feeding, grooming, sandbathing, nestbuilding and exploratory behaviour. The main form of locomotion in all species was quadrupedal saltation. *G. tytonis* had a significantly longer leap length than *G. paeba* in the field. All species cached food in larders and in scattered caches. Sandbathing involved "side-flicking" and "side-rubbing" in all species. Nests were constructed of shredded grass and husks of sunflower seeds. Digging in the sand with the forepaws and kicking the sand back with the hindfeet occurred frequently. Footdrumming by striking the hindfeet alternately on the substrate was performed in response to disturbance of the environment. Laboratory maintenance of hairy-footed gerbils is also described.

INTRODUCTION

Little information is available on the general behaviour of the hairy-footed gerbils of southern African arid regions. Hallett and Keogh (1971) described aspects of the behaviour of *Gerbillurus paeba coombsi,* and Stutterheim & Skinner (1973) reviewed the behaviour of *G. paeba paeba* in captivity. Quantitative analysis of sandbathing and grooming behaviour of *G. paeba* and *G. tytonis* has been conducted (Hamer 1985), and maternal behaviour of *G. paeba paeba* and *G. tytonis* have been described (Dempster & Perrin 1989a). Agonistic behaviour has been studied in detail (Dempster & Perrin 1989b) and provides information which may be related to social structures and dispersal of animals in the environment. During the course of detailed behaviour studies, aspects of general behaviour of captive animals were recorded incidentally. A number of interesting behaviour patterns which merit further investigation were observed and are described here.

Comparative studies of behaviour in closely-related species have been used to elucidate taxonomic relationships, e.g. grooming in squirrels (Ferron & Lefebvre 1980), footdrumming in *Meriones* species (Bridelance & Paillette 1985), and sandbathing in kangaroo rats (Eisenberg 1963a). The ecological significance of food-caching (Pettifer & Nel 1977) and mode of locomotion of desert rodents has been described (Harris 1984). This study attempts to provide basic information on body maintenance activities in four *Gerbillurus* species.

METHODS AND MATERIALS

Animals were live-trapped from Namibia, the northern Cape, and the Alexandria dunefield, eastern Cape. They were maintained in 60 x 30 x 30 cm terraria provided with a layer of sand and a nest box. Food was provided *ad lib.* and consisted of mixed seeds, oats, "Pronutro" (a commercial grain cereal), fresh greens, carrots, and alate termites or mealworms. Water was provided *ad lib.* The circadian light cycle was reversed and maintained at 16L:8D; temperature was maintained at 25°C and relative humidity at 35%.

Animals were observed during the dark phase of the light cycle using light provided by a single 40W red light bulb. Behaviour was first videotaped and described, whereafter a checklist was constructed which enabled the observer to record behaviour during spot-checks and routine maintenance procedures. A total number of 32 *G. p. paeba,* 12 *G. p. exilis,* 29 *G. tytonis,* 12 *G. setzeri,* and five *G. vallinus* were observed for approximately 25 h per species.

The distance between successive footprints was measured on sand-dunes in the Swakop River bed, where only *G. p. paeba* was trapped on this excursion, and in the Central Namib dunefield, where only *G. tytonis* was trapped. Since these were the only rodent species trapped in each area, it was highly likely that tracks in the area were made by the species trapped there. Seven separate tracks in the Swakop River bed comprising 64 footprints, and seven tracks in the dunefield comprising 127 footprints were measured near vegetated hummocks and across open sand. The distances between fore- and hindfeet were measured for 49 sets of *G. tytonis* footprints.

RESULTS

Behaviour was grouped in the following categories: exploration and locomotion; feeding and elimination; grooming and sandbathing; nest-building and sleeping. Several postures are illustrated in Figure 1.

Exploratory and locomotory behaviour

Cautious exploration of an unfamiliar terrarium was conducted with the body elongated and flattened, tail extended posteriorly, and ears erect (Figure 1.1).

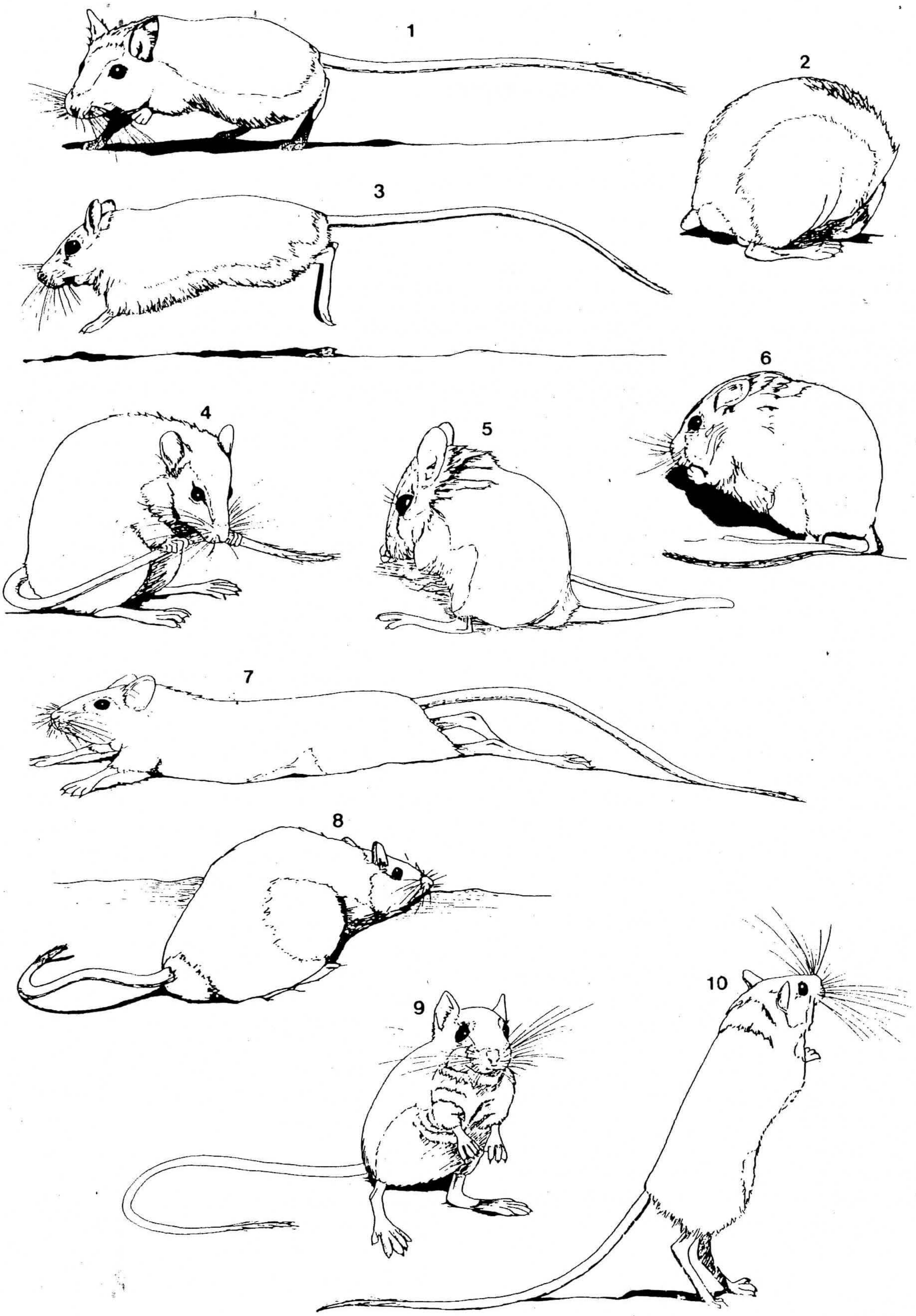

Figure 1: Some behaviours exhibited by *Gerbillurus* species: 1. Quadrupedal walking. 2. Sleeping, 3. Quardrupedal saltation. 4. Tail-grooming. 5. Nose-grooming (juvenile). 6. Eating. 7. Stretching. 8. Crouching. 9. Low upright investigation. 10. High upright investigation. Diagrams were drawn from photographs and videotapes.

Drumming on the sand with the hindfeet accompanied the cautious approach in 14 of approximately 50 observations. *G. tytonis, G. p. paeba, G. p. exilis* and *G. vallinus* drummed by short bursts of rapid thumping of the hindfeet alternately on the sand. *G. setzeri* "pattered" the hindfeet on the substrate, by very rapid alternate movements of the hindfeet occurring in longer bursts and resulting in no audible sound.

During exploration animals of all species sniffed the air while sitting upright with the hindfeet flat (Figure 1.9) or extended (Figure 1.10). A rigid posture, with the body and head pressed down on the sand (Figure 1.8) was observed in repsonse to disturbance on 16 of 50 occasions.

Quadrupedal saltation constituted approximately 80% of observed locomotion. The animal kicked off with the hindfeet and the body was elevated above the substrate. The forepaws touched the ground first and the hindfeet were drawn up behind the forepaws. The tail was held straight out behind the animal when saltation was performed (Figure 1.3). Tracks of *G. p. paeba* and *G. tytonis* observed in the field indicated that in unrestricted locomotion, the hindfeet were placed anterior to the forefeet. Results of measurements of tracks are given in Table 1. The distance between footprints was significantly greater in *G. tytonis* and *G. p. paeba* ($p < 0.001$, two-tailed t-test), and the hindfoot was also significantly longer in *G. tytonis* ($p < 0.001$, two-tailed t-test).

TABLE 1: Mean distance between fore- and hindfoot prints; mean (±s.d.) distance between footprints; and hindfoot lengths in *G. p. paeba* and *G. tytonis*. Sample sizes are given in parentheses.

	G. p. paeba	*G. tytonis*
Distance between fore- and hindfoot prints		9.1 cm (49)
Distance between successive footprints	22.2 ± 4.3 cm (67)	31.0 ± 10.1 cm (128)*
Hindfoot (length (mm)⁺	32.4 ± 1.32 (376)	28.1 ± 1.18 (178)*

* $p < 0.001$ (t-test)

\+ date from Boyer (pers. comm.)

Feeding and elimination

Food was held in the forepaws and seed husks were stripped off using the incisors. Small pieces of food were bitten off, chewed and swallowed (Figure 1.6). Hoarding of seeds was observed in all species. Animals carried seeds in their mouths to a corner of the terrarium. A hole was dug using the forepaws and the seeds were placed in the hole. Sand was kicked over the food using fore- and hindfeet, then pressed down with the animal's nose. All hoarded seeds were placed in a single hole; insects and fresh plant material were not hoarded. Food was stored in the nest by *G. paeba* and *G. tytonis*, and animals of all species also kicked sand over piles of food without transporting it. All animals drank water and pushed their noses horizontally along and into the sand after drinking.

Urination was performed in a corner of the terrarium, the animal backing into the corner with the tail lifted slightly. A drop of urine was deposited on the sand and the perineum was pressed on the substrate. No special behaviour was associated with defaecation.

Grooming and sandbathing

Animals stretched three to four times after emerging from the nest. The forepaws were extended anteriorly and the hindlegs posteriorly, the head was raised and the back hollowed as the animal stretched (Figure 1.7).

Grooming involved the same actions in all species. Animals licked their forepaws and groomed their noses by rapid circular movements, gradually moving up the sides of the the head until they wiped over the ears (Figure 1.5). Grooming of the flanks, belly and anogenital area was accomplished by licking and nibbling of the fur and combing of the fur using the forepaws. Hindlegs were held in the forepaws and nibbled, including the toes. The tail was held in the forepaws and nibbled from the base to the tip (Figure 1.4). Scratching was applied to all parts of the body accessible to the hindfoot. The animals scratched while standing, and nibbled the toenails between bouts of scratching. A "shake" accompanied the completion of a bout of grooming in 15 of 75 observations.

Sandbathing was performed by all gerbil species and was observed more than 50 times. The animals rolled rapidly from flank to dorsum with a "flick" in the sand. *G. tytonis* and *G. setzeri* both performed a side-rub which involved sliding the flank along the sand. *G. vallinus* pushed its nose along and into the sand before sandbathing. Digging preceded and accompanied sandbathing acts.

Nest-building and sleeping

Animals of all species constructed nests using grass or husks of sunflower seeds. Grass was cut into short lengths while it was held in the forepaws. Short sections of grass and shredded seed husks were carried by mouth into the nest where they were formed into a cup shape using the nose and forepaws. Nest entrances were blocked with sand in 10 observations.

On entering the nest, animals turned in a circle so that the tail was curled round the animal. In 52% of observed sleeping animals (n = 72), the posture was a curled position with the head tucked under the body (Figure 1.2). Animals also slept lying on their sides (26%), on the ventrum with the head stretched out anteriorly (17%), and on their backs (5%).

Digging in the sand formed approximately 60% of all observed activity. Animals used their forepaws simultaneously to dig the sand back under their bodies and the hindfeet simultaneously kicked the sand back from the hole. The shallowness of the sand in the terraria precluded the construction of burrows.

DISCUSSION

Very few qualitative differences in behaviour among the five taxa were noted in this study. Many behaviour patterns were typical of rodent species in general, for example, grooming, feeding, sleeping postures, nest-building, and exploratory behaviour (Barnett 1975; Eisenberg 1967; Roper & Polioudakis 1977). Behaviour patterns which are typical of many deserticolous rodent species include quadrupedal saltation, sandbathing, and footdrumming (Eisenberg 1967). These are discussed in more detail here.

Locomotion

Quadrupedal saltatorial locomotion is exhibited by deserticolous species of the families Gerbillidae and Muridae (Eisenberg 1963). Elongated hindfeet and long tails with a terminal tuft, which assist in balancing animals during rapid locomotion (Eisenberg 1963 b), are associated with a saltatorial mode of locomotion, and are exhibited by all *Gerbillurus* species. No qualitative interspecific differences were noted in the form of the locomotion performed.

A significant difference was noticed in the leap lengths of *G. tytonis* and *G. paeba,* which indicates that the former species traverse open spaces faster that the latter. *G. tytonis* is restricted to the Central Namib dunefield, whereas *G. paeba* is widespread in the arid areas of southern Africa. The longer hindfeet of *G. tytonis,* enabling it to move faster in the soft sand of the dunefield, may be a key factor in its survival in this habitat.

The adaptive significance of saltatorial locomotion, which has evolved convergently in many rodent species inhabiting the major deserts of the world, is thought to be predator avoidance (Eisenberg 1975; Harris 1984). *Gerbillurus* species, at times constitute the major portion of the diet of two Namib Desert owl species, *Bubo africanus* and *Tyto alba* (Tilson & Le Roux 1983). Saltatorial locomotion in *Gerbillurus* species is very likely an antipredator mechanism, given the open habitat occupied by these animals. The "freezing" posture observed in *Gerbillurus* species may also serve an antipredator function, since the white parts of the body are concealed, and the body form is made as inconspicuous as possible.

Feeding

Caching of food was displayed by all species of the genus *Gerbillurus;* and has been confirmed in the field for *G. p. exilis* (Ascaray 1984), *G. tytonis, G.p.paeba* and in burrows thought to be utilized by *G. setzeri* and *G. vallinus* (Downs & Perrin 1989). "Larder hoarding" and "scatter hoarding" of seeds were reported for *G. p. paeba* kept in the laboratory (Stutterheim & Skinner 1973).

Field observations of burrows constructed by *G. p .paeba, G. p. exilis* and *G. tytonis* revealed that simple burrows containing a food store comprised approximately 50% of all burrows. Food was found in caches in the larger burrow systems which also contained nests in all *Gerbillurus* species (Ascaray 1984; Downs & Perrin 1989).

Hoarding of food may be an essential survival pattern for animals living in environments where food is not abundant throughout the year (Pettifer & Nel 1977; Agren *et al.* 1989). *Tatera leucogaster* and *T. brantsii* (Subfamily Gerbillinae) kicked sand over seed piles, but did not transport seeds to the burrow (Pettifer & Nel 1977); *Desmodillus auricularis* (Gerbillinae) cached quantities of seeds in nest boxes (Christian *et al.* 1977). *Gerbillurus* species were intermediate in hoarding behaviour; food was stored in burrows and also in caches established elsewhere in the home range. Scatter-hoarding is considered to be the primitive form of caching behaviour. (Pettifer & Nel 1977). Predator avoidance may influence the mode of hoarding, since larder hoarding in an established burrow would diminish the exposure of the animal to predation (Pettifer & Nel 1977). Agren *et al.* 1989) found that family groups of Mongolian gerbils *(Meriones unguiculatus)* co-operated in foodhoarding and established a common food store. Social structure may also influence the mode of hoarding of a particular species.

Sandbathing

Sandbathing has been linked with chemical marking in some heteromyid rodents (Eisenberg 1963a) and *Meriones unguiculatus* (Roper & Polioudakis 1977). Sandbathing has evolved from marking and stretching behaviour, and more primitive genera of heteromyid rodents do not sandbathe (Eisenberg 1963a). Borchelt *et al.* (1976) have suggested that oil on the pelage reduces evaporative water loss, but that excess oil needs to be removed by sandbathing. Grooming serves a thermoregulatory function in *M. unguiculatus,* since the body temperature is reduced after grooming. Sandbathing lightens the fur, thus increasing radiant heat loss (Thiessen & Harriman 1983). *Gerbillurus* species sandbathe repeatedly after exposure to ambient temperatures of 40°C, but not lower temperatures (Downs pers. comm.). Surface temperatures in the habitat of *Gerbillurus* species did not exceed 40°C at night (Downs & Perrin 1989), thus the sandbathing response observed in laboratory experimentation may only occur in extreme conditions.

It has been suggested that gland secretions function primarily for thermoregulation and osmoregulation, and the communication function is secondarily acquired (Thiessen & Harriman 1983). *Gerbillurus* species do not possess a ventral gland as in *M. unguiculatus,* which is used in marking (Roper & Polioudakis 1977). The thermoregulatory function of sandbathing is indicated in *Gerbillurus* species, but it is not yet clear whether it also serves a communicative function.

Footdrumming

G. setzeri performed rapid "pattering" rather than drumming, as exhibited by *G. tytonis, G. paeba* and *G. vallinus.* In all species the stimulus resulting in drumming was a disturbance of the animal's environment. Footdrumming has previously been reported for *G. p. paeba* (Stutterheim & Skinner 1973) and *G. p. coombsi* (Hallett & Keogh 1971).

Footdrumming has been recorded for several *Meriones* species (Roper & Polioudakis 1977; Bridelance & Paillette 1985) and is thought to communicate territorial and sexual information. Information transmitted by footdrumming may be seismic rather than auditory; as has been suggested for mole rats (Heth *et al.* 1987). Stutterheim & Skinner (1973) viewed drumming as a displacement activity in *G. p. paeba,* while Randall (1989) has found that footdrumming patterns of *Dipodomys spectabilis* were individually recognizable, and were associated with territorial defense (Randall 1984). Drumming patterns were found to be species-specific in four *Meriones* species (Bridelance & Paillette 1985). *M. unguiculatus* performed footdrumming relatively rarely, but always in response to some external disturbance (Roper & Polioudakis 1977). Other animals did not respond to the footdrumming of an individual, and there was no evidence to suggest that it was an alarm signal (Roper & Polioudakis 1977). In these respects, footdrumming in *Gerbillurus* species is very similar to *M. unguiculatus.*

The present study has revealed a qualitative difference in footdrumming patters between *G. setzeri* and the other three *Gerbillurus* species. Further investigation may reveal quantitative differences among all species.

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