On the biology of *Xerus inauris* (Zimmermann, 1780) (Rodentia, Sciuridae)

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Abstract

Studied the biology of *Xerus inauris* (Rodentia, Sciuridae) in the western Transvaal (South Africa). Details are given on size and structure of colonies and burrows. Breeding season is described and details on number, growth, and development of young are given. Further toilet behaviour, food and feeding habits, activity, relationship to other species, some aspects of social behaviour, home range, and flight distance are described.

Introduction

Numerous papers exist on the biology, ecology, and ethology of ground squirrels in different parts of the world (Calinescu 1934; Volčanezkij and Furssajev 1934; Heptner 1954; Grulich 1960; Balph and Stokes 1963; Clark and Denniston 1970; Steiner 1970 a, b, 1973, 1974; Yeaton 1972; Drabek 1973; Wistrand 1974; Herzig-Straschil 1976; to give just a few examples). However, on African species, apart from faunistic and biogeographical reports, only a few details of the biology and ethology of *Atlantoxerus getulus, Xerus erythropus* and *Xerus rutilus* have been published (Saint Girons 1953; Ewer 1965, 1966; Poduschka 1971, 1974; O'Shea 1976). On *Xerus inauris,* Sclater (1901), Shortridge (1934) and Roberts (1951) have given outlines of the biology and distribution of the species, and there are distribution maps for the whole of southern Africa (Davis 1974), as well as for the Orange Free State (Lynch 1975) and Botswana (Smithers 1971). The latter author also gives a short, informative report on life habits and reproduction of the species in Botswana, while a few other papers provide informations on aspects of its biology or behaviour (Snyman 1940; Bowling 1958, 1959; Zumpt 1968, 1970; de Graff 1973; Straschil 1974, 1975; Marsh et al., in press). The aim of this study is to provide new information on the biology and behaviour of *Xerus inauris.*

Material and methods

Xerus inauris is a conspicuous, common rodent of the arid parts of southern Africa, due to its strictly diurnal and social life habits and its large size (head and body length $\bar{x}$ = 250 mm, tail $\bar{x}$ = 207 mm; material from Western Transvaal; Fig. 1). The present study was carried out from March 1973 to April 1974 and in July and August 1974.

Present data are from the main study area, the S. A. Lombard Nature Reserve (18 km north west of Bloemhof, 25°35' E, 27°35' S; 1219 m above sea level). The general veld type there is a dry Cymopogon-Themeda veld (Acocks 1953; van Zyl 1965). The mean annual precipitation is 460,4 mm (241,8—740,4 mm; 1951—1973) and rain falls mainly during the summer month. The mean annual temperature is 17,6° C (summer maximum 40° C, winter minimum —8,7° C; 1971—1973) and night temperatures fall regularly below

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Fig. 1. Xerus inauris

zero during June and July. In 1974 the winter minimum reached —11,1° C. Seventy two individuals were shot, body and mass measurements taken, reproductive condition examined, and reproductive tracts and stomach contents preserved. Skulls and skins were prepared for later examination.

In two different colonies in the reserve 43 individuals were live trapped, sexed, measured, and marked (toe clipped for permanent marking and certain parts of the fur dyed black with Nyanzol D for visual individual identification), and released. Thirteen individuals were recaptured once and five others two to five times to renew the fur dye. Food plants eaten by *Xerus inauris* were collected and deposited in a herbarium for later identification and two burrow systems were excavated and mapped. Observations were mainly made from a hide using 7×42 binoculars and a 20×80 telescope seated about 2 m above the ground, while on some occasions bushes or a car were also used as a hide. The use of the term colony is here following the definition by Wilson (1975). In this paper a colony is a community of ground squirrels inhabiting one burrow system or a concentration of adjacent burrow systems; colonies are clearly separated from each other by areas (several times bigger than those covered with tunnel openings) without any burrow system and members of different colonies have no regular contact with each other. Animals living together in one burrow are called a social group.

Results and discussion

Size of colonies and structure of burrows

Xerus inauris inhabits open grassland plains, occuring in colonies amongst patches of short grass in areas with generally tall grass, overgrazed areas, edges of dry pans or riverbeds, or seldom used sandy roads. Trees or bushes may be scattered around that area.

Such a colony may consist of one to three social groups (see "social organization") each of them counting from two to more than ten individuals. Each social group inhabits its own burrow system which can be easily detected by a number of characteristic openings in the ground (from two to more than 100, $\bar{x} = 32$, $N = 15$) with signs of fresh scratches on the earth mounds when they are in use. The areal

covered by burrow openings of a colony was found to be from six square meters (one burrow system) to more than 2000 m² (three burrow systems). Burrows are used for many years, and as the inhabitants frequently reconstruct old tunnels and dig new ones, the warren becomes more and more complicated, but in such cases only part of the burrow system and a few entrance/exit holes are in regular use. Figure 2 gives an example of a relatively simple burrow. In two observed cases, additional new tunnels started off on the ground surface with a small hole and a tiny heap in front, within a few days had joined the adjacent original tunnel system while the earth heap in front of the new hole was formed to a characteristic low crater shaped mound which is, however not visible at all openings.

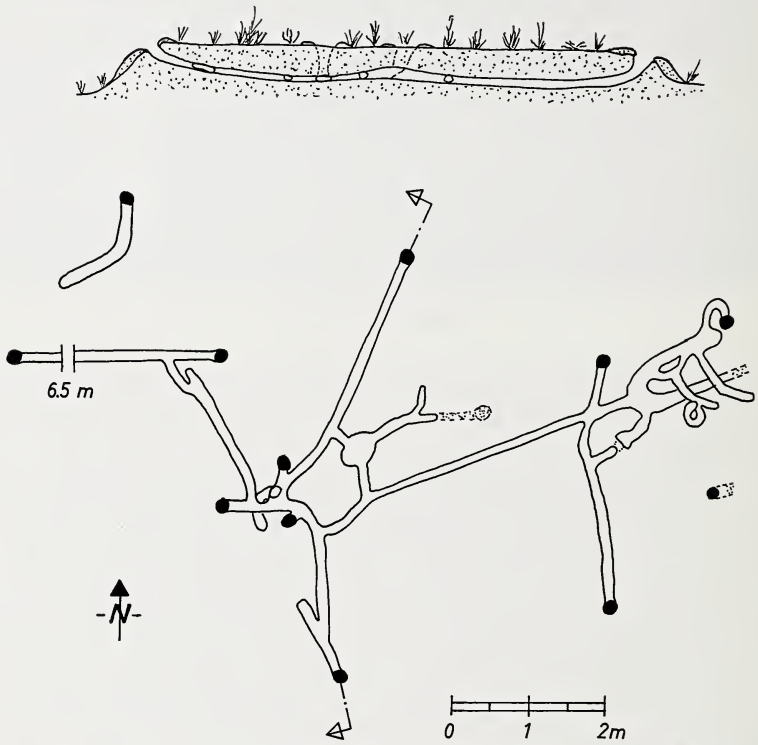

Fig. 2. Burrow of *Xerus inauris.* Dotted areas = tunnel plugged with earth; ● = opening to surface; → = indicating position of cross-section

Tunnel cross-sections are usually oblique-oval, the average width being 14 cm (range 5—25 cm) and the average height 11 cm (range 5—20 cm). Tunnels were found to reach a depth of about 70 cm, which is similar to that mentioned by Snyman (1940), while Zumpt (1970) found tunnel systems up to a depth of 1,5 m. *Xerus inauris* dig by alternate movements of the forepaws to loosen the soil, while obstacles like roots are removed with the incisors. Loose soil is then removed from the tunnel by pushing it backwards under the rump and between the hindlegs, using both forepaws simultaneously, and occasionaly one hindleg might push some loose soil further backwards or sidewards, but the snout is seldom used for pushing earth away. The earth piling up in front of the hole is intermittantly distributed to the sides with both forepaws simultaneously as described above to form low crater shaped mounds.

In the excavated burrows only small concentrations of old grass were detected but in captivity two females (one with young) constructed a tidy bowl-like nest of grass stems cut into pieces about two to three centimeters long. Sometimes they were found asleep in these nests, rolled up with their tails covering their heads. Snyman (1940, p. 49) describes some burrow systems of *Xerus inauris* where he found nests "lined with soft grass" or "where bedding in the chambers consists of fresh straw". In the field adult and subadult females and subadult males were observed gathering grass and carrying from one to ten bundles down the burrow. This is most probably used for lining the nest but it could also serve as food on rainy days.

Social organization and social behaviour

A stable social group inhabiting one burrow system consists of one to four females and their offspring. There also appear to be small instable social groups of for example two adult males, one adult female and one subadult male which may be the female's offspring. Examples of group compositions are given in Table 1. Adult males do not stay continuously with any social group but pass through a colony

Table 1

Social groups at different colonies

Group	month	ad. ♀♀	ad. ♂♂	subad.	juv.	total
Hide IX	5. 1973	2	1	—	—	3
	7. 1973	2	—	—	2	4
	3. 1974	2	1	2	—	5
	8. 1974	2	(1)	—	2	4
Hide B/C	3. 1973	4	1 (1)	8	—	13
	4. 1973	4	1	7	—	12
	5. 1973	4	(1)	6	—	10
	7. 1973	4	—	2?	4	10?
	8. 1973	4	(1)	2?	5?	11?
	9. 1973	4	(1)	4	6	14
	11. 1973	4	—	—	7	11
	2. 1974	3	—	6	—	9
	3. 1974	2	—	5	—	7
	8. 1974	2[1]	(1)	5	—	7
Hide E/F	9. 1973	3	—	—	5?	8?
	11. 1973	3	—	5?	—	8?
	2. 1974	3	—	7	—	10
	8. 1974	3[1]	(2)	7	—	10
Col. 15	12. 1973	1	—	2	—	3
	7. 1974	1	—	2	—	3
	8. 1974	1	—	2	2	5
Col. 38	8. 1974	1	—	2	—	3
Col. 1aS	4. 1974	3	—	6	—	9
Col. 5	4. 1973	1	2?	1	—	4?

[1] possibly gravid; ( ) visiting the colony only; juv. = young up to an age of about 8 weeks; field identification: small size, fur appears more „fluffy" than in older ones; subad. = sexually immature, older than about 8 weeks; field identification: ♀♀ minute mammae, ♂♂ no well visible testes; ad. = sexually mature; field identification: ♀♀ clearly visible mammae, ♂♂ large scrotal testes.

frequently. They tend to sniff at any individual of the group but are chased away by the adult females with small young. Only when the females of a group are ready to mate again is the male accepted and stays with the females and their young of the previous season in the burrow for some weeks. Such a male is then as frequently groomed as any other member of the group by females and subadults. A small territory around the tunnel openings regularly used by one social group is defended vigorously by the dominant female,while the other females do so less intensly. Females of one social group have synchronized parturition (within days). At this period most of the subadults (young of the previous year) are still around but start to disappear gradually from the colony. Any female of a group can approach any young without exciting any animosity in the mother, but they seem to maintain a closer contact with their own offspring than with those of the other females of the same group.

Agonistic behaviour is rarely shown among members of the same social group, but when it was observed was directed mainly at driving off competitors from a limited feeding place. It normally does not include severe fighting or a chase over longer distances, but more often just the approach of the dominant female, or her turning towards the other individual (sometimes with the mouth slightly opened) results in the retreat of the opponent.

Individuals of a neighbouring social group, which at times tend to investigate the burrow entrances of their neighbours, are usually chased away by a resident adult female. They are then often persued by this female right into their territory up to their burrow, and this sometimes results in a reverse chase where the former pursuer is driven off by the dominant female of the local group. Fights with body contact were mainly observed among adult males or adult and subadult males, but even such fights never resulted in severe wounds being inflicted on any of the individuals as described for other ground squirrel species (Steiner 1970 b, 1972).

Distinct play behaviour such as dashing around with abrupt changes in direction, chasing, play fights, and mounting, was only observed in juveniles and subadults of a social group and was mainly shown in the morning after appearing above ground, and in the evening before retiring to the burrow for the night.

Kissing was often observed in *Xerus inauris* when two individuals met but it was not always possible to determine whether it was a nasal contact or a mouth contact and sometimes it seemed that no real tactile contact was made at all. It is most likely that this is not only a greeting ceremony, but is also used for identification as has been described for many other sciurids (e. g. King 1955; Balph and Stokes 1963; Steiner 1970 a; Betts 1976).

Xerus inauris produces several different calls: Alarm call — a very high pitched vocalisation sounding almost like a whistle. It is usually given by an animal disturbed by movements or unusual objects in its surroundings, but seemingly less often when worried by a strange noise nearby. It is normally produced in a high lookout position or sometimes when squatting in the entrance of the burrow, ready to disappear into it. Sometimes it is also given during a short pause while running away from a person or car. Intensity seems to be variable according to seriousness of the danger (see also Zumpt 1970). The position of the tail also probably indicates the different intensity of the alarm. Usually this alarm call causes "looking around" by other individuals nearby, and sometimes all of them rush towards the burrow entrance. One individual running fast towards the home burrow then causes all others of the colony to do so. Sometimes one or two additional individuals join the whistling of the first one, but all members of the group — or colony — present at the time never give the alarm call togehter.

Scream — an unusually intense and loud vocalisation which is produced by an

animal unable to run away in its moment of greatest fear: the first time it was heared when an animal tried to escape through a small hole of a live trap and got stuck. Later on this scream could be "produced" when an individual awakening from a slight ether narcosis after marking was still held with one hand around the neck. The reaction of other individuals to this scream is as yet unknown.

Aggressive growl — a very deep growl heared during aggressive encounters between two individuals — especially when one is chased away by the other. It is most probably given by the aggressor.

Play call — a rather high tschip-tschip-tschip which can be heared when young ones rush around playfully.

Nest-chirping — a very soft mouk-mouk which was only heared from young in captivity at the age of about one week.

Protest squeak — a rather loud squeaking noise, repeatedly given by very small young when handled (by their mother or when hand reared). The oldest juvenile heared to protest in this way was about five weeks old and gave this squeak when it tried to get away from its mother which held it on the ground with the forepaws and groomed it.

Zumpt (1970) notes apart from the different intensities of the alarm call also a "talk" representing satisfaction, which is uttered by a squirrel after entering the colony or, in captivity, at feeding time. Such a call was however never heared during this study.

Breeding season, number, growth and development of young

Xerus inauris reproduces throughout the year, as shown by data on gravid and lactating females collected as well as by an estimation of month of birth of collected and live trapped young. Males caught throughout the year showed no distinct changes in size and mass of testes to indicate sexual inactivity at certain times. Data are not sufficient for quantification but observations indicate clear peaks in the appearance of young above ground in June and September/October, which would follow birth in about May and August/September. Smithers (1971) also found a year round breeding season in Botswana and it seems most likely that this is the case throughout the range of the species, although differences in the peak periods are possible. Zumpt (1970) estimates the breeding season of *Xerus inauris* in the Western Transvaal to be from July to November with a peak in September, the first young appearing above ground in August. However, his findings must be based on inadequate numbers of samples and observations.

Ten marked females produced no more than one litter per year each and regular controls of group composition and approximate age of young at different colonies brought the same result. The average number of pups per litter was 1.9 (range 1—3). For the litter counts only eight litters could be used as in several other cases it was impossible to decide how many of the young belonged to a particular female. The average number of embryos in ten females was 2,1 (range 1—3); whenever corpora lutea could be counted (seven cases) the number concurred with the number of embryos implanted indicating no foetal wastage. The sex ratio of juveniles was 1:1 ($N = 9$). Number of young and the observed range are quite in accordance with the findings of Smithers (1971) in Botswana ($\bar{x} = 2{,}2$ young/litter, $N = 27$, observed range 1—3) but do not agree with other published data e.g. two litters/year with three to six young (Haagner 1920; Asdell 1964).

In June 1973 two females caught at one burrow gave birth to two young each within about two days. The exact days of the births within a period of seven days were unknown; therefore when the young were found their approximate age of five

and seven days was calculated by comparing their stage of development with data on related species (Eibl-Eibesfeldt 1951; Ewer 1966), as data previously published on young *Xerus inauris* (Zumpt 1970), especially concerning the time of opening the eyes, are regarded as inaccurate. The two older ones were at an age of about seven days deserted by their mother but showed a remarkable resistance to cold; they were found lying cold and motionless in a corner of the cage and were judged dead as there was no sign of breathing and the skin was greyish. While being measured they suddenly took a deep breath and from this moment regular breathing was clearly visible and within a few minutes the skin turned pink. They were hand reared from now on but died after two days most probably because of overheating of the artificial nest. The second captive female successfully reared one young while the second one disappeared at an age of about seven days. Pooled data on these young born in captivity do however enable some data on their development to be presented. Results of observations on the development of the four and later on only one squirrel are given in Table 2a, b. A growth curve compiled from data from collected individuals is given in Fig. 3.

Table 2a

Growth and development of young

See text for explanation

Approx. age (days)	Observation
5	Two young scream when mother leaves the nest.
7	Whiskers on head. Very short hair on head and neck. Tail on sides slightly pigmented. Body curved in embryo-like way. Tend to crawl in circles when put on table, would fall down over edge of table. Sleep lying on side. Sucking movements with mouth and push with forepaws when sleeping. Sometimes utter slow mouk-mouk sound while in nest and squeak when handled.
9	Beige hair on head and shoulders $\leqq$ 1 mm, hairs on rest of body and the pigmented sides of tail start growing. Ear notches form a low curved ridge but slit still closed. Slit of eyes start to develop. Incisivi not yet protruding through a distinctive ridge on lower jaw. Turn around to stretch all four legs when touched. Claws on forepaws pigmented, those of hindpaws pigmented on the base only. (Death of hand reared young).
14	Completely covered with beige hair (1—2 mm).
25	Reaction to noise visible.
27	Slit of eyes well developed, still closed.
35	Eyes open. Longer hair on each side of tail.
39	Leaves nest for a short distance.
42	Out of hut with the nest. Grooming itself in the sun. Stands on hind-legs — unstable. Tail held straight upwards, not bent.
50	Feeding on lucerne, dry grass stems. Giving alarm call when disturbed.
56	„Hearth-rugging"[1]. Still has difficulty in handling a grass stem of about 10 cm length.
92	Rising to its toe when standing upright on hindlegs („high sit", Ewer 1963).

[1] Lies flat on its belly, forepaws stretched foreward, hindlegs extendet backwards (Ewer 1963, Straschil 1975).

Table 2b

Growth and development of young. Measurements
See text for explanation

Approx. age (days)	Body mass (g)	Headbody (mm)	Tail (mm)	Hindfoot s. c. (mm)
7	23,5	—	—	—
7	21,5	—	—	—
71	350	188	153	58
80	415	203	174	59
91	435	210	175	59.5
98	445	210	182	60.5
108	475	220	182	61
122	490	221	186	61
153	570	242	186	61.5

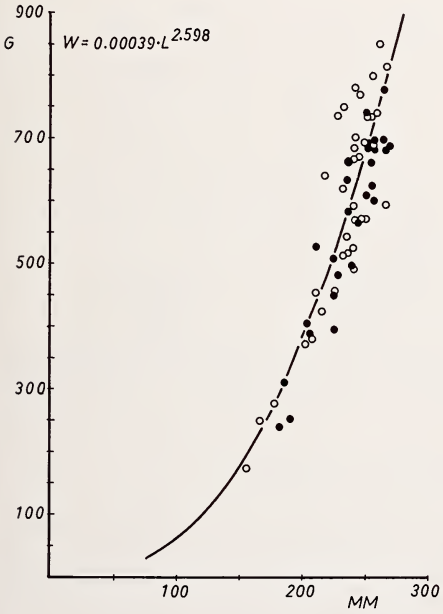

Fig. 3. Growth curve of *Xerus inauris*. W = body mass in g; L = head body length in mm, ○ = ♂; ● = ♀

The last young male survived in captivity until an age of five month by which time it showed no sign of sexual maturity. Moreover, observations on marked young in the field indicate that contrary to Powell (1925) they do not reach sexual maturity earlier than one year — or slightly more than this. The smallest pregnant female ever caught weighed 568 g (HB 245 mm, T 198 mm, HF s. c. 60 mm) while the smallest sexually mature male (according to size of testes) weighed 596 g (HB 265 mm, T 231 mm, HF, s. c. 65 mm). At about this age subadults leave their maternal colony. One subadult male of about one year started frequently visiting the neighbouring social group to make contact with the subadults there which ignored him — while the adult females would chase him away. These were probably his first steps to adolescence.

Data on juvenile moult is scanty but it seems they have their first moult within the first five month of life. Like some *Citellus* species (Howell 1938; Hansen 1954) adult *Xerus inauris* seem to have only one moult per year, between August/September and March/April. Due to a long moulting period the first changed hair can sometimes be shaggy by the time the moult is completed. As a result of burrowing the stiff hair on the head, the paws, and the back is worn first and as they like to sit on their haunches the fur on these parts also wears rapidly. With some individual variation moult proceeds generally dorsally from eyes and ears, ventrally from the throat and anus area, and the base of the tail, dorsally further backwards from the head over the neck, shoulders, and arms. Simultaneously it starts at some spots on the back, hindquarters and hindlegs, while ventrally the line moves down the rump towards the belly where the line meets the one comming up from the

hindlegs. In this later phase the tail hair is also eventually renewed, and the moult then terminates in some spots on the back and tail. Figure 4 illustrates moult pattern and individual variation of it in this species.

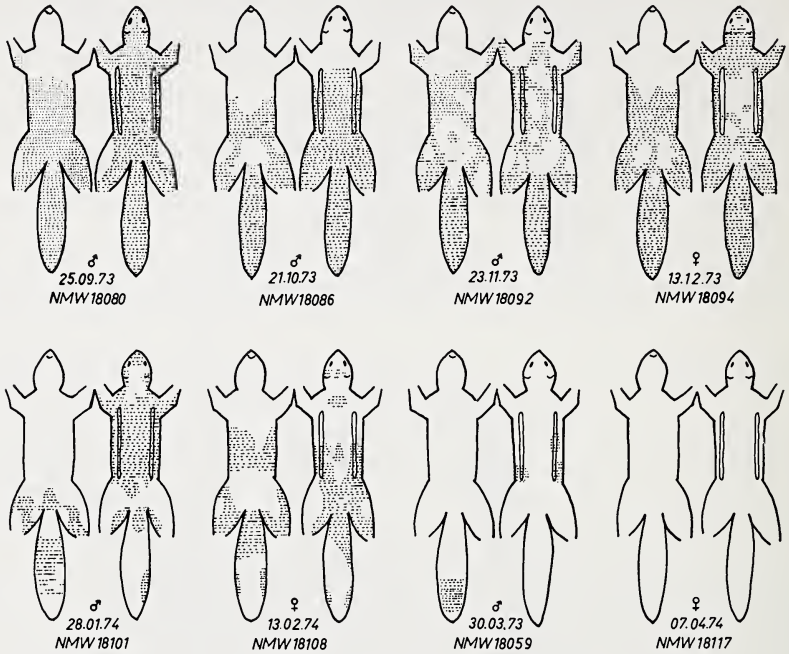

Fig. 4. Moult pattern in *Xerus inauris*. (Data of collection and number of individual in the collection of the Museum of Natural History, Vienna, indicated). Dotted = old hair; plaine = new hair; of different length at certain stages

Toilet behaviour, defecation, micturition

Toilet behaviour in *Xerus inauris* includes a strong social aspect: allo-grooming is carried out regularly and readily among members of one social group. It can either be induced by an animal which invites another to groom it by moving right under its mouth, or one animal chooses another one to groom, this sometimes being preceded by selfgrooming. This latter sequence can be repeated a few times. Allo-grooming is performed by all sex and age groups but females take special care of their smaller young. Allo-grooming is mainly directed towards the back and the throat, followed in frequency by the sides of the body and the head, while the shoulders, breast, fore- and hindlegs and the tail are less often nibbled. Besides allo-grooming, *Xerus inauris* self-grooms its bristle hair mainly in the morning after emergence from the burrow and in the evening before retiring to it. Figure 5 illustrates which parts of the body are taken care of by the hindpaws, forepaws and the mouth.

Frequently both forepaws are used to scratch the belly and the upper parts of the hindlegs; one forepaw also often supports the other when it is being nibbled with the incisors. Both forepaws help holding the hindleg or the tail for nibbling. In this case they sit on their haunches and the tail is either bent forewards on one side of the body or between the hindlegs towards the mouth. The tail is then nibbled

along its whole length. Scratching with the hindpaws and combing with the forepaws as well as nibbling of the tail is done quite often, while face cleaning was observed on fewer occasions. Defecation is not associated with any special behaviour in *Xerus inauris*, and animals drop their faeces at random while walking about. Micturition on the contrary was observed several times in the vicinity of the tunnel openings and its probable marking function has been discussed elsewhere (STRASCHIL 1975).

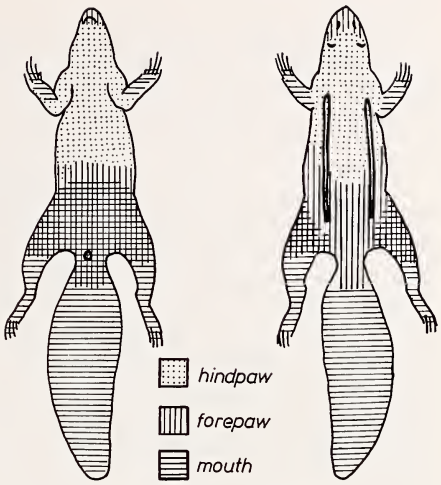

Fig. 5. Self-grooming in *Xerus inauris* — illustrating which parts are taken care of by the hindpaw, the forepaw and the mouth

Locomotion and postures

Xerus inauris walk when covering short distances only, over long distances they run in a slowly relaxed way but in an alert mood and when pursued, they run fast, streched low on the ground, towards their burrow. They never seem to climb and only seldom sit on a stone or fallen tree in the colony. Only once an individual walked along on to top of the stem of a fallen tree, about 50 cm above ground.

Xerus inauris tend to be vigilant in almost any situation when above ground. Occasionally they can be found lying flat and relaxed on the ground — and even then they might at least lift their heads from time to time to look around. Most frequently they squat on their haunches while sunning themselves, feeding, self-grooming, etc. Apart from this general vigilance, any strange noise, alarm call of birds, and movements up to 60—80 m away cause a change from the squatting position into a lookout posture which allows a better view over the area. Individuals then stand upright on their hindlegs, the forepaws usually rest on the chest or might still hold some food. The height of this lookout posture can be regulated from almost squatting on the haunches with varied extension of the hindlegs and the soles plantigrade on the ground, until the hindlegs are fully extended and they are standing on the toes ("high sit", EWER 1963). This latter position was never observed in *Xerus erythropus* by EWER (1966) who suggested that *Xerus* may be unable to do so.

All mentioned postures are also used to reach food items on higher plants. In all described situations the tail might be flat on the ground or bent over the back, or might even be waved up and down. At present it is difficult to interprete most of these tail positions, and therefore some suggestions will be given without any evalution:

Erection of the tail hairs to form a "bottlebrush" is certainly a sign of greatest fear or excitement. An animal caught in a live trap for instance will exhibit such a "bottlebrush" when approached. Tail hair is also spread but not to such an extent when an animal visits the territory of another social group, or when an animal is pursuing such an intruder.

The tail is often bent over the back while feeding, looking around, and sometimes while sun- and sand-bathing. In one case this was interpreted as a slightly alert mood in *Xerus erythropus* (EWER 1966). Although this seems to be the case in certain situations there are indications that it might also be carried this way as

protection against sun (Smithers 1971; Marsh et al., in press; Herzig-Straschil, in press) and rain. The waving up and down of the tail normally coincides with the alarm call, and could enhance this call with a visual sign for other members of the colony, or it could in addition indicate a certain stage of alertness, or the intention to run off any minute.

Flight distance

When *Xerus inauris* is disturbed by noise or movements it runs towards its home burrow and particular burrow openings and rarely seeks shelter in another hole, even in the same burrow system. It seems to see quite well and will spot a cause of disturbance in a distance of up to 40—60 m (or more) while feeding — it then will flee to the colony where the squirrel feels safe enough to sit in the entrance of the burrow — sometimes feeding while watching the cause of its flight, and sometimes giving the alarm call till the intruder approaches as close as 7—15 m before disappearing into the burrow. This distance can get even shorter in places where the animals get used to people, engines, or dogs passing near by or with very young individuals.

Several times an individual also just hid behind a grass tuft or busch or even lay flat in a depression of the ground when disturbed. These animals were probably not worried enough to run towards the burrow, but just waited until the reason for the disturbance passed by.

Home range

While feeding *Xerus inauris* moves some distance out of the colony and often disappears out of the observer's sight. However it was possible to spot some marked individuals for some distance out of the colony, as well as to follow some ones back to their home burrow. From these sight records (for most individuals more than ten within two weeks) home ranges were calculated according to the exclusive boundary method (Stickel 1945). As the number of observations per age and sex group is not large, these give just a rough idea of home ranges in this species (Table 3).

Table 3

Home range

Sex/age	No. of indiv.	Month	Home range m² Min.	Max.	x̄
♂♂ ad.	2	9. 1973	1 689	5 000	3 345
♂♂ subad.	3	5., 8. 1973	750	1 050	900
♀♀ ad.	8	5., 7., 9. 1973; 2., 3., 10. 1974	868	3 327	1 654
♀♀ subad.	3	5. 1973; 3. 1974	1 500	1 900	1 683

Diet and feeding habits

Xerus inauris feeds mainly on vegetable matter but sometimes also on insects. Among the observed food plants the grasses *Cynodon dactylon* and *Enneapogon brachystachyus* were the most important. The main food items in general were the base of grass stems of the following species: *Cynodon dactylon, Enneapogon brachystachyus, Stipagrostis obtusa, Aristida obtusa* and *Boscia foetida.*

Seeds (green or dry) and sometimes the seeds plus the surrounding parts were taken from: *Leucas* sp., *Sophora* sp., *Tribulus terrestris, Urochloa panicoides.*

Juicy green stems and base of leaves were eaten from: *Leucas* sp., *Cynodon dactylon, Urochloa panicoides* and *Chloris gayana africana.*

Further they seem to feed on the roots of *Galenia* sp. Other foodplants of *Xerus inauris* are *Babiana hypogaea, Eriospermum* sp., *Ruschia regens, Mariscus indecorus, Brachystelna circimatum* and *Dipcadi crispum* (M. E. Keith, pers. comm.).

Among agricultural plants maize seemed to be the most important for *Xerus inauris*. The dry maize grains proved to be the best bait throughout the year and animals fed on the provided maize almost exclusively as long as it was available but would eat only the germ-part out of each grain.

Stomach contents of collected animals were investigated in the laboratory and all 64 contained plant material while only 26 contained invertebrate remains in addition. Remains of termites, beetles, locusts and caterpillars could be identified but only in one case did termites fill more than half of the stomach, while in all other cases plant material predominated. No vertebrate remains were found at all. The volume of the stomach contents varied between less than 1 ml and 60 ml ($\bar{x}$ = 22 ml). Zumpt (1968) investigated 175 stomachs of *Xerus inauris* and obtained similar results concerning plant material and invertebrates but found remains of *Xerus inauris* in two cases. Marsh et al. (in press) describe a clear saisonality in the diet of the species in the north of South West Africa.

Xerus inauris shows the typical squirrel-like feeding manner. Any possible food is sniffed at and the forepaws play an important role in reaching and handling the food. Tall plants are bent towards the mouth with the forepaws and they also loosen the earth around the grass tuft with the forefeet before picking it up. Any food is picked up with the mouth and then perhaps handled with one or usually both forepaws while the animal takes one bite after the other and drops the rest, such as the harder parts of the maize grain, grass stems, etc. Generally these animals feed squatting on their haunches but they might feed in several other positions too, standing in a lookout posture or even lying stretched out on the ground.

No food hoarding was observed in *Xerus inauris* (the gathered grass is regarded as nesting material). On a few occasions however a behaviour pattern was observed which might be incomplete food burying. Two females (subadult and adult) each carried a piece of maize cob in the mouth and ran around in the colony; here and there making some digging movements as though searching for a place to burry the cob, but eventually they simply put the cob down and lost interest in it; a third female took three to four maize grains in its mouth (normally one after the other is eaten) walked about in the colony and eventually put all the grains down and started feeding on them. These observations resemble very much those of Ewer (1965) on *Xerus erythropus* where the complete sequence of food burying is to carry several maize grains in the mouth — search for the right place to dig — dig — put in and ram down — cover and tramp — sometimes camouflage. The young *Xerus erythropus* showed this behaviour incompletely only at the beginning and the ontogeny of it followed the described way. Ewer (1965) regards it as a possible inheritance from an arboreal or semi-arboreal ancestral stage and a similar pattern can still be found in real arboreal species as *Sciurus vulgaris* (Eibl-Eibesfeldt 1963).

Activity

Xerus inauris is strictly diurnal. The daily activity above ground starts in winter between about half an hour and one and a half hour and in summer between about one to two hours after sunrise and ends just around sunset (Fig. 6). Thus the

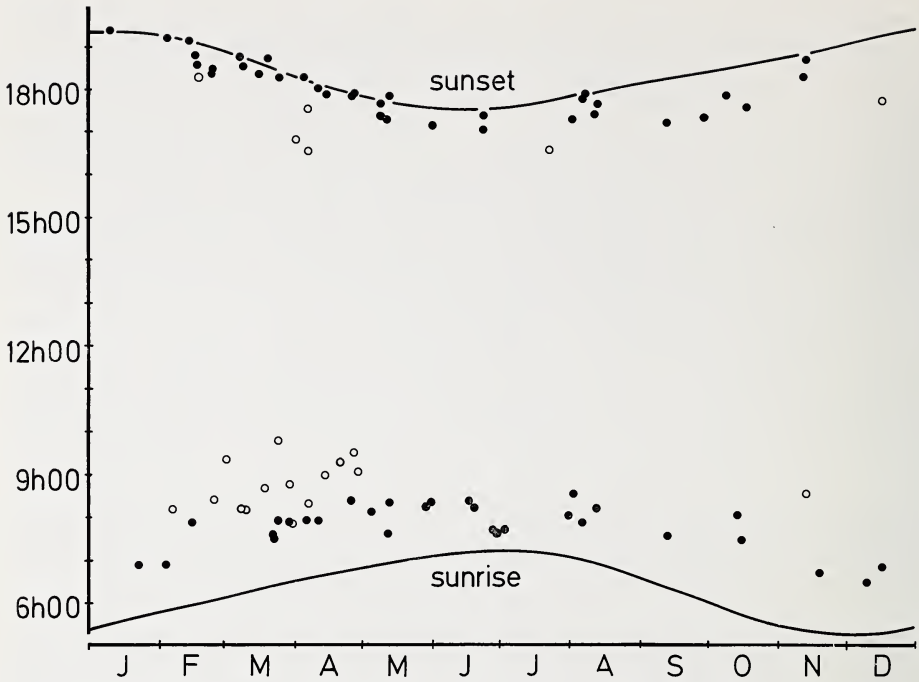

Fig. 6. Activity period of *Xerus inauris* above ground throughout the year. First individual of a colony appearing above ground and last one disappearing into the burrow.
● = sunshine; o = clouds, fog

daily activity period above ground varies from about nine to ten hours in winter and from ten to twelve hours in summer. Generally these squirrels spend almost 70 % of the time above ground searching for food and feeding, 15—20 % squatting on their haunches and looking around, while the rest is spent on running, self-grooming and social contact.

In the morning one or two animals would come above ground and bask in the sun near the tunnel entrance — soon the remainders appear and they all sit around the hole, sometimes grooming themselves or each other. Young sometimes rush around playfully. One after the other then starts feeding near the burrow and within 20 minutes all individuals will do so. Gradually the animals then move further away from the burrow — feeding most of the time. Sometimes an animal returns to the burrow for a short period.

In the afternoon, about one to one and a half hours before sunset, the animals start coming back into the area of the burrow — often they gather around the holes just as in the morning — again doing some self- and allo-grooming. Frequently some of them collect grass and carry it down the burrow and some young might play again and one after the other disappears into the burrow — the last one usually at sunset.

The pattern given above applies to dry and sunny days. Heavy fog or clouds in the morning delays the appearance of the animals above ground considerably and also changes the pattern of emergence; one or two animals come out of the tunnel, look around, the fur erect as if feeling cold, and they disappear again into the burrow — this can happen a few times and it takes up to two hours until all the

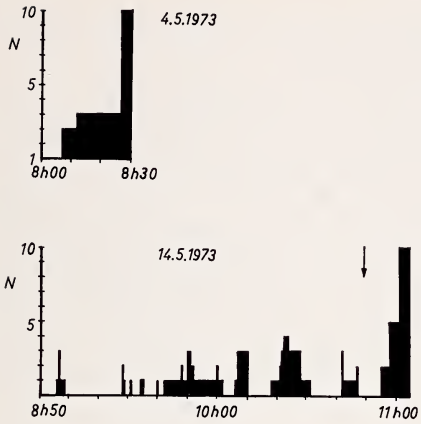

Fig. 7. Patterns of emergence of *Xerus inauris* from the burrow under different weather conditions. Top: sunny weather; bottom: heavy fog, arrow indicating beginning of sunshine

individuals are outside. Figure 7 illustrates this difference in the pattern of emergence according to weather conditions.

Heavy clouds appearing during the day time bring the animals back into the vicinity of the burrow earlier than usual. Rain is avoided by remaining in the burrow. Only on one occasion were two individuals observed feeding while it was drizzling, both being lactating females which probably just had to get some food.

Relations to other species

A distinct reaction to calls of different birds is evident. Calls of Crowned Guinea fowl *(Numida meleagris),* Crowned plover *(Stephanibyx coronatus)* and White-browed sparrow-weaver *(Plocepasser meheli)* near the colony arouses the squirrels attention and they look for a moment in the direction of the sound, but continue feeding, etc. Such calls given by birds when either flying over the colony or when running past it usually make the squirrels run towards the burrow, whereas calls of the Black korhaan *(Afrotis afra)* are ignored. Turtle doves *(Streptopelia copicola)* and laughing doves *(Streptopelia senegalensis)* frequently feed among the squirrels but they pay no attention to each ohter.

Unfortunately it was never possible to observe any encounters between birds of prey or ground raptors and the squirrels. Antelopes passing through the colony slowly, or feeding there are completely ignored while a monitor lizard wandering through the colony caused an alarm call from one individual and the rest of the colony remained in lookout posture until the reptile had disappeared.

Two species of Viverridae come in close contact with *Xerus inauris* frequently: *Suricata suricatta* and *Cynictis penicillata.* The first of these species usually lives in bigger packs (up to 13 individuals were observed) and uses squirrel burrows to stay in just for a few nights. Squirrels and suricates ignore each other when just passing through the colony but even a half grown suricate can put a squirrel to flight when just running (playfully) towards it. Only once did an adult female ground squirrel show some aggression towards a young suricate which then immediately retreated. When a pack of suricates moves into a squirrel burrow they seem to prefer exactly the part being used by the squirrels. They usually arrive just before the squirrels retire for the night and simply occupy the den. The squirrels then sniff at their usual burrow entrance but do not enter it. They show signs of being uneasy and keep running to and fro between the tunnel openings until they

at last seek shelter in another part of the burrow. This happens every night until the suricates leave the area two to three days later. Then the squirrels immediately move back into the original inhabited part of the burrow.

The relationship with the yellow mongoose, *Cynictis penicillata,* is quite different. These Viverrids are solitary or live in small groups only and use their burrow for a longer period. Their home burrow frequently is in an old abandoned squirrel burrow or is even part of an extended burrow system still used by the squirrels. The two species generally do not pay any attention to each other – *Cynictis penicillata* sometimes raise their young right in the middle of a colony and individuals of both species might sun themselves in front of the tunnels within a short distance of each other. Only on three occasions out of 29 observations was a yellow mongoose chased a few meters by a squirrel – in one case at least by a lactating mother – which is a stage when the squirrels generally seem more aggressive. In these few cases the pursued mongoose ran just fast enough to keep its distance from the squirrel but showed no sign of excitement.

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Zusammenfassung

Zur Biologie von Xerus inauris (Zimmermann, 1780) (Rodentia, Sciuridae)

Xerus inauris, ein Nager der Trockengebiete des südlichen Afrika, lebt in Kolonien, die aus ein bis drei Gruppen von jeweils ein bis vier adulten Weibchen und ihren Jungen bestehen; ein adultes Männchen wird nur akzeptiert, wenn die Weibchen paarungsbereit sind. Soziales Verhalten und sechs verschiedene Lautäußerungen werden beschrieben. *Xerus inauris* pflanzt sich ganzjährig fort; im Winter erfolgt ein Geburtengipfel. Weibchen im Beobachtungsgebiet hatten nur einen Wurf pro Jahr (1—3 Junge, $\bar{x}$ = 2,1). Die Tiere erlangen mit etwa einem Jahr sexuelle Reife und haben nur einen Haarwechsel pro Jahr. Putzverhalten, Fortbewegung und Körperhaltungen werden beschrieben. Hauptnahrung sind Grashalme, Blätter und Samen; Insekten werden selten gefressen. Die tägliche Aktivität dauert von einer halben bis zwei Stunden nach Sonnenaufgang bis Sonnenuntergang. Die Beziehungen von *Xerus inauris* zu den Viverridae *Suricata suricatta* und *Cynictis penicillata* werden besprochen.

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Studies on Gerbillinae (Rodentia)

I. Banding patterns of mitotic and meiotic chromosomes of the Mongolian gerbil, *Meriones unguiculatus*

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Abstract

Presented G- and C-bands of the karyotype of *Meriones unguiculatus* and C-bands of meiotic chromosomes during metaphase I. The study was carried out on several male and female individuals derived from a laboratory stock. Mitotic chromosome preparations were obtained from fibroblast cultures, meiotic preparations from testes.

The mitotic chromosomes reveal characteristic G-banding patterns and can easily be identified. After application of C-banding technique, a remarkable distribution of heterochromatin becomes obvious. Though centromeric C-bands can be found in each pair of autosomes, differences in amount and staining intensity are present. Several autosomes show interstitial C-bands and one pair is heterochromatic throughout its length. The X chromosome is characterized by several bands of different staining intensity, whereas the Y chromosome shows uniformly dark staining.

In C-banded preparations of male meiosis, the pairing behaviour of the partly and totally heterochromatic autosomes and of the gonosomes could be analysed.

Several data suggest the presence of different categories of heterochromatin.

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