BEHAVIOUR AND BREEDING IN CAPTIVITY OF THE NAMAQUA GERBIL *DESMODILLUS AURICULARIS* (*CRICETIDAE: GERBILLINAE*)

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ABSTRACT

Desmodillus auricularis was kept in observation cages and subjected to an increased number of light-hours. The animal is nocturnal and its activity rhythm was adjusted using a red light to simulate darkness during the day. Three litters were produced from one pair and observations were made on twelve other litters born in the laboratory from pregnant field-trapped specimens. The breeding season appears to be all year. Litter size varied from one to five with a mean of 3,25. The gestation period was twenty-one days and gestation of a post-partum pregnancy was thirty-five days. The young were not attached to the nipple except when suckling. Behaviour is discussed with special reference to individual behaviour and parent-young relationship. Much of the general behaviour-pattern appears to be typical of most desert-adapted rodents. Hoarding and sandbathing were exhibited.

INTRODUCTION

The Namaqua gerbil occurs in the central, western and northern Cape Province, the Orange Free State, the western Transvaal, Botswana and South West Africa (Meester *et al.* 1964). Its distribution ends on the South West Arid Savanna border apart from isolated populations in the western Transvaal and north-western and south-eastern Free State (Davis 1962).

Breeding and laboratory adaptation of small wild mammals undertaken at this laboratory is done bearing in mind their potential use for experimental purposes in medical research (Davis 1963).

The breeding of the Namaqua gerbil, *Desmodillus auricularis* (A. Smith) has not been studied in detail, although Shortridge (1934) mentioned that it breeds freely in captivity and in 1965 one litter was produced and reared at the Medical Ecology Centre. Laboratory breeding records for the following Gerbillinae occurring in South Africa are available: *Tatera brantsi* (Measroch 1954) and (Meester & Hallett 1970), *Gerbillurus paeba coombsi* (Hallett & Keogh 1971).

Several behaviour studies of other South African wild rodents have been published: Veenstra (1958), Ewer (1967), Hallett & Keogh (1971), Davis (1972), Choate (1972), Brooks (1972).

The breeding and behaviour of one pair of *D. auricularis* and their litters was studied over a period of 12 months; during this time data from three litters conceived in the laboratory were recorded. Twelve litters from pregnant field-caught animals which gave birth in the laboratory were successfully reared in captivity and recorded. [These litters formed the nucleus of a now successfully established breeding colony.]

MATERIAL AND METHODS

A small colony of *D. auricularis*, originating from animals trapped 12 km NW of Vryburg in the northern Cape in March 1969, was maintained in the laboratory in metal cages measuring 30 × 15,5 × 12,5 cm. No special form of lighting was used and the average temperature was 21°C. The cages were supplied with sawdust and wood-wool as nesting material. Until August 1970 no litters were produced. One pair was placed in an observation cage (Hallett & Keogh 1971). An increase in the number of light hours has been found to increase the fecundity of *Tatera indica* bred in the laboratory (Bland 1968 and Hallett & Keogh 1971). The *Desmodillus* specimens, therefore, were provided with a 16 daylight and eight dark hour rhythm each day. Darkness was simulated by a red light which was set by a time switch to come on at 0900 hrs. A white light providing daylight was set to come on at 1700 hrs. Being nocturnal animals, their active period could thus be observed during the day. They were fed sunflower seeds and greens; carrots and potatoes were provided once a week. Water was available at all times.

BEHAVIOUR

Individual behaviour

Laboratory adjustments. The pair of mice in the observation cage adjusted to the change in light rhythm within three days. Each day they became progressively more active during the hours of red light until they awoke and became active just prior to the red light switching on. They remained awake and occasionally moved in and out of the nest-box during the eight hours of red light. At times they remained in the nest-box for five or ten minutes, but did not appear to sleep. They were not very active and often sat on top of the nest-box for long periods at a time.

General locomotory behaviour. In walking or creeping the animals used a diagonal sequence of limb movements. In swifter locomotion a hopping type of movement was used; the two front legs moved alternately very quickly and the hind legs moved together in leaps. During its movements the animal might pause and sit upright on its hind feet, the two forepaws being slightly extended. On several occasions an animal would jump vertically upwards. The height of this leap was varied but was limited by the height of the cage (i.e. 30 cm). The leap occurred when the animals were startled or as an avoidance leap (Eisenberg 1962), which was observed during the course of aggressive interaction.

When the mice were first placed in the observation cage they began to explore the surroundings. The elongate posture was adopted – the body being extended and close to the ground. This was followed by a creeping movement which was followed by walking or slow hops.

Sleep. The mice slept curled up together in the nest-box, the head of one tucked under the abdomen of the other. When only one mouse was in the cage, it slept curled up on its side, the head tucked against the abdomen. When there was more than one mouse in a cage, the animals huddled together. The mouse at the bottom of the heap of animals would often be found lying

on its back. Occasionally a mouse slept sitting up in a corner of the next-box, its back resting against its sides.

Grooming. Grooming occurred frequently just after the mice had woken and emerged from the next-box. Washing consisted of very rapid movements with the forepaws moving together under the mouth and then to either side of the mouth and over the tip of the nose. The head was then rotated sideways and the paws moved over the ears. Scratching was used to groom the body with rapid movements of the hind foot, followed immediately by biting of the claws. Eisenberg (1962) notes that biting the claws after scratching could be related to the removal of parasites. This did not appear to be the case as the mice were kept free of mites (by a weekly dusting of the cages with insecticide). Yawning frequently followed grooming.

Sandbathing (Eisenberg 1963b). During the active hours the mice would frequently jump into the sand bottle, roll on the back and move very rapidly from side to side. The roll was initiated with a swift movement from either the left or the right side. This lasted from four to five seconds and could be repeated up to four times. The pelage of those *Desmodillus* provided with sand in the observation cages appeared healthier than those kept in laboratory cages where no sand was provided.

The mice dug with the forepaws as the earth was kicked back by the hind legs. Eisenberg (1967) classified the components following digging as the "side rub", "ventral rub" and "rolling over". In the case of *Desmodillus* the side rub and ventral rub were not seen and digging was observed unassociated with rolling over. Digging occurred in the litter on the floor of the cage and not in the sand-bottle. Digging was also used to block the entrance of the nest-box.

Feeding. In the observation cages the mice thrived on a diet of sunflower seeds and greens. They picked up the food between the forepaws, placed it between the teeth and carried it to the nest. The food was then eaten inside the nest-box. The outer husk of the seed was broken by the incisors while the seed was held between the forepaws. The inner kernel was eaten and the husks were found discarded in a pile near the entrance. Occasionally the animals ate from the small container of sunflower seeds. Eating occurred during the entire active period but mainly during the first two hours of activity. The mice appeared to eat sand. Gross analysis of the faeces and microscopic analysis after crushing and suspending in normal saline and filtering the suspension, failed to produce evidence of sand in the faeces. Whether the sand was actually eaten is therefore uncertain. They were seldom seen drinking.

Hoarding. Many desert rodents cache quantities of food (Eisenberg 1967). *Desmodillus* exhibited this hoarding behaviour. As many seeds as could be carried in the mouth (usually two at a time) were transported to the nest. Several consecutive journeys were made carrying seeds to the nest. A hole was dug in which the seeds were placed and the bedding or sawdust then kicked over the pile of seeds with the hind legs.

Wood-wool was broken into small pieces and sometimes strewn over the cage floor or cached in the nest-box. This behaviour pattern was termed "hackseln" by Eibl-Eibesfeldt (1951) and as "chopping" by Eisenberg (1967).

Eliminative behaviour. No special posture is assumed during defaecation. Defaecation occurred anywhere in the observation cage and nest-box. Urination was not often seen. Some species of Gerbillinae can recover metabolic water in the kidney and live on food alone (Burns 1956; Kirmiz 1962; Schmidt-Nielson 1964). The fact that the *Desmodillus* were not often observed either drinking or urinating is consistent with their adaptation to a semi-desert environment.

Nest-building. Both entrances to the nest-box were blocked during the inactive period and one or both unblocked during the active period. The entrances were closed by kicking the bedding with the hind legs, the forelegs performing scraping movements on the substrate. The actual nest inside the nest-box was a hollow of bedding and wood-wool almost covered over by the same material.

The nest was made in the following manner. The animal kicked bedding into a small heap, gathering as much material as it needed for the nest. It then bit the wood-wool into small portions and pushed the sides into place by jerking the head under some of the material. When a depression had been formed, it continued jerking the head and nose under the sides and moulded the nest into a small depression with overhanging sides.

Social behaviour

Social behaviour comprises any behaviour pattern involving two or more individuals.

General communication. The senses applied in communication are those of sight, sound, smell and touch. *Desmodillus* has large eyes and the mice were seen to respond readily to movements of the observer. At no time was any sound heard from adult mice, but the young squeaked (see Parent-young relationships). Drumming with the hind feet appeared to constitute an alarm signal. When the mice were suddenly disturbed one of them would drum the hind feet together on a hard surface (i.e. the top of the nest-box). The other mice in the cage responded to this by remaining still and apparently alert. After this initial freezing they would run into the nest-box and remain there until the drumming ceased and for a few moments afterwards. The drumming was of only a few seconds duration but occurred intermittently for two or three minutes. The role of chemical communication in the mice was undetermined. Recognition of con-specifics was naso-anal, and familiarity with the surroundings after the cage had been cleaned appeared to be re-established only after the entire cage had been fully explored.

The preputial glands of *Desmodillus* did not appear exceptionally large. This was determined by dissection of laboratory specimens. The animals did not use urine for territorial marking, but it is possible that the secretion from the preputial glands was used. This remains a question for further study. Communication by touch is discussed under Adult interaction and Parent-young relationships.

Parent-young relationships. The young were reared in the nest-box until they were able to move out of it from the 10th day onwards. The female carried the young in her mouth from one part of the nest-box to the other during the first seven days after birth. This was accomplished by clasping the young across the back between her jaws. During the course of moving them they

were put down and picked up and never carried for long in one clasping position. The male did not carry the young at any stage. The female groomed the young by licking them from anterior to posterior, the action ending in an anal lick. This was noticed on day 5 and subsequently. After the young began eating solid food on day 18 the female ceased licking them. The young remained unattached except when suckling. The female lay crouched over the young or lay curled up sideways when suckling them. When she lay crouched over them, the hind legs were spread slightly outwards to enable the young to suckle.

The female responded to squeaks of the young which occurred when she was absent from the next-box. She would then become agitated and often carried them from one place to another. The squeaks were heard only for the first week after birth.

The relationship between the female and young appeared to be determined by her success or failure to conceive after post-partum oestrus. When no further litter was born the female tolerated the young until such time as she became pregnant. When pregnancy occurred, she showed aggressive behaviour by preventing the young from entering the next-box or eating the sunflower seeds. An upright threat posture was adopted by the female, but, because the young were submissive, fighting did not occur.

Adult interaction. Aggressive behaviour and the establishment of dominance was manifested by the female when in oestrus, and by individuals when moved from one cage to another encountering unfamiliar individuals.

Contact. The elongate posture was adopted initially, the tail being lowered and stretched out horizontally; this was followed by two mice making naso-nasal contact.

Submission. If the encounter was male-female the submission posture was adopted either by the male or the female (this varied in different instances and with different individuals). The submissive mouse laid back its ears, but the eyes were not narrowed as described in the case of *Rattus rattus* by Barnett (1963).

Flight and chasing. The submissive mouse would flee, being chased by the aggressor. The chase led through both entrances of the nest-box, shelter being sought in the sand-bottle. The mice usually ended the chase by fighting, which involved attacking the genitals. This often occurred in the sand-bottle.

Displacement grooming. Occasionally the chase would end without a fight; both mice then indulged in displacement grooming.

The male-female encounter occasionally led to a series of behaviour patterns ending in mating.

If the encounter was between two strange males immediate fighting occurred. This did not involve a chase and the movements were so quick that it was difficult to notice anything other than spontaneous attack. The mice proved difficult to separate on these occasions.

Mating behaviour. Mating was observed on one occasion. The male had been chasing the female. When the female stopped running she approached the male and started bobbing up and down in front of him, after which the male tried to sniff the female's genital region. She attacked him on the rump and bit his tail. The male ran off, the female chasing him. The male ceased running after a few seconds and was approached by the female and naso-nasal sniffing occurred. The female then backed away and was followed by the male. The female then remained crouched and was mounted by the male. Copulation lasted a few seconds, followed by face-washing by the male. The procedure was not repeated immediately, but mating occurred several times during that day.

BREEDING AND POST-NATAL DEVELOPMENT

Three litters were produced and reared during the 12-month period of observation. Two litters were born in October and one in March. Litter size was three in two litters and one in the third. The gestation period was twenty-one days and gestation of a post-partum pregnancy was thirty-five days. Twelve litters, which were born in the laboratory from females trapped when pregnant, were observed and data recorded from these observations substantiate those of the litters produced under laboratory conditions. These litters were born in March and September.

Status at birth

The young at birth are hairless and pinkish in colour. The eyes are closed and the ear pinnae attached. The young remain unattached to the female except when suckling. They are capable of making feeble movements but are not ambulatory. The mean weight at birth was 4,4 grams (19 animals). The auditory meatus is closed. The young make squeaking noises from birth.

Morphological development

As it was considered of prime importance to rear the young to maturity, they were handled as little as possible and no measurements were recorded.

Hair proliferation. Vibrissae appeared on day 3. On day 4 the skin became much darker dorsally and on day 6 hair appeared on the head and very sparsely on the back. The white spots behind the ears became noticeable and covered with hair on day 5. The hair became progressively fluffy and obvious and by day 9 the whole body was covered except the genital region, the hair on the ventral region being white and a pale buff-colour dorsally.

Ear pinnae. Ear pinnae started loosening on day 3 and were fully unattached by day 4.

Toes. The feet were pink at birth and all the toes attached. Both fore and hind toes started separating on day 3, and were fully separated on day 4.

Eyes. The eyes started opening as early as day 8, but in most cases they seemed to be unopen until day 10.

Locomotor abilities

Crawling. The young were able to crawl on day 2. This was a feeble movement which became progressively stronger. By day 7 they could crawl with a firmer co-ordinated movement and on day 8 could walk steadily.

Hopping. The young showed signs of hopping in a series of jerky movements when they were about nine or ten days old. This movement gradually became more co-ordinated and by the time they were weaned at three weeks they were very active. They hopped on to the top of the nest-box at three weeks.

Feeding. The young were not attached to the nipple except when suckling. They were observed eating solid food on day 18 and by day 21 appeared fully weaned.

DISCUSSION

Desmodillus auricularis is a nocturnal animal (Smithers 1971), hence its active period was observed in the laboratory with the red light simulating darkness from 0900 hrs until 1700 hrs. The animals adjusted to the change in light-rhythm relatively quickly. They are not very active compared with *Gerbillurus paeba coombsi* and Roberts (1951) noted that they tend to become fat when food is plentiful. This fact may have some bearing on their inactivity for they are generally somewhat sluggish in behaviour and easy to handle.

Behaviour patterns appeared consistent with those of many desert-adapted rodents. Sand-bathing is a complete movement-pattern functional in dressing the pelage and in marking (Eisenberg 1963a & 1967). Thus in desert-adapted species sand-bathing tends to be concentrated at a specific locus. Because the sand provided was in only one place (i.e. in the sand-bottle), this specificity could not be determined.

The natural food consists of seeds such as those of wild melons and "dubbeltjies" – *Tribulus campestris* seeds, but remains of locusts have been found at the entrances of the burrows (Roberts 1951). The mice have also been noted to feed on the flowers of the wild everlasting *Helichrysum* sp. (Bradfield in Shortridge 1934). In captivity they thrived on sunflower seeds which they ate mostly inside the nest box. Hoarding behaviour was exhibited.

The mice were seldom seen drinking or urinating, which was consistent with their adaptation to a semi-desert environment.

In nature the mice live in burrows which do not extend for longer than 2 m below the surface. The entrances are closed when the animals are in occupation, the loose soil for this purpose including prickly seeds which, as well as forming part of their diet, act as a deterrent to digging attempts by their enemies (Roberts 1951). Hewitt (1931) noted that in some sandy places the veld may be riddled with burrows. In captivity, the fact that the entrances to the next-box were closed during the inactive hours is consistent with observations on nesting behaviour in nature. Although Powell (1925) noted that they seldom scratched earth from their burrows, they frequently scratched the bedding away from the entrances to the nest-box during their active periods.

No sound was ever heard from the adult mice although the young squeaked when left unattended by the female. Drumming constituted an alarm signal. Aggressive behaviour was manifested when the female was in oestrus.

Little or nothing is known of the seasonal activity of this species. According to A. Smith in Shortridge (1934) *D. auricularis* has a tendency to be migratory in times of drought.

D. auricularis has been found to have an extensive breeding season. Powell (1925) noted that the mice breed four times a year and that females containing foetuses were collected in October and November. Smithers (1971) found gravid females in wet and dry seasons in Botswana. According to records from the State Medical Ecology Laboratory gravid females have been found in March, June, July, August, September, October and November. According to Shortridge (1934) litter size varies from four to six.

No litters were produced in a small colony of *D. auricularis* kept for one year and four months under normal laboratory conditions. An increase in the number of light hours has been found to increase the fecundity of *Tatera indica* (Bland 1968) and *Gerbillurus paeba coombsi* (Hallett & Keogh 1971) in captivity. *Desmodillus* provided with a sixteen daylight and eight dark hour rhythm produced and reared three litters.

One of these litters was born in March and two in October. The twelve litters from pregnant field-caught specimens were born in the laboratory in March and September. The gestation period of twenty-one days was slightly shorter than that of *Gerbillurus paeba coombsi.*

It would thus appear that an increase in the number of light hours induces fecundity in *Desmodillus auricularis.* It must be noted, however, that the young born in the laboratory have since been breeding successfully under normal laboratory conditions. The reason could be adaptation to laboratory conditions from birth. The establishment of monogamous pairs is possible only when the male is removed immediately the young are born, and the pair remated after the young have been weaned.

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