

HUSBANDRY STANDARDS FOR KEEPING NAKED MOLE RATS IN CAPTIVITY

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INTRODUCTION

Naked mole-rats are small rodents which belong to the family Bathyergidae, the genus *Heterocephalus*, and finally the species *glaber*. There are 12 species in 5 genera of bathyergid mole-rats. Scientists consider porcupines, chinchillas and guinea pigs to be their closest living relatives. The name *Heterocephalus glaber* means “different-headed hairless” (Rüppell, 1842). The naked mole-rat is a mammal because of body structure and lifecycle but is unlike other mammals. They have very little body hair and are unable to maintain a constant body temperature when the environmental temperature changes more than a few degrees. Furthermore, the naked mole-rat is unique among mammals because of its Eusocial lifestyle (Jarvis, 1981). Naked mole-rats are genetically very closely related to each other (Honeycutt et al. 1991a). Naked mole-rats are endemic to hot, dry regions of East Africa ranging from Kenya to Somalia and Ethiopia (Honeycutt et al. 1991b). Adults have a head and body length of 3.2-3.6 in (8 – 9 cm), tail length is 1.4-1.6 in (3.5 – 4 cm), and body weight of 1.4-2.8 oz (40 – 80 g) (Jarvis et. al. 1991; Lacey and Sherman 1991). Naked mole-rats can be long lived, in captivity some animals have survived over 26 years (and counting) (Sherman, Jarvis, 2002).

Historically the naked mole-rat had not been kept in North American Zoo collections until the late 1980's. The species became desirable in zoological collections after the 1981 publication of their Eusocial behavior by Jarvis. The first few colonies that became available in the U.S. were surplus from Jarvis's research at the University of Cape Town in South Africa. In 1991 additional naked mole-rats became available from a collecting expedition in Kenya conducted by Stan Braude and David Wood organized by the Philadelphia Zoological Garden. Although captive management techniques had been established for this species naked mole-rats presented a challenge in public exhibition because of the species sensitivity to sound and vibration (Brett, 1985). This had affected the successful rearing of offspring and normal behavior. Desensitizing the naked mole-rat for public exhibition with the use of radio proved successful (Wood, 1991). The exhibition of this unique mammal became very popular in Zoos not only for their educational value but also due to the Zoo visitors fascination with this species. Naked mole-rat exhibits quickly became successful as educational and entertaining exhibits as well as marketing promotions in North American Zoos.

GENERAL REQUIREMENTS

1. ABIOTIC ENVIRONMENTAL VARIABLES.

- 1.1 **Temperature:** Naked mole-rats are essentially poikilothermic evolving without the ability to thermo regulate their body temperature (Buffenstein and Yahav, 1991a). Enclosure temperature range must be maintained between 82° - 87° F (26° - 31° C.) allowing the animals to regulate through heat exchange (Brett, 1986, 1991b). Higher or lower temperatures for extended periods will effect the health of the colony and may result in death.
- 1.2 **Humidity:** Naked mole-rats should be maintained in a humidity level of 30-50%. Burrow humidity levels of 80% and higher have been recorded in the wild (McNab, 1966; Withers and Jarvis, 1980). If the humidity level drops too low for extended periods the mole-rats will develop dry skin. The appearance is that of a fine whitish covering over the skin.
- 1.3 **Illumination:** Naked mole-rats live a subterranean existence. They have reduced eyes and visual acuity is poor (Hefner and Hefner 1993). Components of the visual system are present corneal electroretinogram recordings revealed no physiological responsiveness (Hetling et al. 2000). Mole-rats show an initial response to bright lights but do not seem to be effected by natural, fluorescent or incandescent lighting long term. The long-term effects of UV light exposure is unknown, precautions should be taken to protect this species from direct sunlight.
- 1.4 **Space**
 - 1.4.1 Naked mole-rat burrow systems in the wild can encompass nearly 2 miles (3.2 km) for a large colony. Colonies can number from 10 to 290 individuals, with an average of 75 – 80 animals per colony (Braude 1991a, 2000; Brett 1991a). The burrow system must provide everything the colony needs to survive - protection, food and warmth. In captivity naked mole-rats will exhibit normal behaviors and reproduce in much less space. However, there may be a direct relationship between the limits of an artificial burrow system and the number a colony will grow to in captivity. Mole-rats can be maintained simply in a large aquarium or metal water trough. By providing PVC tubing, boxes and woodchips, the mole-rats will establish a burrow system.

Because of the difficulty in maintaining sanitation and proper temperature, they should only be maintained in these conditions on a temporary basis. Use of clear PVC tubes and chambers is the most common method (Jarvis, 1991). A series of 2" (5cm) clear PVC tubes connected by elbows and Ts terminating in round 8" (20.3cm) diameter or square 10" X 10" X 6" (25.4cm X 25.4cm X 15.2cm) clear chambers. These round or square chambers are fabricated with a fixed bottom and removable top for accessing the animals, cleaning and feeding. The tops of the chambers are drilled with a series of 1/4" (6mm) holes to provide ventilation. Hydrostone and wire with a glass panel can be sculpted to create habitats that are realistic in appearance (Mendez, 1995).

- 1.4.2 **Temporary separation:** Naked mole-rats live in a colony which shares a communal scent. Separation such as escapes may result in these individual(s) not accepted back into the colony, and they could be killed. Attempts can be made to reestablish individual(s) in the colony by placing them along with the entire colony in a bucket or other neutral container. The contents of their toilet chamber should also be placed in this container. The colony should remain in this container for at least one hour before being placed back into their habitat. Success with this method is varied and is dependent on the length of separation and the colonies demeanor. Naked mole-rats should never be separated intentionally for more than a few minutes.
- 1.4.3 **Furnishings:** Most members of a naked mole-rat colony spend their active time digging, foraging and maintaining their tunnel system. Items should be maintained in the burrow system to encourage these types of behaviors. Yam, potato and other large tubers can be used to block tunnels. Small cardboard boxes, cornhusk, clump grasses can be placed in a burrow or tunnel. Cardboard tubes from paper towels, toilet paper and wrapping paper inserted in the tunnel system work well. The activity of chewing and moving debris is fundamental to the mole-rat.
- 1.4.4 **Acoustic:** Mole-rats can be sensitive to sound which will affect normal behavior and the successful rearing of offspring (Brett, 1985). Desensitizing mole-rats to sound can easily be accomplished with the use of a radio playing 24 hours a day (Wood, 1991). Volume should be set to approximately the same level as the sound they will be

exposed to during exhibit maintenance and public exhibition.

- 1.4.5 **Substrates and bedding/nesting materials:** Pinewood shavings, cornhusk, grasses and paper towel are materials normally provided for nesting material. Cedar shavings are not used due to its strong odor that may interfere with olfactory communication. Natural substrates such as sand or soil are not normally used because of the difficulty these cause in keeping the exhibit clean, dry and dust levels low which will effect viewing.
- 1.4.6 **Enclosure variation:** Providing items within the habitat that simulate burrowing behaviors will greatly increase activity. Pine wood shavings, grasses, paper tubes, large tubers, small stones give the mole-rats items that can be moved but do not spoil the habitat. Blocking tube(s) with items such as yam or potato will also stimulate burrowing behavior. Mole-rats are relentless chewers, by providing them with controlled activities could possibly reduce exhibit repairs.
- 1.4.7 **Scent and cleaning:** Habitats should be spot cleaned daily by removing old food and spoiled substrate. The entire habitat should be cleaned with mild dish soap every 2-4 weeks depending on the colony size. Mole-rats use a communal toilet chamber which is normally located at a dead end in the burrow system. This toilet chamber is important for the colony to maintain it's olfactory identity and should not be excessively cleaned. The toilet chamber should be cleaned once a week by emptying contents and rinsing with water, drying and adding new substrate. Toilets should be cleaned with mild dish soap about once a month.
- 1.4.8 **Air changes:** Mole-rats having evolved in subterranean burrow systems and require little ventilation for good health. The naked mole-rat's blood has a high oxygen affinity (Johansen et al. 1976) and the lungs are minimally developed (Maina et al. 1992). The number of air changes per hour should not effect the required temperature and humidity range in areas housing naked mole-rats. Vents or fans should not blow directly into mole-rat habitats.

1.4.9 **Containment:** Naked mole-rats are relentless chewers and in time will chew through or damage most materials other than metal or glass. Mole-rat jaw muscles constitute 25% of the animals total muscle mass (T. Grand, vide Sherman et al. 1992).

1.4.10 **Transportation**

1.4.10.1 **Type of transport container:** Two types of containers are normally used when transporting mole-rats by air (Jarvis, 1991). A wooden box with a sheet metal lined interior, series of ¼” (6mm) ventilation holes drilled into the lid and a single row around all 4 sides. Holes drilled into the sides should be located near the top of the box, approximately ¾ the distance from the bottom. This will allow for proper ventilation but will prevent the mole-rats from chewing at the holes and possibly injuring themselves on the sheet metal. Lid is secured with screws.

Metal box made from galvanized steel or aluminum with a hinged or fitted lid. Series of ¼” (6mm) ventilation holes drilled in a single row around all 4 sides approximately ¾ the distance from the bottom. The box is placed inside a standard Sky Kennel and secured by putting the two halves together. Foam padding is placed on the top and bottom of the metal box creating a tight fit inside the Sky Kennel.

1.4.10.2 **Container size:** The size of the box is dependent on the number of animals being shipped. A box measuring 15” X 15” X 12” (38cm X 38cm X 30.5cm) can transport approximately 10 – 30 mole-rats. Smaller boxes should be used for fewer animals allowing them to huddle together for warmth. Larger boxes should be used for larger colonies to prevent overheating. When transporting naked mole-rats by car or hand carrying them, a plastic cooler works very well.

1.4.10.3 **Food and water:** Mole-rats acquire all of their water needs from the food they eat (Urison and Buffenstein 1994). They should never be given water. Yam and some high in moisture fruits such as banana and apple should be provided during shipment.

- 1.4.10.4 **Bedding during transport:** A layer of pinewood shavings 2-4" (5–10 cm) thick should be placed in the container.
- 1.4.10.5 **Flooring:** No special flooring is necessary to separate animals from their urine and feces, pinewood shaving will suffice.
- 1.4.10.6 **Temperature:** Naked mole-rats are very sensitive to temperature and care must be taken to protect them from extremes. Effort should be made to ship mole-rats when the temperature range is 75-86°F (23-30° C) during transit. Communication with airport personnel regarding the naked mole-rats temperature sensitivity is important.
- 1.4.10.7 **Noise during transport:** Effort should be made to minimize noise and disturbance as much as possible during transport. Adult mole-rats can be very tolerant to these disturbances but very young animals are excessively carried and may not survive. It is advisable not to ship a colony of mole-rats with young less than 3 months old.
- 1.4.10.8 **Separation for transport:** Mole-rat colonies should be kept together at all times but large colonies can be separated for some hours during transport. Colonies that have been separated for transport must be put together immediately upon arrival.
- 1.4.10.9 **Access during transport:** Mole-rats can be safely transported by air without the need of accompanying staff. Arrangements should be made with airline personnel to take special precautions to maintain their temperature needs.
- 1.4.10.10 **Duration of transport:** Mole-rats shipped in closed containers by air transport should not exceed 24 hours. Mole-rats transported with access by animal care staff can take a number of days with a supply of food.
- 1.4.10.11 **Release after transport:** Mole-rats should be released into their exhibit or quarantine holding upon arrival. Colonies split for transportation must be reunited immediately.

2. BIOTIC VARIABLES

2.1 Food and water

- 2.1.1 **Water:** Mole-rats acquire all of their water needs from the foods they eat even though some of these foods may be high in salts (Urison and Buffenstein 1994). Water should never be given to mole-rats.
- 2.1.2 **Food:** In nature mole-rats feed on a variety of roots and tubers (Brett, 1991b). Natural food items are low-quality, high-fiber, digestive efficiencies are 88% (Buffenstein and Yahav 1991b). In captivity they do well on a base diet of sweet potato or yam. A combination of items such as banana, raisins, carrots, peas, corn, peach, apple, pear, frozen mixed vegetable should also be included.
- 2.1.3 **Feeding:** Mole-rats should be presented food in one chamber, normally a dead end for the ease of removal and cleaning. They should have access to food 24 hours a day since individuals will feed at any time throughout the day.
- 2.1.4 **Enrichment feeding:** Blocking a tunnel with foods such as yam, sweet potato, corn on the cob or carrot will provide activity as well as food.

2.2 Social Considerations

- 2.2.1 **Group composition:** Naked mole-rats have evolved with a highly structured social organization (Jarvis 1981). This organization consists of a caste system made up of a single breeding female, 1-3 breeding males, soldiers and workers. The breeding female or “queen” dominates the colony. Soldiers and workers can be of either sex but the colony sex ratio is male biased (Braude 1991a; Brett 1991a; Jarvis 1985; Sherman et al. 1992). Workers make up the largest group within the colony. All members of the colony help to care for the young and provide cecotrophes during weaning. Each individual naked mole-rat is in physical contact with the rest of the colony from birth to death. When the breeding female dies or is removed from the colony another female will take her place. During this transition, serious aggression may occur by competing females causing injuries and possible fatalities.

2.2.2 **Temporary isolation/separation:** Naked mole-rats should never be Intentionally separated for more than a few minutes unless to found new colonies. Individuals can be separated for a few weeks and then reintroduced as founders for new colonies. Escaped animals can sometimes be reintroduced by following procedures outline in section 1.4.2.

3. **HEALTH and NUTRITION**

3.1 **Diet**

3.1 **Nutrient requirements:** Naked mole-rats have a low metabolism feeding on a variety of roots and tubers in the wild (Brett 1991b). Sweet potato or yam is the staple in a mole-rat captive diet. Combinations of items such as corn, apple, raisins, pear, peach, carrot, banana, peas and frozen mixed vegetables should be added daily. Individuals will feed at anytime throughout the day. Fresh food must be accessible at all times.

3.2 **Health**

3.2.1 **Preventative medicine:** No vaccinations are currently recommended for rodents. Routine fecal checks should be performed twice yearly.

3.2.2 **Medical management:** Mole-rat teeth continually grow but are normally worn down by tunnel excavation and by the filing of upper and lower against each other (Jarvis 1969; Lacey et al. 1991). With appropriate dietary components and this species tendency to chew on whatever is available no tooth clipping should be required. Teeth may grow too long and interfere with feeding if opposing teeth are damaged or lost. Trimming teeth with the use of toenail scissors is easily accomplished until missing teeth grow back. This procedure should be done as needed and the individual(s) returned to the colony immediately. Because of the rapid tooth growth in this species clipping may only be required for a few weeks.

4. **REPRODUCTION**

4.1 **Breeding:** The single breeding female (queen) mole-rat breeds with 1-3 breeding males throughout the year. Litters are normally born in 80 – 90 day intervals. Litter size can range from 1 - 24 pups but average litter sizes are 10 –19. Because of available space and the lack of predation in captivity naked mole-rats will stop raising litters. Periodic removal of non-breeding animals to establish new colonies can

stimulate the successful rearing of litters. It is advised to allow the colony to self regulate its size.

4.2 **Neonate care:** Naked mole-rat colonies become very sensitive to disturbance when newborns are present (Brett 1986). Pups are moved and carried excessively when the colony is disturbed. This causes injuries and does not allow the pups to nurse. Routine care and noise should be kept to a minimum. If possible, all activity except for feeding should cease until the pups are 15 – 20 days old. Colony members will stay with the pups keeping them together in one chamber. The “queen” will enter this chamber allowing the pups to nurse. Pups will solicit cecotrophes from colony members when they are 2 – 3 weeks old becoming independent at 4 – 6 weeks.

4.3 **Sexing:** Naked mole-rats can be sexed by holding the animal upside down by the tail, look between the two orifice for the presents or absences of a horizontal red line. The presents of a red line indicates a female. Sexing naked mole-rats can become easy with practice.

5. BEHAVIOR MANAGEMENT

5.1 **Aggression:** Mole-rats will periodically fight or spar with one another to establish or maintain their status within the colony. This type of fighting is usually minor with no serious injuries. Serious aggression can occur when, the breeding female has died and females compete to replace her, more than a pair has been separated to found a new colony, animal(s) which have escaped or been kept separate from the colony for too long and are returned. Newly established breeding female may attack her siblings once she has had surviving litters of her own. Mole-rats that are seriously attacked and injured may eventually be killed if left in the colony.

5.2 **Staff:** Animal care staff should be trained in small mammal husbandry and provided with information regarding the unique care requirements and social structure for this species.

Definitions

Caste: Individuals within a colony belonging to a particular morphological type or age group, or that share a particular behavior pattern and perform the same specialized function.

Cecotrophes: Soft, partially digested pellets of feces eaten to replenish protozoa and provide nourishment.

Eusocial: Used of a social group in which members are fully integrated and cooperate in caring for young, with non-reproductive individuals assisting those involved in producing offspring, and in which different generations contributing to colony labor overlap.

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