

From ZOOKEEPING : Husbandry and Care of Small Mammals

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Editor's note: We apologize for not including the ZOOKEEPING article last issue. ZOOKEEPING is a high level book created by many experienced veterinarians, zoo directors and curators, conservationists and also zookeepers FOR zookeepers and other zoo personnel interested in learning and improving the care of zoo animals throughout the world. The book ZOOKEEPING is a very large and heavy tome and expensive for countries with a low currency. We thank the authors for permitting us to share these useful articles. The Husbandry and Care of Small Mammals is not complete. The second part of it will appear next month in ZOOS' PRINT. S.Walker, Editor, ZOOS' PRINT.

INTRODUCTION

There are over 4,500 species of mammals, and they are found in the oceans, high in the mountains, in the hottest deserts, and in the coldest places on the planet. Some are adapted for burrowing, some for swimming, some for running at high speeds or for long distances, and some for climbing, leaping, gliding, or flying. However, most are not specialists at moving around the environment, but can move quickly in many of the above-mentioned ways to find food or for flight/fight purposes. Most are secretive, cryptically colored, and nocturnal in nature and therefore are difficult to observe or even find in their natural habitats. They range in size from the tiny bumblebee bat (*Craseonycteris thonglongyai*), weighing in at less than two grams, to the massive blue whale (*Balaenoptera musculus*), which can weigh more than 120,000 kg (264,600 lbs). Most are less than one-half meter long—and these and other mammals that zoo professionals call “small mammals” are sometimes identified as being “smaller than a bread box.”

Larger mammals such as hoof-stock and primates will be covered in their own chapters, but basic concepts for management of all mammals run throughout small mammal husbandry, including guidelines for species-appropriate exhibit size, bedding, and nutrition. In modern zoos, for instance, small mammals have been managed in taxonomically specialized areas with names like “Small Mammal House,” “World of Darkness,” or, more recently, as part of the diversity in habitat immersion exhibits, “Amazonia,” “Australia,” or “American Prairie.” The best of these exhibits recreate natural habitat and diet so that the animals are “up close and personal,” so that zoo guests can observe the nuances of mammalian adaptations and species-appropriate behaviors, and so that guests are engaged and inspired to conserve these unique and charismatic animals. Although only small collections of small mammals continue to exist in zoos and aquariums, much research has been done on small mammal relatives from different taxonomic groups due to their use in laboratories, as nutrition models, and as companion animals (or “pocket pets”). For some mammals, research is routinely done to aid

agriculture or commercial activities, and information about them is found in a variety of specialty publications and websites maintained by a variety of small mammal interest groups.

This chapter will emphasize management of small mammals in human care. After studying this chapter, the reader will understand:

- the interrelationship of mammal behavioral needs and keeper behavior, and important safety precautions keepers should take to protect themselves and their animals, specifically small mammals as mammalian examples.
- best practices for furnishing and cleaning small mammal enclosures.
- key physical and behavioral traits of small mammals.

NATURAL HISTORY

Mammals are defined by their mammary glands and their obvious hair, whether in the subclass Prototheria (monotremes), the infraclass Metatheria (marsupials) or the infraclass Eutheria (placental mammals). Mammary glands that provide milk nutrition to newborns may be in slits (as in cetaceans), in multiple smallish teats (as in multimammate mice and others), or in relatively large breasts (as in sloths). Their hair is often an adaptation for temperature control, and naked mole rats (*Heterocephalus glaber*), which live underground in sandy soils of East Africa, have few hairs scattered over their wrinkled skin; they can thermoregulate by finding appropriate temperatures underground. Tropical mammals have less hair, and different types of hair, than do thick-coated mammals from arctic or montane regions. Many mammals actively thermoregulate; they can bunch up their bodies or their hair coats can fluff up (piloerect) to create a warm blanket of air around the body. Specialized hairs include the whiskers that help nocturnal mammals find their way in dark undergrowth, Tail Patagium (wing membrane), Fifth finger Foot (five toes), odor/chemical-holding hairs that aid mammals in marking territories, and quill-like defensive hairs in mammals like porcupines.

Some small mammals have become domesticated by humans (e.g., dogs, cats, ferrets of the order Carnivora), are commensal with humans (e.g., rats, mice of the order Rodentia), or are in the process of being domesticated (e.g., foxes [*Vulpes* sp.] on fur farms, and “pocket pets” like hedgehogs [*Erinaceus europaeus*]). Whether domestic or wild, the diversity of mammalian natural history and habitat has

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resulted in behavioral specialties, and diets must be carefully considered in the development of exhibitry and husbandry techniques for each species. Canids are generally omnivores, felids are obligate carnivores, mustelids are specialized feeders, and so on. Just within the rodent group of 30 families and more than 1,700 species, there are animals with a wide variety of feeding strategies, from generalists to specialists. Similarly, a diversity of feeding strategies is found across the entire class of mammals, as well as within smaller taxonomic units. Of course there is also a diversity of adaptations that need to be considered when developing husbandry. Small mammals adapted to the Arctic are not capable of thermoregulating in what for them is extreme warmth, and conversely, small mammals adapted to the tropics may be hypersensitive to drafts or cold.

Natural histories of mammals provide a framework for working with these species. Although vertebrate species represent only about 5% of all animal life on earth, and mammals are only 12% of all vertebrate species, mammals are very diverse and can be found in just about every ecological niche that will support life. Some of their defining hairs are modified into sensory whiskers that help them survive a nocturnal lifestyle in these varied environments. Their hair and skin is often modified for attack or defense; examples are the horns of rhinoceros, the scales of armadillos, and the quills of porcupines. Some mammals have almost eliminated hair to help themselves keep cool, as in the naked mole rats that live underground in Africa, or the hippopotamus that remain underwater to stay cool during the day. Arctic mammals like the arctic fox (*Alopex lagopus*) have the most hairs per skin area of any mammal, to help themselves stay warm in their cold environment. Mammals are much more often nocturnal than birds, but exceptions are such primates as golden lion tamarins (*Leontopithecus rosalia*), such squirrels as Prevost's squirrels (*Callosciurus prevosti*), several viverrids such as meerkats (*Suricata suricatta*), and larger mammals including hoofstock. Even mammals typically thought of as being mostly nocturnal, such as cats, foxes, and weasels, may be active during the daytime.

Some mammals, like raccoons (*Procyon lotor*) and bobcats (*Felis rufus*), have very broad diets and the ability to live in a variety of habitats, and therefore have very extended ranges. Others, like Oriental water shrews (*Chimarrogale* sp.), which live in water and eat a relatively narrow range of aquatic invertebrates, and koalas (*Phascolarctos cinereus*), which live in trees and eat only eucalyptus, have very narrow ranges. Herbivores eat food that cannot escape (plants), while omnivores and carnivores are more adapted to eat prey that can and does escape. Even so, herbivores are often equipped (adapted via the teeth and gut) to most efficiently use only certain types of vegetation, such as roots, seeds, leaves of bushes, leaves of grasses, or leaves of trees. Some

bats (order Chiroptera) are fruit eaters and can feed from a roost, while other bats and insectivores are insectivorous and need to feed on moving insects. Carnivores may show hunting specializations like the crouch-wait-rush-and-bite behavior of cats or the front foot dexterity of otters (*Lutra* sp.) and raccoons, or they may be distance runners like wolves (*Canis lupus*). Some herbivores may show hoarding behavior, and may need to store large piles of food to feel "comfortable"; some carnivores may show caching behavior, in which they eat part of their prey and bury the rest. Each species has its own tooth, fang, and claw architecture and strength adaptations based on its diet and habitat.

Many mammals have evolved shelter-building behavior and construct dens, tunnels, tree nests, and other elaborate structures. Some of these behaviors are so innate and so specific that keepers will need to provide specific materials to allow appropriate shelter construction and associated activities (e.g., reproduction) to occur. For instance, many small mammals make nest sites within their shelters, and often prefer different types of bedding for their nests (or sometimes prefer a "clean" nest with no bedding at all). As an example, North American red tree mice (*Phenacomys longicaudus*) build their nests only in Douglas firs (*Pseudotsuga menziesii*), and their preferred food is the needles of that tree; a keeper of this species could potentially provide an artificial nest, but might need to consider the provision—and method of presentation—of fresh fir branches for their needles (as food for the mice) and branches (to serve as trail systems and runways).

Mammals communicate in a variety of ways including visually, auditory (by sound), olfactory (by scent), and with tactile (touch) stimuli. A mammal's highly developed facial musculature, control over erection of hair, and ability to assume a variety of positions enables it to communicate in a visual way that is not observed in many other animals; primates, canids, and hoofed animals are especially well-studied in this respect. Think of a cat that lays its ears back, opens its mouth, and hisses; a dog laying back its ears and lifting its lip to show its entire length of upper teeth while growling; or any animal that simply shows an open mouth—a clear threat without any noise. Elephants make sounds below the level of human hearing ("infrasound"). Small primates and medium-sized carnivores generally communicate within the range of human hearing. Bats and shrews use sound well above the level of human hearing ("ultrasound"), and bats' use of echolocation ("radar") is well studied. Certainly any person would be well aware of the intent of a small cat or dog that growls; other small mammals challenge a keeper's awareness, but also growl or even grind or chatter their teeth to signal that the keeper is too close. Rodents use ultrasonic vocalizations in a variety of social ways: for example, as calls by infants to adults, as inhibitions of adult-infant and adult-adult aggression, and even

as territorial announcements. Mammals communicate olfactorily via specific scents called pheromones, and we know these scents communicate information including precise species, sex, age, reproductive status, and territory boundaries among a variety of mammals. For the keeper it is important to remember that full cleaning with detergent or disinfectant of an environment marked by an olfactorily-oriented mammal such as the tree shrew (*Tupaia* spp.) may create some stress for the creature; it is better to spot-clean inside the enclosure and then fully clean about 25% of the area at a time, to limit the stress. As for tactile communication, the pre-copulatory behavior of many mammals may include a male laying its chin on a female's rump, nuzzling the female's genitalia, or touching various body parts of a conspecific. A dog (*Canis lupus familiaris*) may greet its "friends" with a mouth-greeting. Many aspects of mammalian communication have not been studied in detail, and keepers who are interested in it may find it rewarding to spend part of their days helping communication researchers.

Keepers need to remember all of this great diversity and address it effectively to be successful when working with mammals.

Good Practice Tip: *Small mammals mark their territories in nature and in human care. When cleaning their enclosure, a keeper should leave at least one-fourth of its area unscrubbed and undisinfected, so that the residents' odors remain in the exhibit. This should minimize stress in the animals.*

SMALL MAMMALS AND THE ANIMAL KEEPER

Keeper attitude and behavior around mammals, including delicate small mammals, is important. Keepers need to thoroughly understand the small mammals with which they work, so that they can work around them safely and effectively. Some such mammals can be "delicate" and flee at breakneck speed at the slightest unexpected movement, some can be aggressive toward keepers at relatively unpredictable times, and some can be very situationally hypersensitive to keeper activity (during feeding time, in breeding conditions, or when nesting with young).

One must take great care to not injure these animals or to injure oneself when working around them. Keepers need to be concerned about safety around small mammals, whose social behaviors range along the continuum from asocial to social. Relatively asocial small mammals include carnivorous and highly territorial ones (marsupials such as kowari [*Dasyuroides byrnei*], placentals such as weasels, and some rodents), which are really only social during reproductive periods of male-female courtship and mating and female infant-rearing; some of these are frequently intolerant of conspecifics outside

breeding season, so keepers need to take great care with introductions. Other species' natural histories include living in bonded pairs or family groups, and these animals may be tolerant of one another and even of their keeper when they are kept in small groups; examples include otters and North American beavers (*Castor canadensis*). Still other animals are highly social, live in large groups, and are highly tolerant of group members but perhaps not tolerant of "outsiders," keepers, or group members which have been separated from them for a certain amount of time; examples include bats, meerkats (*Suricata suricatta*), and spiny mice (*Acomys* sp.). The most extremely social of all small mammals are naked mole rats, in which there are even breeding "queens," as there are in social insects. Small mammals, like other mammals, may seem very quiet. This is a good adaptation to nocturnal life, and to life in different habitats in general. Small mammals are different from birds and insects in this way. But they communicate with scents, and with body posturing. So keepers need to be aware of the mammals' body odors, and if they change, it may indicate fear, aggression, illness, or a change in their reproductive status. An animal's body posture, ear movements, or lip shape may send a message to the observant keeper that it is ready to flee or attack (the "flight/fight" response to a stimulus). Small mammals' flight distances vary from species to species, on the basis of their ability to flee. Naked mole rats have not evolved an ability to flee; rather, they can dig quickly. In nature they live in stable ground, so in zoos, keepers need to ensure that they have a stable habitat. Squirrels, on the other hand, have evolved an arboreal ability to run and jump; so keepers need to ensure that squirrels in zoos have appropriate high places to move away to, and they also need to establish good relationships with the squirrels, to help decrease their flight distance. Blue duikers (*Cephalophus monticola*) are some of the world's smallest hoofed animals, and are often considered "small mammals"; like mara or Patagonian cavies [*Dolichotus patagonum*], hares, and other running and jumping animals, they have relatively large flight distances. They can break their very thin legs if keepers do not work hard modifying their behavior with the goal of calming and habituating them to human care. Small mammals can be surprisingly aggressive. This behavior may be regulated primarily by limited resources, including food or space for flight away from a keeper or conspecific perceived as a threat, as well as by reproductive season. These factors are all modulated by internal motivations such as hunger or hormonal readiness. New techniques in endocrinology may give modern keepers a huge advantage over keepers of the past who were solely reliant on external physical cues from animals; we now have the ability to gauge changes in hormonal status and to ascertain whether animals are undergoing seasonal changes, are stressed, have diseases, and so on.

Good Practice Tip: *Understand the animals.*

Knowledge of an animal's natural history, individual history, and captive care needs can make a keeper very successful. Careful study of published research on the species, or on similar species, to fully understand an animal's environmental, behavioral, and nutritional needs, will help keepers enhance the lifelong welfare of the animals in their care.

RESTRAINT AND HANDLING

Animals must be handled appropriately. Keepers should understand as much as they possibly can about the species they care for and every procedure used in handling or transporting them. One should plan all handling by reviewing the animal's natural history and individual history, as well as the best handling practices for the species. The appropriate equipment should be available and in working order. Is a handling box, crate, or vehicle needed? The best possible handling technique for mammals is to box-train or injection-train the animals well in advance of the need to transport them in boxes or give them injections. Sometimes a keeper will need to net a small mammal or other animal, but if the keeper is the animal's keeper or primary trainer they should attempt to maintain their positive relationship with the animal by having someone else do the netting. One good idea is to practice netting techniques with a lacrosse stick and lacrosse ball, then with the working net and the same fast-moving ball; if the keeper is not a quick netter but the team really needs to use nets, the keeper should allow the best netters to do the job for the sake of the animal's welfare. One should know where all emergency equipment is located in the work space before starting a procedure, and know the level of the veterinarian's experience. A keeper should discuss normal respiration for the species with the veterinarian, and then provide backup monitoring of breathing and heart rate to help the veterinarian know when the animal's breathing changes from normal. If the animal is being transported to a different location for a procedure, the keeper should be familiar with that facility and know where to find emergency supplies. Building doors should be closed and locked prior to

the procedure and a radio should be nearby in case keepers need to call for additional help. Keepers should use the appropriately sized net, use good and accurate netting techniques, know how to spin (twist) the net to control the animal, and know where the animal is located in a net at all times. If the animal in a social group, the keeper should try to move a short distance out of the animals' line of vision, and hearing. One should try to use a net-to-box transfer, which is a transfer directly from the safety of the net to the safety of the box. The animal's abilities should not be underestimated; a keeper should remain calm and communicate effectively with the animal care team during handling procedures.

An animal's behavior can change in a non-routine situation: an animal that is normally "tame" toward keepers may become aggressive if members of its social group are being captured. If keepers lose control of a handling situation, there can be multiple bite wounds to people. If a keeper loses his or her grip or is bitten, he or she needs to communicate this calmly so that another team member can help (meanwhile, he or she should try to not let go of the animal until a colleague can help with the restraint). Safety of the animals and people must be the primary consideration; when actually handling the animal, one should get control of the head near the back of the neck and get control of the limbs as appropriate. Keepers should stay focused and constantly be aware of their surroundings when handling or transporting an animal; they should pay attention to their gut instincts and use common sense during these times. If keepers have pre-crated the animal to save time for the veterinary team, it is their responsibility to constantly monitor the animal until the veterinarian takes over and gives monitoring instructions. A good keeper should also clean the crate when the procedure is done, and not leave the dirty crate for others. An appropriate number of trained people should be stationed outside the enclosure to manage the door.

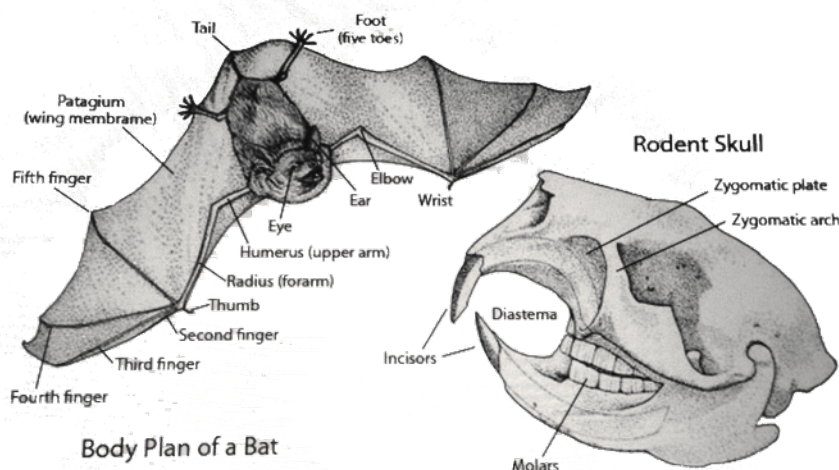


Figure 26.1. Basic anatomical features of small mammals: (1) Body plan of a bat; (2) a rodent skull. Most members of this order (1700-plus species) have incisors with sharp enamel ridges and a gap (diastema) left by the absence of canine and premolar teeth. Illustrations by Kate Woodle, www.katewoodleillustrations.com.

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