THE PROPER CARE OF LABORATORY RODENTS

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Introduction

Where rodents are used for scientific study it is, of course, of prime importance to avoid cruelty and to curtail the suffering that might be associated with experimental procedures. The *humane* care of animals, however, ought to go beyond that to an active attempt to promote comfort and well-being.

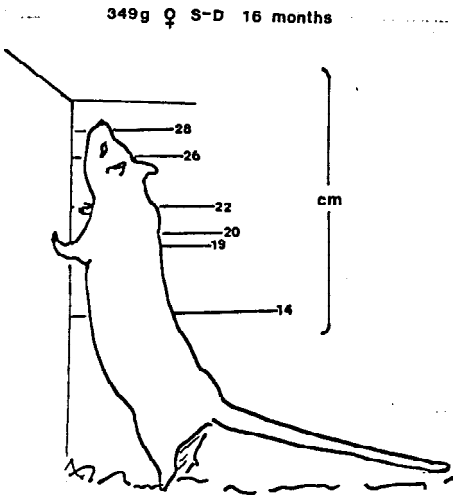

Figure 1: Adult rat in full bipedal posture, showing the headroom required.

Although rats and mice have lived with man for millennia, people in general know very little about them. Rodents as a whole have an "image problem": Very few people like them and even fewer love them. Generally rodents are seen as disease carrying vermin to be exterminated, rather than creatures to be cherished. When one adds to this the consideration that rats and mice are phenomenally adaptive, with a remarkable ability to withstand efforts to eliminate them, it is not surprising that they are capable of growing, living and breeding in conditions which are far from ideal—they are great survivors.

There are excellent books covering the proper care of laboratory rodents, but their emphasis is more often on experimental procedures and the physiological aspects of care, than on the *quality* of life of the animals who *involuntarily* make such a huge contribution—in terms of millions of animals "used" and "sacrificed"—to the advancement of biomedical science. In this chapter the emphasis is reversed, and the focus shifted on behavioral considerations rather than physiological data.

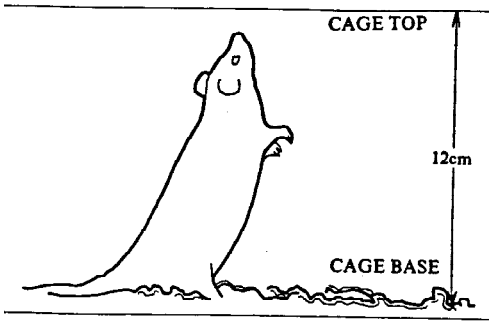

Figure 2: Adult mouse in orienting stance, showing the headroom required.

This chapter deals with the care of the most commonly used rodent species, namely mice, rats, ham-

Comfortable Quarters for Laboratory Animals, Viktor Reinhardt, editor. Animal Welfare Institute, Washington DC, 1997.

sters, and guinea pigs. The currently recommended caging parameters for these species must be re-thought and revised if they cannot be shown to satisfy basic behavioral, physiological and exercise needs of the animals who live in such enclosures. In order to decide the best way to satisfy those needs, it is logical to start by measuring the rodent rather than the cage. A description of the four species' biology will make it clear why gross body weight should not be the only measure used to determine caging standards.

Species-typical characteristics

Rats and mice are closely related and belong to the same family *Muridae.* They are long-tailed conspicuously inquisitive rodents who are biologically adapted to live in groups.

The most commonly used laboratory **rats** are mutants of the Grey Norway rat *(Rattus norvegicus).* Selective breeding over hundreds of years made the mutant forms "domesticated," lacking the timidness and ferocity of their wild cousins. Adult rats usually weigh between 200 and 1000 grams (7-35 oz.) and measure 40 to 50 cm (16-20 in.) from nose to tail. Their height in bipedal position is 25-30 cm (10-12 in.; Figure 1). Their natural longevity is 3-4 years. Two types of red-eyed albinos are the prevailing laboratory rats: the relatively small, fine boned and elegant Wistar rat, and the larger, relatively coarse boned and rough coated Sprague-Dawley rat. Pigmented, black-eyed rats are less common. The most widely used types are the Wistar Hooded and Lister Hooded rats. Their vision is far better than that of albino rats and they are less distressed by bright light.

Laboratory **mice** are, like rats, a domesticated variant of a wild ancestor, the house mouse *(Mus musculus)*. Laboratory mice have come to be recognized as a distinct subspecies, namely *Mus domesticus domesticus.* Adult mice usually weigh 20 to 40 g (0.7 .-1.4 oz.) and have an overall length of 12 to 15 cm (5-6 in.). When standing on the hind legs a mouse has a height of 10-12 cm (4-5 in.; Figure 2). Mice usually live no longer than two years. There are hundreds of different strains, both pigmented and albino, in common use. Viable mutations naturally occur in mice and in addition numerous variants have been genetically engineered. For example, tumor bearing or diabetic mice are now readily available along with many other artifically created "biomedical models" bearing unusual physiological conditions which mimic human disorders and diseases.

Hamsters, unlike rats and mice have a more individualistic disposition and often prefer solitude over social company. The hamster is a strong and determined digger and chewer and something of an escape artist. Even when kept in a large enclosure, a hamster will still work hard to get out and explore the wider world.

There are many species of hamsters. The one most commonly found in laboratories is the Syrian golden hamster *(Mesocricetus auratus).* They have relatively large heads and strong shoulders. Their back legs are much weaker than the muscular front legs—which serve as

digging “machines”—while the little stumptail is no longer than a centimeter or so. Hamsters can dig extremely well, shifting amazing quantities of material when the opportunity occurs. They are also great gnawers who can easily chew their way through a centimeter of wood in a single night. The whole body is very flexible, allowing the hamster to get through spaces and gaps that look impossibly small.

A mature hamster measures 8 to 12 cm (3-5 in.) from head to tail and weighs around 100 g (3.5 oz.) though individuals may weigh twice as much as this. In bipedal posture an adult animal has a height of 11-14 cm (4-5.5 in.).

Hamsters have some physiological characteristics which make them particularly valuable for research. Females have the shortest known gestation period of any placental mammals. The young are born after only 16 days, and reach sexual maturity at the age of ten weeks. A female may rear eight litters per year. The natural life expectancy of hamsters, however, is only 1.5-2 years. Hamsters go into hibernation when temperatures drop to unusually low levels, and there is evidence that they may also estivate when temperatures rise to unacceptably high levels.

The golden hamster is a late arrival on the laboratory scene. All the millions of hamsters alive today apparently derive from one litter dug up in the Syrian desert near Aleppo [Haleb] in 1930. For a “wild” animal the hamster is remarkably tame and tractable unless provoked. Hamsters have cheek pouches which enable them to carry large quantities of food or bedding.

Guinea pigs *(Cavia porcellus)* are classic domesticated animals originating from South America. They are very docile, relatively plump—though cute—animals who have a much lower general activity level than the other three species. Domestic guinea pigs are usually allowed to wander freely about the house. When kept in a cage there is no need for a cover because the animals are poor climbers and will make no serious attempts to escape.

There are three main breeds: the short-haired, the long-haired and the rosetted guinea pig. The young are born after a relatively (to their body size) long gestation period of about 66 days. A newborn guinea pig does not look like a “pup” but like a small-sized adult. He or she starts nibbling and eating solid food already on the day of its birth. Young guinea pigs—unlike adults—are very active and engage in energetic locomotor play activities alone or with other peers. However, they are very precocious and the stage of infantile gamboling is brief. Young females may successfully breed when they are only three weeks and give birth to their first litter at the age of only three months. Males engage in sexual activities as early as the third week of life.

Mature animals may weigh more than 1 kg (2.2 lb.) and measure up to 30 cm (12 in.). Guinea pigs can live eight years or longer. They are very sociable animals who naturally live in small harem groups comprising about eight animals. They are poor diggers but usually occupy “safe” burrows abandoned by other animals. Vocalization plays a very important role

in their social and sexual behavior and there is always some "purring," "whistling," "squeaking" or "teeth-chattering" to be heard in a guinea pig room. Guinea pigs will always give a friendly caretaker a noisy welcome. Olfactory communication probably plays an even greater role than vocal communication. Scent marking with urine squirted on the coat of another animal, and scent marking with secretions from perineal and supracaudal glands rubbed on the substratum reflect the animals' relative social status and social roles within the group.

Meeting Rodents' Caging Needs

There are two distinct sets of criteria which determine what is judged to be the proper cage for a laboratory rodent.

Hard criteria address questions such as:

1. How do cage size and group size relate to body growth?
2. How do cage size and group size relate to morbidity rates?
3. How do cage size and group size relate to mortality rates?
4. How do cage size and group size relate to reproductive performance?

Soft criteria take into consideration questions like:

1. What will the animal choose, if given a choice?
2. How much of the species-typical behavioral repertoire can the animal carry out in a given enclosure?
3. How do the physical dimensions of the animal relate to the size of the enclosure?
4. How do different caging conditions affect the animal's behavior?

The hard criteria cover the absolute minimal welfare conditions even if they are rather reminiscent of the Victorian workhouse. They are not even particularly controversial, since scientists do not want to work with stunted, disease-ridden animals and no commercial animal suppliers would survive unless they can meet these basic criteria. To that extent most of the recommended standards, and those which have the additional force of law, must be judged successful—when earnestly applied and effectively enforced—because they eliminate the worst abuse.

The soft criteria are more controversial because they go beyond the minimum requirements for keeping animals alive and healthy. For people who attach importance to animal welfare the soft criteria make the difference between an animal with a reasonable *quality* of life and one that merely continues to exist as a "biological research tool" until it has been "used" and killed.

Cages must, by their very nature, have dimensions. Current national and international guidelines pertaining to the housing of laboratory animals express caging standards for rodents in terms of minimum floor space and minimum height related to the body weight of the animal. To judge the adequacy of these standards the task is:

1) to look at the physical dimensions of the animal and relate that to cage dimensions,

2) to look at the species-typical behavioral repertoire (ethogram) and determine how much space the caged animal actually requires to carry out these "natural" behaviors.

This approach is not so much concerned with mere survival but with comfort and behavioral health.

Species-typical behaviors

Postures

When standing on all four feet, rats and mice—unlike hamsters and guinea pigs—require extra horizontal space for their long, normally straight held tails. To assume a natural quatripedal position an adult rat needs 35-48 cm, an adult mouse needs 11-14 cm.

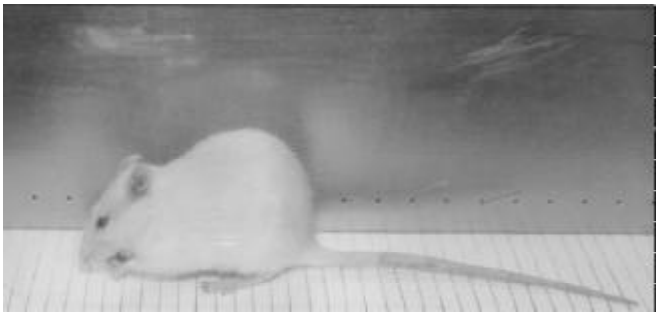

Figure 3: Female rat eating on a 1 cm grid to show stance and space (31 cm) required.

Squatting is very often seen in rats, mice and hamsters. An animal's weight is shifted on the back feet, the spine is hunched, the forepaws lifted off the ground and the nose held lower than the ears (Figure 3). The hamster—thanks to the tiny tail—sometimes seems to sink so far down onto the back feet that he/she looks like a round, furry ball. The animals usually take the squatting position when they eat, drink, gnaw and groom themselves. Squatting is not a typical posture for guinea pigs who are distinctively quadrupedal animals who usually keep all four feet on the ground to be in stable stationary position. Brief autogrooming of the face is the only behavior that guinea pigs perform with regularity in the squatting position.

Figure 4: Lister hooded male rats "challenging" each other in bipedal position.

The bipedal position serves rats, mice and hamsters as an orienting stance in which the weight is on the back feet and the spine extended upward. The base of the tail is used as a stabilizing tripod (Figure 4). The forepaws my be supported on a firm vertical surface allowing the animal to stretch right up until it is standing on tiptoe. The head is up and the ears are pricked. Hamsters spend a considerable amount of time in this "checking-out" position, until they become unstable and sometimes simply fall over. The head room required for an adult animal to make the bipedal orienting stance is up to 30 cm (12 in.) for rats (Figure 1), up to 11 cm (4 in.) for mice

(Figure 2), and up to 14 cm (5.5 in.) for hamsters. Guinea pigs don't show the bipedal orientation stance.

Eating/drinking/gnawing

Most rodents drink by licking rather than lapping. They readily rear up on their hind legs, sometimes gripping the nozzle of a water bottle with the forepaws to get their fill. For rats, mice and hamsters water must be available at all times, even if the animals seem to drink very little. Water-nozzles supplied by piping from a central tab system should be tested daily to ensure that no blockage occurs. Water bottles should be changed, emptied and sterilized at least once a week. Guinea pigs do best without water; however, their food must be generously supplemented with fresh produce, such as carrots, cauliflower leaves, turnip tops, beet tops, dandelion and other greens.

Rats, mice and hamsters will eat powdered or mushy food from a dish or from the floor, but their species-specific habit is to secure a piece of food in their teeth and carry it to a suitable spot where they adopt a squatting posture and transfer the food to the forepaws (Figure 3). Holding the food in their paws, they nibble gently at it; if they do not like the taste they drop it immediately. Like "pigs," guinea pigs pick up the food with the mouth not with the paws. The food item, e.g., a carrot, may be held against the floor with one paw to facilitate the eating process. The main food staple for laboratory rodents is usually a commercial high quality pelleted diet fed ad libitum. This may be supplemented daily with natural food items such as sunflower seeds, or root vegetables. Guinea pigs should always be provided with high-quality hay (Figure 5).

Figure 5: Guinea pigs should always be provisioned with high quality hay, supplementing the standard pellet diet.

The opportunity to gnaw is an essential physiological and behavioral need for all rodents. If they are not given the chance to regularly gnaw, their front teeth overgrow and make it more or less impossible for them to eat at all. Hard, pelleted diet usually provides for sufficient gnawing. Natural food items, however, such as carrots, grain/seeds, and/or pieces of soft wood provide the most species-appropriate items for gnawing. Laboratory rodents should always have free access to them. Hamsters gnaw persistently. They may empty an entire food rack containing

more than their own weight of pellets, pouch the food and busily transfer it to the nest area where it is hoarded.

Figure 6: The ideal double-cage arrangement: The right cage section is covered with a black perspex screen and serves as dark-and-sheltered sleeping/nesting area. The left cage section serves as living area; when used for mice, rats and hamsters, the living room is covered with a wire lid for gymnastics.

Figure 7: A PVC pipe is a suitable substitute burrow for hamsters in which they can hide and build a secluded nest. The woodchip bedding is a basic means of environmental enrichment.

Comfort behavior

Overgrown teeth resulting from insufficient gnawing opportunities may jeopardize the well-being and health of an animal not only by interfering with normal food intake but also by interfering with normal self-grooming. All rodents spend a considerable part of their time grooming themselves. They do this in the squatting or standing position with tongue, teeth, paws and claws. For example, when a hamster wakes up he or she will spend up to half an hour grooming before doing anything else. At the end of the "morning-grooming" the entire coat of the animal looks wet and the fur is standing up all over it. Because they are nocturnal animals, rats, mice, hamsters and guinea pigs usually sleep during the light phase of the day. They should, therefore, have access to a relatively dark and sheltered place where they can "tunnel" and/or sleep (Figures 6 and 7).

Hamsters, and to a lesser degree also mice, are biologically adapted to sleep in properly constructed nests. They need appropriate nesting material such as shredded dyefree paper.

Rats, mice and guinea pigs will sleep in a heap or separately depending on the ambient temperature. They are easily aroused and do not normally sleep for long periods without waking intervals. Mature rats, mice and hamsters settle down to sleep by tucking their heads between the forepaws while in the quadrupedal position. As they move into a deeper sleep phase, rats suddenly keel over onto a side, usually at full length with tail extended. To assume

this natural sleeping posture an adult rat requires a floor space of 15 x 35-45 cm. Rats and mice sleep in a curled position only when chilled. Guinea pigs take a sternal recumbency position with the chin resting on the forepaws.

Hamsters appear to sleep very heavily, and usually want to be alone when sleeping. They wake occasionally to have a small snack. To do this they move only enough to take a bit of food out of the store near the nest, squat while they eat it and then go back to sleep, never having left the nest.

When waking up, most rodents stretch and yawn with fully opened mouth while the head is thrown back and the forelegs extended. When a rat stretches, one forepaw goes forward of the head while a back foot is stretched out beyond the tail base, the tail itself being arched; then the feet are reversed. Finally, the animal shakes itself.

Locomotor behavior

Most rodents will progress by creeping when they are nervous, insecure or alarmed. In this mode of locomotion the animal flattens its belly against the floor and shoves the trunk forwards by "paddling" with laterally extended limbs.

When a rat or mouse is walking normally, the tail is carried off the ground straight out behind the trunk. Any other pattern is distorted and indicative that the animal is kept in an enclosure which is too small.

The running pace is probably three or four times longer than the walking pace. When rats and mice are running, the tail is carried straight out behind the body with the tip of the tail upturned. The animals can achieve considerable speed, especially in a panic-stricken dash. When merely exploring a new place they lop along at a much more modest speed.

In all four species, juveniles and females in estrus spend conspicuous amounts of time running around. In general, mice run more than rats. Hamsters can run, but more usually will trot about in a busy fashion. Adult guinea pigs run only when they are startled; young animals, however, often engage in exuberant running-and-hopping games.

It should go without saying that solid floors are much more appropriate for the feet of rodents than wire floors which impact the feet in a biologically abnormal manner and may cause discomfort, pressure sores and pain. They may also cause chilling even in a warm room.

On PVC (polyvinyl chloride) floors, the claws of rats, hamsters and guinea pigs may "overgrow" because the surface is not abrasive. If this happens, the claws must be clipped or the animal will experience considerable discomfort.

Unlike guinea pigs, rats, mice and hamsters are extremely good climbers, digging their claws into any suitable surface, bracing themselves with their tails and making use of any foothold no matter how slight. They will work hard to gain access to an area which allows them to climb. Mice often choose to jump in a situation in which a rat or hamster would climb. In fact,

they are prodigious jumpers. Mice can easily jump several feet. Their righting reflexes are remarkable, and they will always land on their feet even when they happen to fall. Although much less adept than mice, most rats can jump two or three feet away from unacceptable restraint, often regardless of the consequences. Hamsters and guinea pigs will try to jump, but they have too little strength in their back legs to make this very successful. At its simplest a hamster will jump recklessly away from a hold. Guinea pigs may show unusual abilities when distressed and jump over a 30 cm high cage wall, and flee.

Purposive activities

Digging is a very stereotyped action pattern. The substratum is loosened with the forepaws and teeth and kicked away with the hind feet. The impulse to dig is weaker in rats and guinea pigs than in mice. Digging is a typical hamster behavior and the animals may spend considerable amounts of time vigorously, competently and persistently excavating the ground and building burrows. A “little” golden hamster can make his way into the cells of an ordinary brick wall within less than a night, and disappear. Only a carrot will bring the him back to light.

It is impossible to fully satisfy the instinctive need for digging in caged rodents. A dust-free woodchip (preferably irradiated) bedding offers a good compromise solution which allows the animals not only to engage in quasi-digging maneuvers but also to forage, i.e. search for food particles. Woodchip bedding should be regarded as a basic, inexpensive means of environmental enrichment (Figure 7). The bedding also absorbs urine and moisture from feces. Regularly changed bedding is the best guarantee of a hygienic cage environment.

Apart from females approaching parturition, rats and mice do not show much purposive nest building activity. Preferred sleeping sites are “nest-like” but do not usually have much structure. Guinea pigs show no inclination to build nests. Hamsters, however, of both sexes build rather elaborate sleeping nests and adjacent larders. If they have the option they will first dig a burrow and then build their nests underground. Laboratory hamsters should always have access to shredded dyefree paper and or high quality hay to allow them to build a comfortable and safe nest.

Hamsters are great collectors. They hoard food routinely all year round and also collect all sorts of bits and pieces of wood, paper, cardboard, string, wire, etc. and take them to the nest. Hamsters also store their own fecal pellets, no doubt for recycling if other food is in short supply. Rats and mice hoard only if they are exposed to severe food deprivation. Guinea pigs never hoard.

The natural defense of most rodents who experience threat is not to hang about, but to run and hide, and if possible huddle with other conspecifics in a safe place. Being placed on an open, bright surface is an especially threatening situation for animals who are not tame be-

cause it exposes them full-view to potential predators. In order to increase the sense of security of such fearful animals, it is recommended to add vertical barriers and sections of PVC tubing. This indirectly increases the usable floor space and provides additional wall contact, tactile comfort, escape routes, and areas for exploration.

Social behaviors

Play is largely composed of non-serious chasing and fighting, rolling around together, harmless rough-and-tumble engagements and quasi sexual interactions. Play is a form of vigorous exercise which is essential for the well-being and normal social and sexual development of young animals. Adult animals play only very rarely with each other. It must be emphasized that young animals require more space, relatively, for play activities. Therefore, they should not be allocated less space than is appropriate for adult animals.

Mutual grooming among adults is common in rats, but uncommon in the other three species(it is absent in guinea pigs). During grooming, rats spread a group-specific scent on each other with saliva.

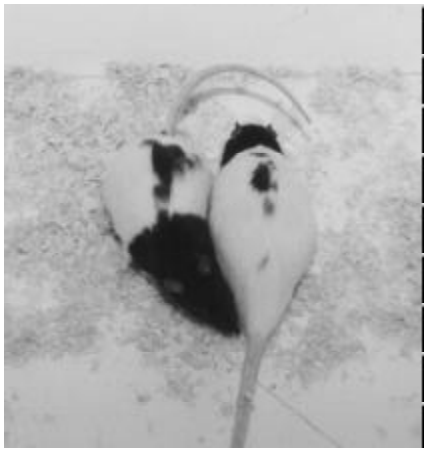

Figure 8: Urogenital sniffing is often a prelude to fighting between male rodents (here, strange male Lister hooded rats).

Mutual ano-genital sniffing among same-sex animals is often a prelude to a dispute (Figure 8). At this point a fight may be averted in rats, mice and hamsters if one animal rolls over onto his or her back and emits a submission call. If this happens the dominant will stand over the other and do nothing more—both may even fall asleep in this position. If, however, neither animal gives way to the other, both will rear up and start to box with their forepaws while making attempts to bite each other. Any such encounter may be ended by a submissive posture and call. If this fails to happen, the animals may injure each other badly. Overt fighting can be a serious problem in all caged rodents because the defeated animal cannot effectively stop the attacks of the aggressor by running away and escaping from the opponent's sensory field.

Male guinea pigs indulge in elaborate threatening displays to demonstrate their relative social status claims. Quite often they will become over-excited and get involved in a fight, boxing and biting each other. Rather than showing submissive gestures, the subordinate partner may suddenly behave like an estrus female and stop emitting the male-typical pheromones. This trick effectively saves him from any further attacks, and the dominant male will now treat him like a female and display courtship rather than aggressive behaviors. In fact, males are strictly inhibited from attacking females, and the subordinate male who plays the

female role runs no risk boxing the courting, previously aggressive opponent in typical female-fashion. Running away stimulates rather than inhibits aggression if there is no place to hide.

Fighting among male guinea pigs is predictably triggered by the presence of an oestrus female. There is always one male who monopolizes such females, and he clearly dominates all other males, who live in social stress most of the time. Females get along with each other much better than males; they never engage in fighting. It is recommended to keep only one mature male with a few females to avoid aggressive disturbances within the group.

In hamsters, males fight much less and break up fights more quickly than females; they seldom attack females, who in turn have little reservation to attack not only males but also other females. It is advisable to keep female hamsters in single cages, and house the males in small groups of litter mates.

Reproductive and parental behaviors

Mating is largely opportunistic, but a greater degree of pair bonding is seen in mice and guinea pigs than in rats and hamsters. When in full oestrus the female becomes unusually active and accepts copulation from any sexually competent male. During coitus ultrasonic calls are emitted by female rats, mice and hamsters while female guinea pigs whistle and males purr during mating. These vocalizations seem to serve to deter other group members from interfering with the mating couple.

The newborn of rats, mice and hamsters not only need the attentive care of their mothers but also a distinctive nest to keep them warm and safe during the short periods when the mother leaves them. A well-designed cage provides a *distinctive* sheltered nest area/box/pipe away from the feeding location (Figures 6 and 7). Parturient females must have access to shredded paper or soft wood to build appropriate nests for the successful rearing of their offspring (Figure 9). The mother carefully covers the pups when she leaves the nest. Sometimes, however, pups may explore the environment outside of the nest. Females—and to a lesser degree also males—

Figure 9: A three days old litter of Lister hooded rat pups. The well-structured nest is built with shredded dye-free paper.

have a strong drive to retrieve such pups even if the young are already too old to relish the attention.

Newborn guinea pigs are so precocious that they do not need a nest. Actually, they would probably playfully destroy such a structure on the very first day of their life. In sharp contrast to rats, mice and hamsters, guinea pig mothers do not seem to care much about their own offspring. They don't groom their young and will not defend them if need arises. If two females have young of the same age, a naive observer will not be able to tell from the animals' behavior which offspring belongs to which female, because both mothers treat all the young equally.

Guinea pig mothers lactate and nurse for no longer than three weeks. It is the lactating female—not the young—who sets the timetable for nursing. If she feels ready to nurse, she will get restless and walk back and forth thereby attracting the attention of all infants who will gather and follow until the "nurse" sits down on her favorite location and tolerates the suckling procedure. Once started, the nurse will box away any straggler even if it happens to be one of her own progeny. After about 10 minutes, the female abruptly walks away leaving a heap of perplexed young.

When rats or mice are comfortable and relaxed they usually nurse in the "half moon position." In less benign circumstances they nurse in a "cover position," standing over the pups in a protective manner (Figure 10). When there is sufficient nest material, and the ambient temperature is adequate, the mother will leave the nest between feeds. In more demanding conditions, when the temperature is too low, and there is insufficient nest material, she will remain crouched over the pups to keep them warm. If the caging system allows her to do so, the mother will "escape" from the increasingly mobile and demanding offspring once they are two or three weeks old; however, she will normally allow some sporadic nursing until the pups are four or five weeks old. Female mice will rear two or three sets of pups together in a single nest in a way that rats will not. The female hamster nurses for four to five weeks and is particularly protective, i.e. hostile toward other conspecifics during that time. The pups are also fed on soft fecal material before they can eat hard food; this is a biologically normal behavior which should not be prevented.

Figure 10: Lister hooded rat nursing her ten-day-old pups in "cover position."

Minimum space and cage recommendations

The ethogram provides a base from which the behavioral needs of a species can be derived and which allows one to make recommendations regarding the minimum space and caging conditions required by the animals to satisfy those needs and experience a state of behavioral and physical well-being.

Rats

The cage in which a mature rat can adopt species-typical postures and stances and can carry out essential activities has to measure between 35 x 25 x 18 [height] cm for the smallest females and 50 x 30 x 30 [height] cm for the largest males. Table 1 lists the minimum space requirements by sex and body weight.

Body weight of rat [1g = 0.035 oz.]	Minimum floor area cm^2 (in^2)		Minimum height cm (in)
	for 1-3 rats	for an additional rat	
male up to 150 g female up to 140g	900 (140)	300 (47)	18 (7)
male 150-250 g female 140-170 g	1200 (186)	450 (70)	20 (8)
male 250-450 g female 170-310 g	1500 (233)	600 (93)	22 (9)
male 450-900 g female 310-615 g	1800 (279)	800 (124)	26 (10)
male over 900 g female over 615 g	1800 (279)	1000 (155)	30 (12)

Table 1: Minimum space recommendations for laboratory rats

Rats of any age should not be caged singly or in large groups. For adults the group should not be more than six animals, for juveniles not more than ten animals. Rats kept in larger groups tend to be too aggressive and are more prone to disease.

Mice

Adult mice should be kept in cages that are 28 x 12 x 11 [height] cm to meet their spatial requirements for the expression of species-typical behavior patterns. Group size should be restricted to three or four individuals. Juveniles do best in groups of 6-12 animals; the floor space of their cage should be at least twice the size of the adults' cage to account for their vigorous playfulness.

Mice are sometimes caged in large numbers in rat cages. This is not recommended, because mice can quite easily escape from rat cages. Escaped animals may enter other cages and create havoc, or return to their own group once they have had a look around. They usually carry out these expeditions during the hours of darkness and caretakers may not become aware of what has been happening.

Hamsters

Hamsters are very active animals and are less content in cages than rats and mice. Having very strong drives to perform activities—such as digging, gnawing, climbing and hoarding—

which involve considerable energy expenditure, a hamster needs space which seems disproportional to her/his actual size. The hamster cage should provide a sleeping area, a larder area, a separate urinating spot and plenty of space and structures for climbing.

Because they are not very sociable, hamsters need special caging arrangements. It is best to house adult females singly or with one litter in cages that measure at least 30 x 20 x 18 [height] cm. The same cage size is needed to house up to three male litter mates in a reasonably compatible situation. Four to six adult male litter mates or groups of up to eight juveniles should be housed in cages measuring 40 x 30 x 18 [height] cm.

Guinea pigs

Guinea pigs are much too social to be housed singly. If a medical condition requires temporary single-caging, the floor space should be not less than 35 x 35 cm (14 x 14 in).

Guinea pigs are best housed in harem groups consisting of one mature male and three to six breeding females, or in same-sex groups of up to eight individuals. Exchanging the breeding male of a harem group with another mature male constitutes no problem because the new male will automatically be accepted by the females as α animal of the group. Male-only groups should be housed in such a way that they have no olfactory or auditory contact with females in order to avoid aggressive conflicts triggered by sexual competition. The mere exposure to the urine of an adult female guinea pig will turn even the most compatible male cage mates into fractious enemies who no longer tolerate each other's presence.

The cage of a group of guinea pigs should provide a floor area of not less than 1000 cm^2 (190 $in.^2$) per adult breeding animal, and not less than 750 cm^2 (109 $in.^2$) per adult non-breeding animal.

Given the constraints of spatial confinement and the fact that a group of five breeding females can easily produce 60 viable young guinea pigs per year, it is advisable to remove the precocious offspring after natural weaning after the age of about a month and rear them together as new groups. This allows the adults to continuously stay together without facing the risks associated with overcrowding.

Guinea pig cages need no covers. The animals normally will not climb/jump over cage walls that are 20 cm (8 in.) high.

Recommended ambient conditions

The cost of providing proper ambient conditions for laboratory rodents can be very large, but failure to offer these conditions can render the most carefully planned and executed experiments worthless because the animals get ill or die. The idea that any sort of room is "good enough for rats or mice" still persists in some quarters; it is mistaken.

The correct ambient conditions for a rodent stock or breeding room are the following:

1. The light falling on rodent cages should not be less than 20 lux or more than 30 lux.

2. An even temperature must be maintained throughout a rodent room. The temperature at cage level should range between 19-22°C (66-72°F).

3. Relative air humidity should be around 55%.

4. If the correct temperature and humidity is to be maintained throughout the animal room, air circulation must be carefully organized. The cages should be far enough apart for the air to circulate freely around them without creating drafts. Normally 15 air changes per hour can create an acceptable environment.

5. The animals should not be frightened by sudden noises. It is particularly important to avoid continuous noise in the ultra sonic range as it makes rodents—who also use ultra sonic communication—very irritable. Common sources of unacceptable ultra sounds are taps dripping into metal sinks and visual display units (VDUs). Plastic or ceramic sinks are a good idea. When computer terminals are installed in rodent rooms, the VDU should be switched off when not in use.

Proper handling

Unlike guinea pigs who are truly domesticated and hence seemingly confident with people, rats, mice and hamsters have a spontaneous fear of man and avoid being handled. They can lose this shyness if a little time is spent handling them as juveniles. An effective technique is to put half a dozen 3-4 weeks old cage mates into a bucket—using cupped hands to make the transfer from the cage—and then putting your hand into the bucket and allowing the young to explore it thoroughly. By putting your hand over and under the animals, they get used to the contact and can in a day or two be easily lifted a few inches in one hand. The bucket prevents the juveniles from avoiding the hand, thereby conditioning them to accept the human hand as a neutral, non-threatening environment. It is only necessary to do this exercise a few times over five days to create a rodent who will readily accept proper handling throughout his or her lifetime. This simple technique is relatively labor-intensive, but it is reliable and makes life a great deal easier for both the rodent and the handler.

In an ideal world all rodents are best handled by being picked up with a firm-and-gentle hold over the shoulders and quickly supported by allowing their feet to rest on your other hand or sleeve. To a considerable extent proper handling depends on the handler rather than on the animal subject. Nervous people make animals (and people) nervous and consequently unpredictable in their reactions to handling. Inexperienced handlers often grip too hard and hurt the animal. Rodent handling is an interactive process requiring skill and empathy.

It is unusual for laboratory rats to object to being picked up in shoulder hold. Small rats fit comfortably into the hand when lifted and may be held in one hand if the tail is anchored between the third and fourth finger, and the thumb kept under the jaw. Bigger rats need the

support of the second hand or a sleeve to make them feel secure when lifted.

As a mouse's tail is very strong, lifting at the base of the tail is probably not distressing provided additional support is also offered. If the tail of a mouse is grasped further away from the body, the animal is quite capable of climbing up its own tail in a fraction of a moment and biting the handler (who deserves it for hurting the subject). Very young mice may be picked up in cupped hands.

Hamsters are very variable in their response to handling. Some may be readily picked up in cupped hands or with the shoulder hold but others will tolerate neither approach. It is extremely important to allow a hamster to fully wake up before you handle him/her. A hamster can be easily picked up when fast asleep, only to wake up and bite in one reflex moment. Unlike rats and mice, hamsters have very poor righting reflexes and can be badly hurt if dropped. It is therefore a good idea to use a plastic mug when carrying hamsters. They will enter the mug readily and remain quiet if a hand is placed over the top.

Guinea pigs are easy to handle. They should be picked up with both hands, one around the shoulder and the other supporting the hindquarters.

Conclusion

Laboratory rodents deserve the same professional care as other, perhaps more charismatic laboratory animals, because their well-being also determines the quality and reliability of scientific research data collected from them. In order to design a species-appropriate and scientifically sound housing protocol it is essential to view the world with the eyes of a rat, mouse, hamster or guinea pig. It is through patient observation and a grain of humbleness that such a view can be cultivated.

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