

## **ZOO STANDARDS FOR KEEPING SPRINGHAAS IN CAPTIVITY**

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### **GENERAL INTRODUCTION**

The common names, springhaas and springhare, are used interchangeably in the literature and the zoo world. In this outline of standards, the common name springhaas will be used.

In the past, taxonomists have been puzzled by the relationship of the springhaas to other rodents, some placing it with the *Hystricomorphs* and others with the *Sciurormorphs* (Kingdon, 1974). Springhaas are not related ancestrally or collaterally to other rodents and their pre-Miocene history is a mystery (Smithers, 1983). Taxonomically this animal is still a puzzle, but most experts suggest that it warrants a superfamily rank of its own to separate it from other living rodents. At the species level, the question of whether there is one or two species of springhaas has not been settled. Some authors suggest that the East African springhaas, *Pedetes surdaster*, is just another subspecies of the South African springhaas, *Pedetes capensis* (Coe, 1969; Butynski, 1979; Smithers, 1983). Matthee and Robinson (1997) studied the mitochondrial DNA of 68 springhaas and concluded that, given the genetic, morphological, and ethological differences between the two geographically isolated groups, there is strong support for giving the East African and South African springhaas populations full species status.

Whether there are one or two species, and regardless of the number of subspecies considered (there are at least thirteen described) these standards apply to all springhaas.

With the exception of the tail, springhaas look like small kangaroos. They have short front legs and powerful long hind legs. Their tail, which is well haired, is as long or longer than the head and body and has a thick dark brown or black brush tip. They have large eyes and long, narrow ears. The five toes on the front limbs have long, sharp, curved claws for digging and the four toes on the hind limbs have hoof-like nails. The front feet have a pad with a hard outer edge and a semi-circular flap of tough skin which is fringed with short, bristly hair and is used with the claws in manipulating food (Smithers, 1983).

The dental formula is I 1/1, C 0/0, PM 1/1, M 3/3 (Norwak, 1991). Their head and body length is 360-430 mm, the tail length is 400-480 mm. Body dimensions are similar for both sexes (Macdonald, 1985). The body weights of 41 wild caught springhaas ranged from 2412 to 3400 g for males and from 2762 to 3725 g for females (Kofron, 1987). The coat is yellow-brown, cinnamon or rufous brown on the upper parts, the lower half of the ears and the basal half of the tail. The upper half of the ears, the distal half of the tail and the whiskers are black and the under parts and the insides of the legs vary from white to light orange (Macdonald, 1985).

When springhaas are feeding, the body is held low with the weight shifted to the front feet. Then the hind feet are moved forward in rabbit-like fashion. Locomotion proceeds in a series of short hops on the back feet with the front legs held close to the body, resembling a kangaroo. When chased they can move very fast in long leaps of up to 2m with the tail flung from side to side to maintain balance (Smithers, 1983). The springhaas' preference for open, flat country is probably influenced by their gait. When moving quickly, the bipedal leap is very unstable and is unsuited for circumventing obstacles or traversing broken land (Kingdon, 1974).

## 1. Abiotic Environmental Variables

1.1 **Temperature:** In the wild, low temperatures affect springhaas activity. At temperatures near freezing few springhaas leave their burrows (Butynski, 1984). Springhaas rely on their burrows to provide a more moderate, stable temperature and higher humidity than is found in their desert habitat (Butynski and Mattingly, 1979). If provided with burrows or nest boxes, springhaas can tolerate temperatures from about 32 to 90 degrees Fahrenheit. The ideal temperature range for springhaas is 60 to 80 degrees Fahrenheit. Although a desert species, springhaas avoid the heat by being active only at night and using a burrow during the day. In captivity, at least one death has occurred when a springhaas was exposed to temperatures above 100 degrees Fahrenheit.

1.2 **Humidity:** In wild springhaas, moderate to heavy precipitation reduces activity (Butynski, 1984). On the other hand, wild springhaas spend most of the day in their burrows where the humidity is higher (Butynski and Mattingly, 1979). This would imply that springhaas prefer a moderate humidity level. So, although springhaas can tolerate a humidity range of < 20% to >70% their optimal range is 40-60%.

1.3 **Illumination:** Wild springhaas are strictly nocturnal. They have only one daily activity period, beginning approximately 30 minutes after sunset and ending approximately 30 minutes before sunrise (Butynski, 1984). Although some springhaas are exhibited outside in natural day light the majority of springhaas are housed inside in nocturnal "reverse lighting" exhibits. The day/night cycles are usually 12 hours long, but are sometimes varied seasonally to mimic the natural day length changes that occur in the wild. These day/night lengths are varied from 10/14 to 14/10 hours over the course of six months. There is no indication that any lighting system is more likely to make the springhaas more active or increase reproduction. Red lights, blue lights, and dimmed white lights all work equally well (Laird, 1993).. Regardless of the type of illumination used, springhaas are generally inactive during normal visiting hours. It appears that the amount of noise and disturbance that occurs during the day is equally as important as light levels in determining activity cycles in springhaas.

### 1.4 Space:

1.4.1. **Spatial needs:** Springhaas are large rodents that need a large enclosure with flat surfaces to accommodate their unusual locomotion. To allow for a normal level of activity, enclosures should be about 100-sq. ft. for 1 to 5 animals and about 200-sq. ft. for more than five animals. The amount of vertical space is not as important in springhaas as horizontal space. So any enclosure height that is sufficient for routine maintenance will be adequate. Their enclosures should also include burrows, nest boxes, or other places for them to hide. As rodents they are chewers, therefore their enclosures should not be made of material that they can chew.

1.4.2. **Inter-individual distances:** In the wild, springhaas exhibit little social cohesion within groups. Direct observations in the field on behavior and group formation indicate that with the exception of low-density situations, springhaas have widely overlapping home ranges. Research also suggests that they do not actively defend territories except perhaps the area in the immediate vicinity of the burrow (Butynski, 1984). Springhaas burrows are occupied either by one animal or at most a female and her single young (Butynski and Mattingly, 1979). Springhaas do occur in social groups. They have been observed in groups to a greater degree than might be expected by randomly foraging individuals.

The advantage of this behavior in terms of predator detection is obvious, but grouping must be balanced against the need to forage for dispersed food items (Augustine *et.al.*, 1995). That they are at least semi-social is illustrated by the fact that in captivity, even when given the opportunity to occupy separate enclosures they almost always remain together (Coe, 1967).

Depending on the individuals, springhaas will share nest boxes, burrows, and other sleeping sites as well as a food source. However, it is best to provide at least one hiding/sleeping site for each animal and more than one source of food and water when groups of springhaas are housed together. As wild springhaas females rear their young in burrows, pregnant springhaas should be housed in a separate enclosure until the young springhaas is weaned.

- 1.4.3. **Exhibit/enclosure furniture:** Springhaas should be provided with nest boxes, tunnels, and/or burrows for sleeping and hiding. At least one for every animal in the enclosure. They should also have a substrate in which they can dig such as sand, soil, etc. It is best if the nest boxes, tunnels, or burrows can be buried in the substrate and filled with some substrate so the springhaas can “dig” out their own burrows. Springhaas are excellent diggers. If exhibited outside, care should be taken to design an exhibit they can not escape from by digging under the walls. Excessive furnishings in an enclosure can inhibit the springhaas ability to move around the enclosure owing to its unusual method of locomotion. The ability to scatter/hide food in the substrate and around the enclosure will allow the springhaas to exhibit its natural foraging behavior. As springhaas are rodents, they should also be provided with browse or tree branches to chew.
- 1.4.4. **Visual, acoustic, and olfactory barriers:** Springhaas are strictly nocturnal. Therefore bright light and noise disturb them and keep them from being active. An effort should be made to balance the needs of the springhaas for dim lighting and quiet with the visitors' need to see the springhaas. Regardless of how successful this balance may seem, the springhaas should be provided with hiding areas so they can get away from the public, keepers and each other. Glass-fronted enclosures provide the best acoustic and olfactory barrier. If the public space is also dimmed, this will reduce the amount of light entering the enclosure and reduce the springhaas ability to see the public. Also, if the public area is dimmed it will improve the viewing of the dimmed springhaas enclosure.
- 1.4.5. **Substrates and nesting/bedding materials:** Springhaas fecal material is normally very dry and as they rarely drink any water they do not produce large amounts of urine. Any of the following can be successfully used as bedding materials: wood shavings, straw, hay, bed-o-cobs, bark chips/mulch, and wood wool. Substrates made of materials such as concrete or fiberglass provide for ease of cleaning and disinfecting. Substrates of sand and/or soil make cleaning more difficult, but provide a softer substrate and the opportunity to dig.
- 1.4.6. **Change and variation in the environment:** Springhaas are prey animals who rely on known hiding spots and escape routes to avoid predators. Because of this, significant and/or frequent changes to their enclosure can cause stress. Occasionally adding some new cage

furniture such as a new branch or rock or adding a new sleeping/hiding site can enrich their environment.

- 1.4.7. **Enclosure cleaning:** Both sexes have a pair of perineal glands lying in a slit between the penis or clitoris and the anus. Captive springhaas are known to anal-drag, presumably as a means of scent marking (Smithers, 1983). This scent marking of their enclosure is part of the process of defining their home range. Too frequent cleaning of their enclosures can disturb this process. Natural substrates such as sand and soil should be spot cleaned daily and completely changed out when odor becomes a problem or before new animals are added. Concrete substrates should be spot cleaned daily and hosed and disinfected on a weekly or biweekly schedule.
- 1.4.8. **Pest control:** The better the enclosure is for the springhaas, natural substrate, hiding places, bedding, and scattered food, the better it is for pests and a good pest control program is a necessary. Snap traps or poison should not be placed in areas that springhaas have access. These items should be positioned outside the enclosure around the perimeter. Poisons should be of the types that can not be removed from the bait boxes and carried by rodents into the enclosure. Snap traps can be placed in springhaas-proof containers with mouse size holes and placed in the enclosure. Removing the springhaas on a routine basis and baiting the empty enclosure can be an effective method of pest control.
- 1.4.9. **Safety and containment:** Springhaas do not present a danger to people unless cornered or mishandled. They are capable of delivering a severe bite and can scratch with their hind legs. It is normally safe to enter and service an enclosure with springhaas present. The main concerns with containment in springhaas are their ability to dig and chew. If house outside in an enclosure with natural substrate the enclosure's barriers should extend at least 3 feet below the surface. Springhaas burrows are about 80 cm (31 in.) deep, and range in length from 10 to 46 m (32-150 ft.) (Macdonald, 1985).

Springhaas are very good at chewing through wood, plastic and other soft materials if they are provided with an edge to chew so all enclosures, including holding cages should be made of material they can not chew. If the enclosure or holding cage is made of wood etc., it should be constructed in such a way that there are no edges that the springhaas can chew.

- 1.4.10. **Transport:** For shipment purposes, all transport crates should meet IATA (International Air Transport Association) recommended guidelines.
  - 1.4.10.1. **Type of transport container:** Ideally, a transport container for springhaas should be lined with metal to prevent escape by chewing through the container. If the transport container is made of a material that can be chewed then it should be constructed in such a way that there are no edges that the springhaas can chew. The shipping container must be made of non-toxic materials. All inside edges must be smooth and rounded.

There should be ventilation holes on at least three sides of the container most on the upper parts. One third of the front

of the container must be made of wire mesh. Two rows of meshed ventilation openings with a diameter of one inch must be present on the sides and top at a distance of two inches center to center. Any opening large enough for the springhaas to put a body part through should be covered over with wire mesh. The animal must be protected from unauthorized access.

1.4.10.2. **Appropriate size of transport container:** The height of the container should allow the animal to stand fully erect. It should be large enough to allow the animal to turn around and lie down in a normal manner. The container should provide at least 150 to 180 sq. in. per animal.

1.4.10.3. **Provision of food and water during transport:** Food and water containers must be provided either fixed inside the container or attached to it with a means of access. These containers must have rounded edges and made of non-toxic materials and of a suitable size for springhaas. Feeding and watering instructions should be given to the shipper and food provided.

Springhaas do not normally need to drink water. Therefore it is not normally necessary to provide water during transport. They should be provided with food items that are high in moisture to meet their nutritional and water needs during transport.

1.4.10.4. **Provision of bedding:** Bedding such as wood shavings should be added to the container for comfort and to absorb urine and feces. For international shipments, be sure the type of bedding used is acceptable to the receiving country.

1.4.10.5. **Mechanism for separating animal from urine and feces:** Springhaas normally have dry feces and produce little urine. If bedding is added to the transport container, this should be adequate to separate the animal from its urine and feces. If bedding can not be used, then the animal should be on a floor that allows the urine to pass through into a leak-proof container bottom.

1.4.10.6. **Temperature range during transport:** If protected from the wind in bedded containers, springhaas can easily tolerate temperatures between 45 and 85 degrees Fahrenheit. If there is a possibility that they will be exposed to temperatures outside of this range provision should be made for heat or cooling.

1.4.10.7. **Appropriate light and noise levels:** Every effort should be made to keep disturbance to a minimum during transport. Springhaas should be kept in darkened containers to avoid stimulus from their surroundings. Ventilation openings should be covered with burlap to provide the animal with privacy but allow for air circulation. Crate doors should be secure to prevent rattling. During transport, containers

should be located away from people, loud equipment and other sources of potential stress.

- 1.4.10.8. **Group size and separation of animal for transport:** Shipping an animal is always stressful to the animal, therefore it is always best to transport springhaas in separate containers. Even if springhaas are normally housed together, the stress of shipment can cause aggression between animals that normally get along well.
- 1.4.10.9. **The need for handler/veterinarian access during transport:** Except in an emergency, it should not be necessary to have access to springhaas during transport. Although not an aggressive species, the handling of springhaas during transport, especially by inexperience individuals, can lead to injury to the handler or animal and the possibility of escape. When ever possible the springhaas should be visually check during the transport process.
- 1.4.10.10. **Duration of transport:** If provided with adequate food and bedding, springhaas can remain in their transport containers for days. Because springhaas are small animals, transporting them over distances in excess of a few hundred miles is best done by air transport.
- 1.4.10.11. **Transport destination concerns:** When the springhaas has arrived at the transport destination, it should be released from its transport container as soon as possible. It should be released into an enclosure that is already setup to receive the springhaas. The enclosure lights should be dimmed the proper diet and water should be provided as well as bedding. The animal should be observed to be sure that it did not receive any injuries during transport.

**1.5 Water features:** Springhaas are distributed mainly throughout the semi-arid steppes of eastern and southwestern Africa (Matthee and Robinson, 1997). The best springhaas habitats are flat open areas supporting a short grass cover with little or no woody vegetation and having sandy soils for burrowing (Butynski, 1984). Wild springhaas rarely encounter open water sources. Springhaas enclosures do not usually have water features, just a source of water for drinking.

## 2. Biotic Variables

### 2.1 Food and Water:

- 2.1.1. **Containers and protocols for feeding:** Any type of container that is made of non-toxic materials and that is easily cleaned and disinfected and whose sides are low enough so springhaas can feed or drink from will do. Although springhaas rarely drink, water should be available at all times.
- 2.1.2. **Food stuffs and feeding schedules:** For sample diets and nutrition standards see below. Because springhaas are nocturnal and are often inactive during public hours, it is best to offer their food during public hours to stimulate them to be active.
- 2.1.3. **Variability in food type and presentation:** Identifying food items that can be successfully substituted for the normal diet items and rotating these items

can enrich the springhaas' life. Rotating food items can also improve appetite and increase activity. Scattering and hiding food items around the enclosure can also improve activity and mimic normal foraging behavior.

## 2.2 Social Considerations:

### 2.2.1. Group Composition:

2.2.1.1. **Age and sex structure of social group:** In the wild, springhaas exhibit little social cohesion within groups. Direct observations in the field on behavior and group formation indicate that with the exception of low-density situations, springhaas have widely overlapping home ranges. Research also suggests that they do not actively defend territories except perhaps the area in the immediate vicinity of the burrow (Butynski, 1984). Springhaas burrows are occupied either by one animal or at most a female and her single young (Butynski and Mattingly, 1979). Springhaas do occur in social groups. They have been observed in groups to a greater degree than might be expected by randomly foraging individuals (Augustine *et.al.*, 1995). That they are at least semi-social is illustrated by the fact that in captivity, even when given the opportunity to occupy separate enclosures they almost always remain together (Coe, 1967). Aggression among captive springhaas is rare, but does occur. When three females were added to a pair at the Rochester Zoo, their introduction resulted in savage fighting, the male being the aggressor (Velte, 1978).

While housing adult females together usually works well, housing adult males together usually leads to aggression. Groupings of more than one adult female, one adult male with more than one female, and pairs usually do well. Young springhaas over three months of age can be housed with any of the above groups, but young males should be separated from adult males before they reach sexual maturity at about one year of age.

2.2.1.2. **Temporary isolation:** Parturient females should be isolated a week or more prior to giving birth. Assuming she is successfully rearing her young, they should remain separate until the young springhaas is about three months old. Hand-reared springhaas should also be separated for other springhaas during the rearing process. It is beneficial to the hand-reared springhaas' social development to introduce it to other springhaas as early as possible. These introductions should be done under close supervision. It may also be necessary to temporarily isolate surplus males until transported or a mate is found for it. Isolated individuals whether single adults or mothers with young should be housed in an enclosure with a minimum of 20-sq. ft. of floor space. They should also have the same bedding, cage furniture, etc. as is mentioned in section 1.4.

2.2.1.3. **Seasonal separation of sexes:** In captivity, springhaas are not seasonal breeders, so seasonal separation of sexes is not necessary. Mixed sex social groups are normally compatible at all times of the year.

- 2.2.1.4. **Nursery groups:** Springhaas do not form nursery groups in the wild. Springhaas burrows are occupied either by one animal or at most a female and her single young (Butynski and Mattingly, 1979). Female and their young should be isolated for all other springhaas until the young is about three months old.
- 2.2.1.5. **Forced “emigration” of adolescents:** Except to avoid inbreeding, adolescent females can remain with the breeding group into adulthood. Adolescent males should be separated from adult males before they reach maturity at about one year of age.
- 2.2.1.6. **Multigenerational groups:** Springhaas are very long-lived rodents. Captive springhaas routinely live into their late teens. At least one springhaas lived into its early twenties. Therefore, it would be possible to keep multigenerational groups of females together as long as breeding males were exchanged to avoid inbreeding.
- 2.2.1.7. **All male groups:** Captive adult male springhaas do not normally tolerate the presents of other males in their enclosures. If it is necessary to house more than one male in an enclosure providing scattered feeding sites, more sleeping/hiding sites than animals and a number of visual barriers should reduce the chances of aggression.
- 2.2.1.8. **Life stage variation in patterns of social affiliation:** Young springhaas between the ages of three months and one year appear to associate well in any group situation. As springhaas mature, some adult females and most adult males become less tolerate of other springhaas
- 2.2.2. **Group size:** There appears to be increasing success in reproduction with larger group size. One or two males (if they will tolerate each other) and four to six females would make a good breeding group as well as an excellent exhibit. Although a single springhaas in a well design enclosure could make a good exhibit, a group of two or more springhaas will more likely demonstrate the range of springhaas behaviors.
- 2.2.3. **Conspecific groups:** Groups of springhaas housed in adjacent enclosures do not appear to influence each other.
- 2.2.4. **Mixed species groups:** A list of some of the species that have been housed with springhaas include: Senegal galapos, Senegal bushbabies, aardvarks, potto, grey-headed fruit bats, echidna, African hedgehog, meerkats, rock hyrax, Kirk’s dikdik, crested porcupines, tree hyrax, aavdwolves, and fennec foxes (Laird, 1993).

The success of these mixed species groups varies depending on individual animals, the size and complexity of the enclosure, and other animal management considerations. Large enclosures, many sleeping/hiding spots, scattered food sources, and visual barriers can all contribute to a successful mixed species group. When picking species to mix with springhaas, choosing species such as bats or hyrax that would use a different level of the enclosure can improve the chances of success.

The single biggest problem with springhaas in mixed species exhibits, is other species killing springhaas babies. Although no one has reported observing another species killing a springhaas baby, a number of babies have been found dead and partially eaten. Those reporting these deaths have assumed that another species housed with the springhaas had killed and eaten the baby. If a chosen species exhibits no aggression toward adult springhaas, then removing parturient females from the enclosure can eliminate the above problem. The mother and young can be returned to the enclosure when the young are about three months old.

2.2.5. **Introductions:** Overall introductions between springhaas of different sexes go well. Introductions between female springhaas vary and care should be taken to observe them during active periods to be sure there are no signs of aggression. Introductions between adult males are difficult. Males who seem to be getting along well can become aggressive toward each other without warning. Before the actual introduction, put the animals in adjacent enclosures with visual, olfactory and limited tactile contact. If the enclosure setup does not allow for this method, the new springhaas can be placed in a “howdy” cage and placed in the enclosure. This technique will allow the new animal to have visual, olfactory and limited tactile contact with its new enclosure and cage mates. Observe animals during active periods to determine compatibility. Once the animals are in the enclosure together continue the observations until compatibility is assured. Watch for signs of aggression such as missing fur and bite wounds. The above methods work for introductions to mixed specie enclosure also.

2.2.6. **Human-animal interactions:** Springhaas are prey animals and rely on flight as a means of defense. Captive springhaas have been known to injure and even kill themselves by running into fences or walls. Improper handling by keepers has also lead to injuries. On the other hand, springhaas are capable of delivering a severe bite and can scratch with their powerful hind legs. Captive born springhaas and wild born springhaas that have been in captivity of a while are quite comfortable with keepers in their enclosures. Hand-reared and tamed mother reared springhaas do interact with keepers when they enter their enclosures.

It is important to move slowly and keep disturbances to a minimum during enclosure servicing. During feeding and spot cleaning the springhaas can remain in the enclosure, but during major enclosure cleaning it is best to remove the springhaas. Wild caught springhaas often resist capture and handling, while hand-reared animals that have been handled since birth, accept capture and handling without protest. Restraining the springhaas with one hand holding the body from behind and under the forelegs while the other hand holds the hind legs is a technique that is safe for both the animal and the handler. It is always best to use handling gloves when restraining springhaas.

### 3. Health and Nutrition

#### 3.1. Diet:

##### 3.1.1. The nutrient content of a recommended diet on a dry matter basis:

Nutrient	Recommended diet
Protein, %	17.81
Fat, %	9.00
Fiber, %	5.75
Vitamin A, IU/g	14.29
Vitamin D, IU/g	1.82

Vitamin E, mg/kg	109.5
Thiamin, mg/kg	6.86
Calcium, %	0.69
Phosphorus, %	0.59

(Source: Chicago Zoological Society)

This recommended nutrient content is adequate for all life stages from post-weaned young to geriatric including pregnant and lactating females.

3.1.2. **Two sample diets:**

Apple	35g
Carrot	108g
Sweet Potato	108g
Leafy mix*	97g
Monkey Chow	40g
Rat Chow	40g
Sunflower seeds	11g

\*A mixture of leaf lettuce, spinach, celery, and kale.  
(Source: Chicago Zoological Society)

Mazuri™ monkey crunch biscuits (6 to 9 whole biscuits)  
 Peeled and sliced sweet potatoes (1/4 lb.)  
 Fresh or thawed frozen corn kernels (1/4 to 1/3 cup)  
 Cracked walnut or pecan (1 nut)  
 Whole wheat bread (1 bite-size piece, approx. 1/8 slice)  
 All of the above is sprinkled with:  
 Chaparral™ zoological vitamins with added vitamin E and Selenium  
 Super 14™ powder or Biotin™ powder Vitamin C  
 The springhaas also get fresh grass when available (usually all year),  
 free choice mineral salt block, a small amount of alfalfa hay  
 (occasionally) and several fresh green tree limbs to chew each night.  
 (Source: Kangaroo Conservation Center)

These recommended diets are adequate for all life stages from post-weaned young to geriatric including pregnant and lactating females.

3.1.3. **Variables on dietary requirements:** If fed a nutritionally balanced diet free choice, most springhaas will maintain good condition regardless of age, body size, reproductive status, activity level, seasonal changes, or health status. Some geriatric springhaas have difficulty in maintaining a good body weight and it may be necessary to make adjustments to their diet.

3.2. **Medical management:**

3.2.1. **Quarantine and hospitalization:** Quarantine should last 30 days, longer if findings warrant. A complete physical exam should be done half way through the quarantine period. During the quarantine, three fecal examinations should be done. If the diet from the sending institution differs from the receiving institution a gradual transition should be done during quarantine. If animals were housed together at the sending institution then they can be housed together during quarantine. They should be monitored for signs of aggression that may result due to the stress caused by the shipment. Springhaas appear to do well when housed separate, therefore they may be isolated during quarantine.

3.2.2. **Preventive medicine:** Routine physical exams should be done annually. Fecal examinations should be done every six months. If treatments for parasites are necessary then three follow-up examinations should be done 7-10 days post treatment.

3.2.3. **Capture, restraint and immobilization techniques:** Wild caught springhaas often resist capture and handling, while hand-reared animals that have been handled since birth, accept capture and handling without protest. Captive born mother-reared springhaas and wild caught springhaas that have been in captivity for a long time vary in their tolerance to capture and handling.

Springhaas can be trained to enter a crate by herding or for a treat. It is also possible to hand-grab some springhaas especially while they are sleeping. If provided with a transfer box to sleep in, it is then possible to trap them in the box when necessary. Netting a springhaas is also a possibility, but frighten springhaas have been known to run into barriers and cause injury or death. Restraining the springhaas with one hand holding the body from behind and under the forelegs while the other hand holds the hind legs is a technique that is safe for both the animal and the handler. It is always best to use handling gloves when restraining springhaas. Many minor medical procedures (nail and tooth trims, administration of medications, and blood draws) can be done by hand-restraining springhaas. If chemical restraint is necessary, Ketamine hydrochloride at 12.7 mg/kg by itself or in conjunction with xylazine at 1.2 mg/kg or isoflurane at 2-5% are drugs that have been used successfully (Laird, 1993).

3.2.4. **Management of neonates and geriatric animals:** A physical exam should be done on all hand-reared springhaas as soon after birth as possible. A neonate physical should also be done on mother-reared springhaas, but this should be delayed until there is a good mother infant bond. Geriatric springhaas often have difficulty in maintaining proper body weight. These animals should be weighed on a regular basis and adjustment made to their diet to keep their weight within normal ranges.

3.2.5. **Management during pregnancy:** Parturient females should be isolated a week or more prior to giving birth. Assuming she is successfully rearing her young, they should remain separate until the young springhaas is about three months old. Mothers with young should be housed in an enclosure with a minimum of 20-sq. ft. of floor space. The floor should be covered with bedding. A nest box, hollow log, or some other hiding/sleeping cage furniture should be provided for privacy. In order to help the infant maintain its body temperature, the enclosure should have a temperature range of about 65 to 90 degrees Fahrenheit. Disturbances of the mother and infant should be kept to a minimum.

#### 4. **Reproduction:**

4.1. **Seasonal changes in physiology and behavior:** Breeding was found to be seasonal in Zimbabwe (Kofron, 1987) and non-seasonal in Botswana (Butynski, 1979) South Africa (van der Merwe *et. al.*, 1980) and Kenya (Coe, 1969). Kofron (1987) states that seasonal variation in the availability of food may be the cause of seasonal breeding in Zimbabwe. In captivity, springhaas have been born in every month (Laird, 1993). In captivity estrus in females is determined based on

the male's behavior. The male is observed sniffing the female under the tail, following her around the enclosure, and attempting to mount her. Before actual copulation, there is some preliminary mounting, but the animals are usually very secretive and do not breed when being observed (Laird, 1999).

- 4.2. **Introductions:** As captive springhaas reproduce at any time of the year and introductions between opposite sex animals normally go well, introductions for reproduction can be attempted at any time. The timing of introductions is often based on the dates that would be best for the births. It is therefore important to know the gestation period. Rosenthal and Meritt (1973) suggested a gestation period of 80-82 days; Velte (1978) estimated gestation to be in the range of 72-82 days; Kofron (1987), based on plasma progesterone levels in the blood, place the gestation length at 79 days. A springhaas at Brookfield Zoo experienced one gestation period of at least 124 days. This time period (124 days) is the length of time she was separated from any springhaas before giving birth. Also, Asa Zoological Park in Hiroshima, Japan recorded two longer gestation periods of 143 and 139 days (Daimaru, 1996 personal communication).
- 4.3. **Management for parturition:** Although female springhaas have given birth in enclosures with other springhaas present, it is suggested that females be isolated for birthing. Parturient females should be isolated a week or more prior to giving birth. Assuming she is successfully rearing her young, they should remain separate until the young springhaas is about three months old. Hand-reared springhaas should also be separated from other springhaas during the rearing process. It is beneficial to hand-reared springhaas' social development to introduce it to other springhaas as early as possible. These introductions should be monitored closely. Mothers with young should be housed in an enclosure with a minimum of 20-sq. ft. of floor space. The floor should be covered with bedding. A nest box, hollow log, or some other hiding/sleeping cage furniture should be provided for privacy. In order to help the infant maintain its body temperature, the enclosure should have a temperature range of about 65 to 90 degrees Fahrenheit. Disturbances of the mother and infant should be kept to a minimum.
- 4.4. **Hand-rearing:** Maternal rejection of infants is common in captivity. Many institutions have had to hand-rear infants as a result of maternal rejection, maternal aggression, weight loss owing to inability to nurse or illness (Laird, 1993).

Hand-reared infant springhaas should be housed in either a human incubator with the temperature set at a range of 80 to 90 degrees Fahrenheit or in a small enclosure with an auxiliary source of heat. They can be kept on a natural light cycle to facilitate keeper care. For feeding, a 6cc syringe with a kitten-sized flexible nipple works well. The plunger on the syringe is slowly pushed at the rate the infant takes the formula. The infants drink best when they are held lying flat on a lap, since this is the normal position they use when nursing from their mother. For the first day or two, they are offered formula every 2 hours, as they may only drink 2 to 4cc's at a time. The intervals between the feedings and the amount offered per feeding are gradually increased.

Two successful hand-rearing formulas are: (1) Esbilac™ puppy formula mixed with water 50/50 and heated to around 100 degrees Fahrenheit (Source: Kangaroo Conservation Center). (2) 15g Multimilk™, 5g Esbilac™ powder, 80g boiled water and three drops of Lactaid™. This formula is made up 24 hours before use so the Lactaid™ can break down the lactose, refrigerated and after 72 hours all unused formula is discarded (Source Chicago Zoological Society).

Infant springhaas start to eat solid food at 10 to 14 days old and are usually weaned at 60 to 90 days old. They can be offered the same diet as adults cut into smaller pieces.

Springhaas infants urinate and defecate spontaneously and therefore do not need to be stimulated. During the hand-rearing process, infant springhaas should be weighed regularly to evaluate their progress. Introductions of young (3 month to 1 year) to adults normally are successful. Hand-reared males may need to be separated from adult males before they reach sexual maturity at about one year of age.

- 4.5. **Contraception:** The primary means of contraception in springhaas are separation of the sexes and castration of males. The main drawback with castration is that it is non-reversible. Separation of the sexes is the most common form of birth control in springhaas. Springhaas do well when housed as individuals or in single sex groups, although some males will not tolerate other males in their enclosures. The option of housing springhaas as individuals or in single sex groups allows the manager to control breeding. In general, springhaas do not reproduce well in captivity, so contraception is currently not an important management issue.

## 5. Behavior management:

- 5.1. **Managing for routine husbandry:** Most springhaas can be habituated to the presents of keepers in their enclosures. So routine cleaning, feeding, and visual inspection should not be a problem. Providing them with multiple nest boxes, dens, tunnels, etc. allow them more than one place to hide while their enclosure is being serviced. Springhaas can be conditioned to enter these “hiding” areas. If these “hiding” areas are portable and can enclose the springhaas they can be used as a method to capture the animal, transport the animal to another enclosure, or as a temporally holding area. Routine handling of springhaas normally increases their tolerance of keeper contact. Hand feeding of treat items can be used to train springhaas to approach keepers, shift into another enclosure, and enter transport boxes.
- 5.2. **Managing for non-routine husbandry:** Routine and careful handling of springhaas normally increases their tolerance of keeper contact. If handled often and properly, hand restraining of springhaas will allow keepers to treat minor injuries, draw blood, give injections, crate, etc. Hand feeding of treat items can be used to train springhaas to approach keepers, stand on a scale, shift into another enclosure, and enter transport boxes.
- 5.3. **Introductions:** Introductions between springhaas of different sexes usually go well. Introductions between female springhaas vary and care should be taken to observe them during active periods to be sure there are no signs of aggression. Introductions between adult males are difficult. Males who seem to be getting along well can become aggressive toward each other without warning. Before the actual introduction, put the animals in adjacent enclosures with visual, olfactory and limited tactile contact. If the enclosure setup does not allow for this method, the new springhaas can be placed in a “howdy” cage and placed in the enclosure. This technique will allow the new animal to have visual, olfactory and limited tactile contact with its new enclosure and cage mates. Observe animals during active periods to determine compatibility. Once the animals are in the enclosure together continue the observations until compatibility is assured. Watch for signs of aggression such as missing fur and bite wounds.

- 5.4. **Training and facility design:** Enclosures for springhaas must allow the animal to feel secure, provide it with the opportunity to dig and forage for food. The facility should allow the keeper to service the enclosure and feed and observe the animal with little disturbance. The keeper should develop a cleaning, feeding and observation routine that causes little stress to the animal. Time should be allowed in the daily routine to do basic training. The animal should be trained with positive reinforcement, such as hand feed treats, to approach the keeper, shift, enter a transport box, stand on a scale, etc. The keeper should handle the animal on a routine basis to desensitize the animal to human contact.
- 5.5. **Staff skills and competencies:** As with keepers of any animal, springhaas keepers should have a thorough understanding of springhaas natural history, behavior and physiology. They should be careful and patient when working around springhaas. They need a good understanding of positive conditioning and training techniques.
- 5.6. **Enrichment:** Taking into consideration the springhaas' needs in their enclosure design and daily care is the basis of a good enrichment program. Springhaas are fossorial. Providing them with the opportunity to dig and even dig their own burrow can be very enriching. The springhaas forage for food in the wild. Providing them with scattered, hidden food will increase their activity. Hiding food items in substrate or hay are techniques that provide enrichment for springhaas. Their enclosures should be as large as possible and flat to allow these large rodents to utilize their unusual method of locomotion. As springhaas avoid stressful situation by hiding, they need to have a number of hiding area, one or two more than the number of animals in the enclosure to allow for choice. Springhaas are rodents and like most rodents they like to chew. Providing them with branches, cardboard boxes, rawhide chews, etc. can be enriching for the springhaas and keep them from chewing up their enclosures.

### Suggested Readings

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