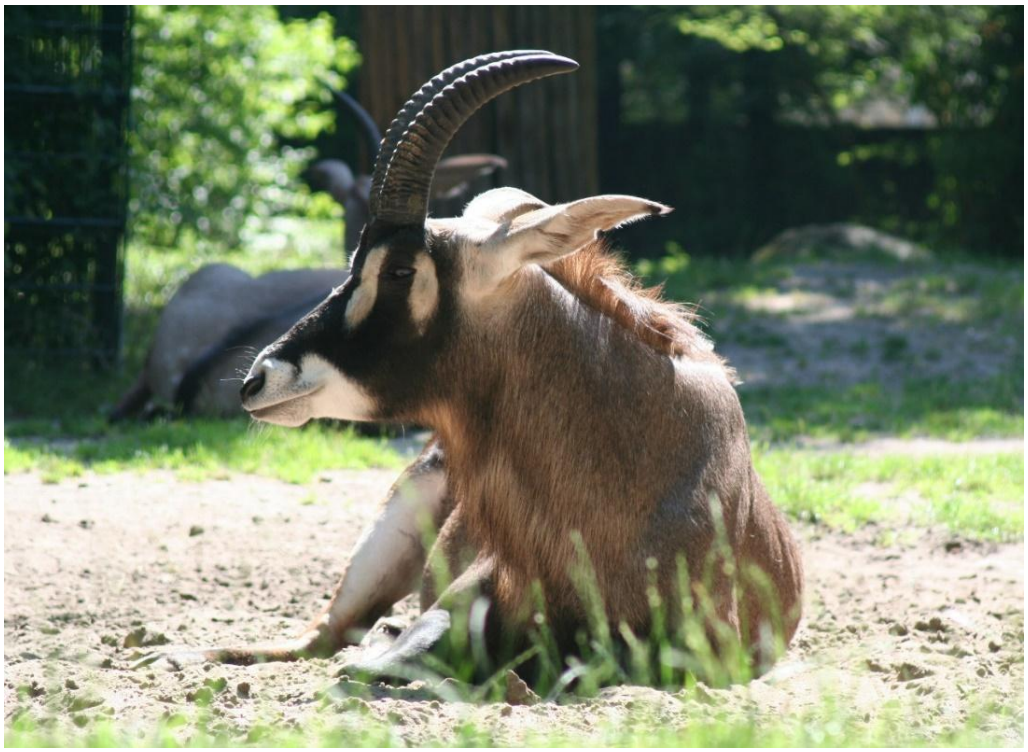
EAZA Best Practice Guidelines

Roan Antelope
(*Hippotragus equinus*)

Edition 1



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Preamble

Right from the very beginning it has been the concern of EAZA and the EEPs to encourage and promote the highest possible standards for husbandry of zoo and aquarium animals. For this reason, quite early on, EAZA developed the “Minimum Standards for the Accommodation and Care of Animals in Zoos and Aquaria”. These standards lay down general principles of animal keeping, to which the members of EAZA feel themselves committed. Above and beyond this, some countries have defined regulatory minimum standards for the keeping of individual species regarding the size and furnishings of enclosures etc., which, according to the opinion of authors, should definitely be fulfilled before allowing such animals to be kept within the area of the jurisdiction of those countries. These minimum standards are intended to determine the borderline of acceptable animal welfare. It is not permitted to fall short of these standards. How difficult it is to determine the standards, however, can be seen in the fact that minimum standards vary from country to country. Above and beyond this, specialists of the EEPs and TAGs have undertaken the considerable task of laying down guidelines for keeping individual animal species. Whilst some aspects of husbandry reported in the guidelines will define minimum standards, in general, these guidelines are not to be understood as minimum requirements; they represent best practice. As such the EAZA Best Practice Guidelines for keeping animals intend rather to describe the desirable design of enclosures and prerequisites for animal keeping that are, according to the present state of knowledge, considered as being optimal for each species. They intend above all to indicate how enclosures should be designed and what conditions should be fulfilled for the optimal care of individual species.

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PREFACE

In 1999, the EAZA conference in Basel passed a resolution to set up a studbook for the roan antelope (*Hippotragus equinus*, SAINT-HILAIRE, 1803). Seven years later, the EAZA decided to convert this studbook into a European Endangered Species Programme (EEP). Zoo Hannover, as the site of the world's first breeding of roan antelopes in 1967, was given the honour of leading this programme.

Despite its elegant appearance, the roan antelope remains a rare guest in the world's zoos. The first roan antelope came to a European zoo, the Zoo of London, as early as 1878. In the following years, further specimens of the imposing antelopes were shown in European zoos. In 1893 the first roan antelopes came to Hannover. In 2000, at the beginning of the documentation in the studbook, they numbered 102 individuals in 12 European zoos. With the introduction of the EEP, the number increased to 139 roan antelopes in 24 establishments in 2011. Today (as of 08/2026), the population is holding around 140 animals in more than 20 Zoos.

The roan antelope is an attractive species for zoo keeping. Not only because of its size − it is the second largest antelope − but also because it is extinct in some parts of its original range in Africa. It has great potential for reintroduction and zoos can make a significant contribution to the conservation of this species, now and in the future.

Vernacular names for the roan antelope

- Korongo (Swahili)
- Abu-uruf (Arabic)
- Bwore (Luo)
- Echilil (Aesopian)
- Echolia (Karamojong)
- Oforo (Lugbara)

The last publication of a roan antelope studbook with husbandry guidelines was eight years ago, so it is time for an update. Due to evolved knowledge regarding the husbandry of this large antelope, the "Best Practice" has to be recompiled and published.

1 BIOLOGY

1.1 Taxonomy

1.1.1 Classification

Family: Bovidae
Tribe: Hippotragini
Genus: *Hippotragus*
Species: *Hippotragus equinus* – Roan antelope

The roan antelope (*Hippotragus equinus*) belongs to the Bovidae family. It shares the genus Hippotragus with the extinct bluebuck (*Hippotragus leucophaeus*) and the sable antelope (*Hippotragus niger*). Characteristic of the genus are the backward curved horns in both sexes. The roan antelope was first described by GEOFFROY SAINT-HILAIRE in 1803. The suffix *equinus* is derived from the Latin word "equus" and refers to the horse-like appearance.

For a time, the extinct bluebuck (*Hippotragus leucophaeus*) was listed as a subspecies of the roan antelope. ROBINSON ET AL. (1996) proved on the basis of a genetic analysis that it is a distinct species.

Occasionally, four species are listed under the genus *Hippotragus*: the above-mentioned species and additionally the Roosevelt's sable antelope, *Hippotragus roosevelti*. This classification is based on GROVES & GRUBB (2011), who applied the phylogenetic species concept instead of the traditional biological species concept. Instead of being based on "reproductive isolation", species in this concept are defined as follows: "A species is the smallest population or grouping that differs from other populations or groupings by fixed heritable differences." The classification according to GROVES & GRUBB (2011) with *Hippotragus roosevelti* as a distinct species can be found in the "*Handbook of the mammals of the world, volume 2: hoofed mammals*" (WILSON & MITTERMEIER, 2011).

1.1.2 Subspecies

The taxonomic status of *Hippotragus equinus* subspecies is uncertain. ANSELL (1972) describes six subspecies based on morphological and geographical characters:

1. ***Hippotragus equinus koba*** (GRAY, 1872)
   Distribution: Senegal to Benin
2. ***Hippotragus equinus cottoni*** (DOLLMAN and BURLACE, 1928)
   Distribution: Angola, Botswana, Congo, Central Malawi, Northern Malawi and Zambia
3. ***Hippotragus equinus equinus*** (SAINT-HILAIRE, 1803)
   Distribution: Mozambique, South Africa and Zimbabwe
4. ***Hippotragus equinus langheldi*** (MATSCHIE, 1898)
   Distribution: urundi, Congo, Ethiopia, Kenya, Rwanda, South Sudan, Tanzania and Uganda
5. ***Hippotragus equinus charicus*** (SCHWARZ, 1913)
   Distribution: Cameroon, Congo, Chad and Nigeria
6. ***Hippotragus equinus bakeri*** (HEUGLIN, 1863)
   Distribution: Sudan

However, genetic studies by APLERS ET AL. (2004) did not provide support for this classification. They found that roan antelopes can be divided mainly into two groups: the West African population (corresponding to the subspecies *H. e. koba*) as one group and the populations in East, South and Central Africa (representing the subspecies *H. e. cottoni*, *H. e. equinus* and *H. e. langheldi*) as another group.

1.2 Morphology

Roan antelopes are the largest and heaviest African antelopes after the eland. The weight of male roan antelopes ranges from 230 to 300 kg, with an average of about 280 kg. Female roan antelopes are somewhat lighter, weighing 215 to 280 kg, with an average of 260 kg (KINGDON, 1982).

Roan antelopes can reach a head-torso length of well over 200 cm. The body length of the western subspecies *Hippotragus equinus koba* can even be up to 320 cm, that of the southern subspecies *Hippotragus equinus equinus* up to 265 cm (CASTELLO, 2016). The shoulder height is 120-160 cm. Male individuals are more powerfully built than females. The tail length is 60-75 cm, and the length of the transversely grooved horns is 55-100 cm, with females having shorter horns than males. The long ears, characteristic of roan antelopes, measure 35-38 cm (KINGDON, 1982; GROVES & LESLIE, 2011; CASTELLO, 2016).

The coat of the roan antelope is short and smooth. Colouring ranges from off-white with a slightly reddish tinge to fawn to medium and dark brown. The underside of the body is greyish to yellowish white. Calves may range from reddish to yellowish-brown and brownish in coloration. The distinct, erect mane is grey-brown with brown-black tips. The tail hairs and ear tufts are black-brown. The characteristic face blaze of black-brown to deep black with contrasting white is striking.

Roan antelopes have skin glands that are located in front of the eyes. These skin glands are noticeable by the flattened hair tufts. There are also skin glands in the interdigital spaces. Like all bovids, female roan antelopes have four teats.

Fig. 1: *Roan with offspring at Zoo Hannover*
© Erlebnis-Zoo Hannover

Loud vocalizations are rare in roan antelopes. They typically emit a high-pitched whistle sound when enraged or a horse-like snort when alarmed or frightened, and a low hiss when wounded. When female roan antelope are driven or harassed by a roan male, they may utter scream-like sounds. Mothers and calves also communicate with each other via soft calls.

1.3 Physiology

Roan antelopes are ruminants and thus have a digestive system designed to provide as much energy as possible from fibrous plant material, their molar teeth are well-developed to grind cud (food that returns from the stomach) for further digestion. Their stomach is divided in four compartments – the rumen, reticulum, omasum, and abomasum – and occupies much of the abdominal cavity.

In general, antelopes can regulate their heat balance well. The Arabian oryx, for instance, has the "Rete mirabile" - a network of fine arteries that act like a blood-driven air conditioning system. According to measurements by von REINERS & LOTH (2014) on anesthetized roans, the heart rate at rest is 40-44 beats per minute. In stressful situations, such as surgery, it can increase to 100 beats/min. The respiratory rate is between 28 and 56 breaths per minute.

1.4 Longevity

According to GRZIMEK (1988) roan antelopes in human care reach ages of up to 17 years. The maximum age in the European studbook was recorded for a female roan antelope in Arnhem that reached 25 years (ZIMS 2024). In Serengeti Park Hodenhagen, three male roans reached 20 and 21 years. WEIGL (2005) records the following highest ages for females of the different subspecies:

Hippotragus equinus equinus	at Pretoria Zoo/ South Africa	13 years
Hippotragus equinus bakeri	at Zoo Dvůr Králové/ Czech Republic	15 years/ 3 months
Hippotragus equinus cottoni	in Catskill White Oaks	23 years
Hippotragus equinus langheldi	in Bush Garden Zoo/ USA	25 years/ 10 months

1.5 Zoogeography and ecology

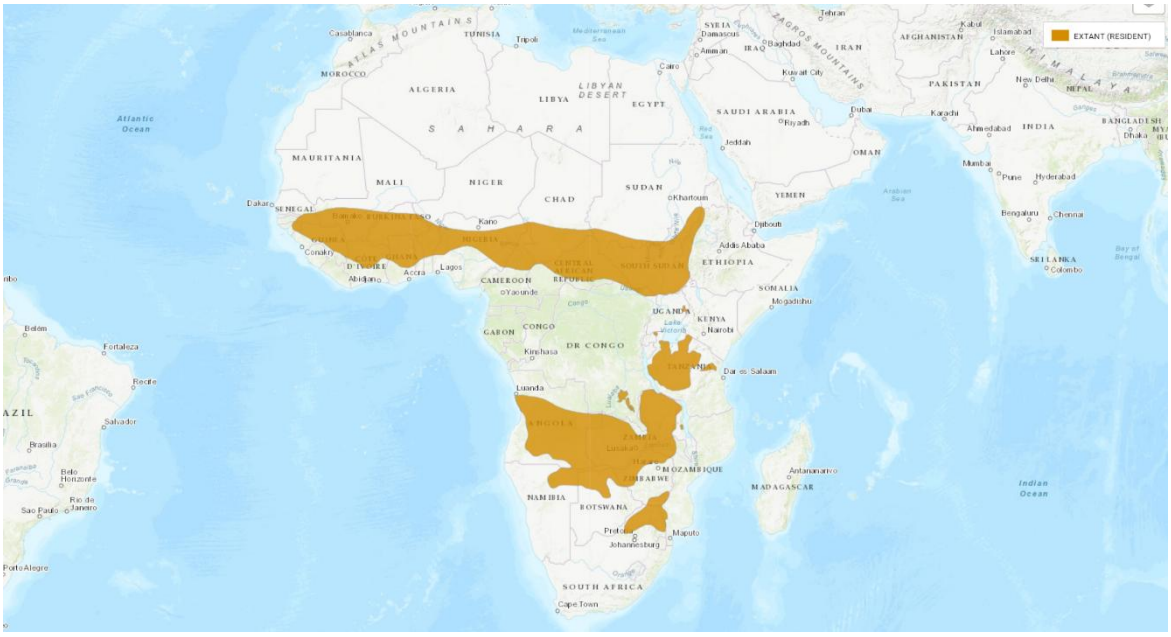

Fig. 2: *Geographic distribution of Hippotragus equinus*
© IUCN (International Union for Conservation of Nature) 2008. Hippotragus equinus. The IUCN Red List of Threatened Species. Version 2022-2

1.5.1 Distribution

The roan antelope is still widespread in large parts of sub-Saharan Africa (DÖRGELOH ET AL., 1996; **Fig. 2**). The total population was estimated at 76,000 animals in 1998, with 60% in protected areas in 1999. About one-third of the total population was stable or growing at that time, two thirds were declining (EAST, 1998).

However, the local distribution of roan antelopes is patchy and irregular (SKINNER & SMITHERS, 1990), so they sometimes occur in low densities. While the roan antelope is most common in West and Central Africa, populations in South and East Africa have become smaller. The species is even locally extinct in Burundi, Eritrea, and possibly Gambia.

The largest populations are found in the following protected areas:

- National Park Niokolo-Koba (Senegal)
- Comoé National Park (Ivory Coast)
- Arli National Park, Singuo Reserve, Ranch de Nazinga (Burkina Faso)
- Mole National Park (Ghana)
- Pendjari National Park (Benin)
- Waza National Park and National Parks and Hunting Zones of the Northern Province (Cameroon)
- Manovo-Gounda St. Floris National Park (Central African Republic)
- Moyowosi & Kigosi Game Reserve, Katavi National Park & Rukwa Game Reserve (Tanzania)
- Luangwa Valley National Parks (Zambia)
- Nyika National Park (Malawi)

Most of these large, protected populations are stable or even increasing in numbers. The populations in the protected areas of Comoé, Arly-Singou and Kameron's Northern Province, on the other hand, are in decline.

1.5.2 Habitat

Roan antelopes primarily inhabit forested, long-grass wet savannas. They also use semi-arid habitats and graze selectively in recently burned areas when new vegetation sprouts (GROVES & LESLIE, 2011). Moreover, proximity to water is a crucial factor for their survival and thus dispersal: they can go without water for a maximum of two to three days (KINGDON, 1982). Roan antelopes are generally distributed both in areas with more trees and in areas with fewer trees. According to KINGDON (1982) roan antelopes in East Africa prefer forest savannahs with stands of *Commiphora* (balsam tree) and *Colosphosperum* (mopane). The trees provide them with shaded areas. Numerous other ungulates such as eland, mountain oryx, and hartebeest are also common in these areas.

1.5.3 Conservation status

In 1996, the roan antelope was temporarily classified as "threatened" by the IUCN (KIMANZI & WANYINGI, 2014). However, the 2008 IUCN assessment indicated that there was insufficient evidence to support such a classification, and so the status was changed to "least concern". The most recent IUCN Red List assessment also classifies *Hippotragus equinus* globally as „**least concern**“(IUCN SSC ANTELOPE SPECIALIST GROUP, 2017) - but with a significant downward trend. The population is currently estimated at 50,000 to 60,000 individuals. The low density and isolation of roan antelope metapopulations also make it a species of national interest in many countries (MARTIN, 2003).

Primary causes for the decline of roan antelope populations are poaching as well as the loss of habitat through the creation of new settlements and agricultural use (CHARDONNET & CROSMARY, 2013). As a result, roan antelope have been eliminated from much of their former range. Today, they mainly occur in protected areas and other areas with low densities of people and livestock. However, roan antelope seem to be able to resist poaching pressure better than

many other large ungulates in Africa, whose populations suffer more from poaching (EAST, 1998; CHARDONNET & CROSMARY, 2013).

The population at Kruger National Park decreased from 450 animals in 1986 to only 20 animals in 2001. HARRINGTON ET AL. (1999) as well as GRANT ET AL. (2002) assume the reason to be an increased predation pressure by the numerous lions living in the park, caused by the construction of many artificial waterholes and thus a concentration of ungulates at these places. HOFER ET AL. (1996) consider illegal hunting by humans in the 1970s responsible for the decline of East African populations in the Massai Mara National Reserve. In the process, populations declined from an estimated 150-200 animals to only 22 roan antelopes in 1995 (EAST, 1998).

1.5.4 Reintroduction

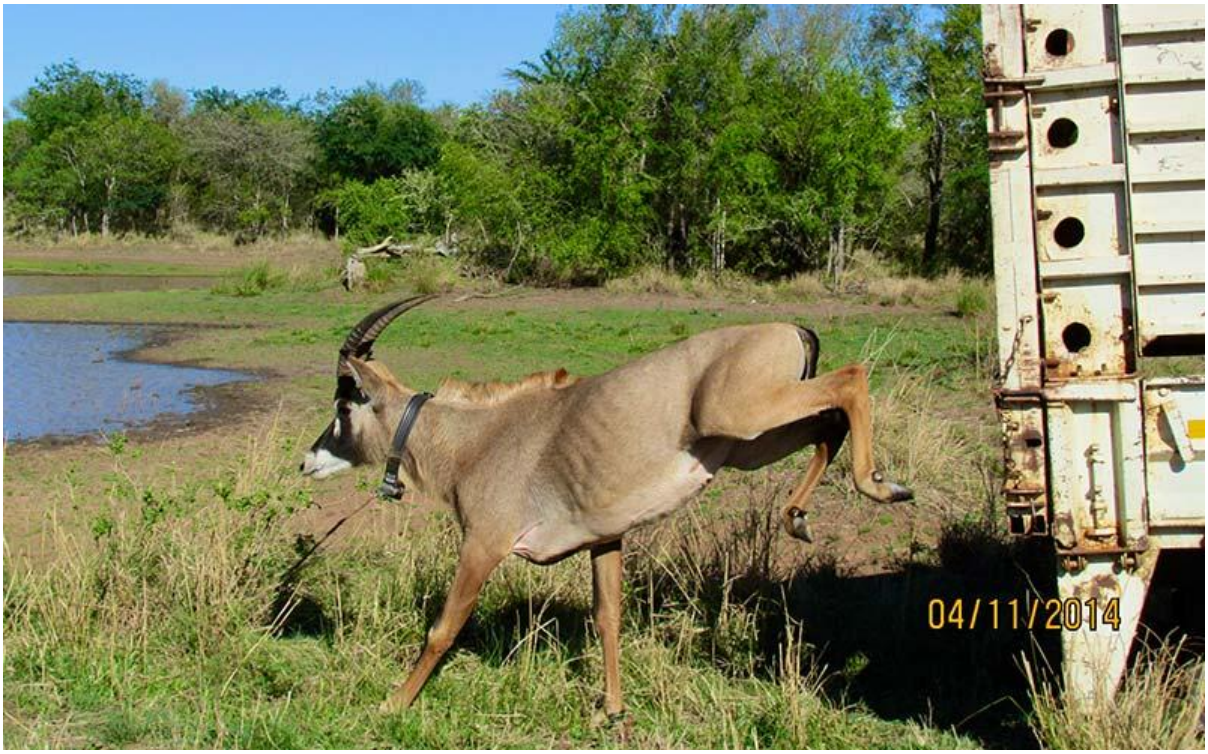

Fig. 3: *Young buck during reintroduction*
© Dr. Hamish Currie

In Eswatini, (formerly Swaziland, East Africa) the roan antelope was extinct. On the initiative of the South African organization "Back to Africa" in cooperation with Zoo Knowsley and Zoo Dvůr Králové, eight animals were reintroduced in the private Mkhaya Nature Reserve (MONADJEM, 1998). In 2016, more than 30 animals were living there again (HAVEMANN ET AL., 2016). Roan antelopes have also been reintroduced in some areas of South Africa: Marakele National Park, Weenen Game Reserve and Karkloof Nature Reserve in KwaZulu-Natal (ROWE-ROWE, 1994; CHARDONNET & CROSMARY, 2013).

1.6 Diet and feeding behaviour

Roan antelopes are ruminant "grazers" (grass and roughage eaters): in the wild, they feed mainly – about 90% – on leafy, freshly grown grasses. In addition, they also eat shrub and tree foliage as well as herbs (CASTELLO, 2016), especially in the dry season – during that time to about 50% besides the grasses. They prefer sweet grasses of the genera *Themeda, Hyparrhenia, Panicium, Heteropogon, Digitaria, Eragrostis* and *Cenchrus*, as well as herbs and also seeds of the genera *Colophospermum* (mopane), *Grewia*, *Lonchocarpus* (lancepods) und *Kigelia* (sausage trees). Roan antelope seem to be able to tolerate low-quality food and to use plant parts that are not used by other herbivores; thus, they avoid food competition (HEITKÖNIG & OWEN-SMITH, 1998). They cover their mineral requirements by seeking out places with mineral-rich soil and ingesting that soil (KINGDON, 1982).

The eastern and southern roan antelopes feed mainly on various grass species. In contrast, western roan antelope show a mixed feeding strategy: only about half of their diet consists of grasses. The remaining components are mainly leguminous species and shrubs. In addition, they feed on various aquatic plants in the water areas. (CHARDONNET & CROSMARY, 2013).

Feeding is the main activity of the roan antelope: the animals feed in the morning hours and again from late afternoon on. In the hot midday period, they take "digestion breaks" in the shade of trees.

1.7 Reproduction

1.7.1 Sexual maturity

Like sable antelopes, roan antelopes become sexually mature at about 24 to 36 months of age (GRZIMEK, 1988). Males, however, usually get to reproduce much later: they first roam in bachelor herds and only gain territories with females with about six years of age. Females can reproduce as early as two years of age but are not quite ready to raise calves until they are three years old. They can give birth to a young at intervals of about 10.5 months from this time on. In human care, sexual maturity of antelopes may occur more rapidly. Thus, in sable antelopes at Zoo Hannover, the first birth was observed after 28.6 months (DITTRICH, 1972). Sexual maturity of that female was thus at 19.6 months and not, as observed in the field, at 24 months at least. The same may apply for roan antelopes.

1.7.2 Courtship and mating

Roan antelopes do not have a specific mating season. Male roan antelopes detect the readiness of females to mate – the oestrus - by the hormones present in the females' urine. Only during this time do females copulate with males. Typically, oestrus in roan antelopes lasts two to three days, often only one and a half days, as reported by a long-time director of the Zoo Hannover (DITTRICH, 1972). Females then usually return to oestrus every two weeks to four months. Studies by THOMPSON & MONFORT (1999) report an oestrus synchronization in sable antelopes (*Hippotragus niger*), which are closely related to the roan antelopes.

According to JOUBERT (1970) the mating of roan antelopes is preceded by a ritual, similar to the ritualized fighting between males. The male holds his head high, while the female holds her head low. Both partners first stand in reverse parallel to each other and then circle around each other. WALTHER (1988) calls this behaviour "mating circling". During the circling, the male executes so-called "running strokes" when standing behind the female: Using his foreleg, he

gently strikes against the hind leg of the female. The circling continues and both animals smell the genitals of their partner. When the female antelope is ready to mate, she lowers her head, stands wide-legged and twists her tail. Then the male mounts the female from the rear. It places its chest on the croup of the female, head and neck remain stretched.

In human care, roan antelopes show the same mating behaviours as in the wild.

1.7.3 Gestation period and seasonality

Data about the gestation period in the field are lacking, the available data is from zoo populations. According to that data, the gestation period lasts about 268 to 286 days (KINGDON, 1982; CHARDONET & CROSMARY, 2013; ZIMS, 2024).

The times of year where calves are born vary in the wild. In central East Africa, for example, young are born from April to November, and in some cases as late as October to December. In south-eastern Africa, births are typically in January to February, while in the southwest they are observed from August to November. In Zaire, on the other hand, they are observed year-round with a focus from February to May.

Postpartum oestrus is possible in roan antelope. In this case, female roan antelopes ovulate again within a month of giving birth. Normally, roan antelope are ready to mate again after about ten to thirteen months. In roan antelopes in human care, a new oestrus has been observed about five to eight weeks after giving birth.

1.7.4 Juvenile development

Twin births, as known from nilgai and saiga antelopes, are not known in roan antelopes, neither in the field nor in human care. As a rule, and as in most antelopes, only one young is born.

The birth weight of roan antelopes in nature is between 14 and 21 kg (GRZIMEK, 1988). This is confirmed by data from the European studbook (ZIMS, 2024): birth weights were taken from 11 calves born from 2022 to 2024 in Zoo Paris (France), Serengeti Park Hodenhagen (Germany) and Zoo Dvůr Králové (Czech Republic). On average, a roan antelope calf weighed 15.89 ± 2.2 kg. After birth, the calf can stand up quickly; the first attempts to stand up often occur within the first 20 minutes. In the first weeks of life, the young animal nevertheless remains in a hiding place between tall grasses. The mother also stays away from the herd for a few days before and about one week after birth. Once or twice a day the mother comes to suckle the calf, usually in the early morning and a second time at night. In some cases, orphaned calves are cared for by lactating females. Young calves drink while kneeling on its carpal joints. After a few weeks they begin to eat some green herbage (CHARDONNET & CROSMARY, 2013).

The mortality rate in the wild is high in this first phase of juvenile development: about 80% in the first seven weeks (WILSON & HIRST, 1977; DÖRGELOH, 1998). In some cases, this is not due to predators (as is usually the case), but due to theileriosis, an infection with a tick-borne blood parasite that usually mainly affects cats.

At four weeks of age, young animals can already weigh 32 to 34 kg. At about four to six weeks of age, when strong enough to keep up with the daily movements of the herd, the calf joins other young animals in a "nursery" within the herd. It spends more time with the other calves than with its mother (WALTHER, 1988). According to KINGDON (1982), the young animal is suckled for at least four months, and is usually weaned at the age of six months. This can be confirmed by experience reports in human care.

Fig. 4: *Young animal drinking at Zoo Hannover 2012*
© Erlebnis-Zoo Hannover

1.8 Behaviour

1.8.1 Activity

There are only few observations in the field about the daily routine of horse antelopes. Thus WALTHER (1988) reports that the main activity phases are in the early morning hours and in the late afternoon as well as in the evening. In between, roan antelopes rest in shaded areas. This resting phase is only interrupted by a walk to the watering place in the midday. When grazing, roan antelope can move two to four kilometres away from their watering place (JOUBERT, 1974).

1.8.2 Locomotion

Roan antelopes use grazing areas that are several square kilometres in size. The size of the area depends on the food supply. According to ESTES (1991), roan antelopes in the Kruger National Park move between 1 and 1.1 km per day in their grazing area. Roan antelopes reach 57 km/h (~35 mph) as top speed when they are on the run (ESTES, 1991). This makes them far slower than many other antelope species commonly hunted by lions and wild dogs. Nevertheless, roan antelopes appear to be under little predation pressure after the first few months of life.

Roan antelopes exhibit various gaits, including canter and trot. The canter is generally very different among the *Hippotragini* species. Roan antelopes jump higher and bend their legs more than other species. For example, the Addax have a rather flat canter with minimal flexion that appears to be stiff-legged. The trot does not occur as a regular gait in all *Hippotragini*, but rather represents the transition between walk and canter. In excitement or alarm situations, a stylized trot is performed. Young equine antelopes also playfully display various movements from running, chasing, prancing, trotting, bucking to jumping. They also often have mock fights with various objects.

1.8.3 Predation

The predators of the roan antelope include all known African predators. According to HARRINGTON ET AL. (1999) these are among others the lion, the leopard, the spotted hyena and the African wild dog. Young animals unaccompanied by adult roan antelopes are particularly at risk (BEUDELS ET AL., 1992).

SPINAGE (1986) describes the killing of a roan antelope buck by several cheetahs in East Africa. GUGGISBERG (1963) reports a pair of lions following a herd of roan antelope. Initially, the adult roan antelopes seemed quite nervous, but they suddenly changed their behaviour, turned toward the lions, advanced in a broad front, and forced the lions to retreat.

1.8.4 Social behaviour

Roan antelope form herds of at least three animals (HALTENORTH & DILLER, 1977) and up to 35 animals, with herd sizes of five to 15 individuals being the most common (KINGDON, 1997). At the end of the dry season, the animals may join to form herds of 60 or more animals (HALTENORTH & DILLER, 1977).

The herds consist of females with young and a single dominant territorial male. Since they are potential rivals, the buck does not tolerate other males within a 300 to 500 m radius of the herd. Males and females sometimes stay together only temporarily. There is a clear hierarchy among adult females within the herd, determined by strength and age: an older dominant female leads the group. As the leading animal of the herd, she takes the front position during migrations and when searching for watering places, a social organization comparable to elephant herds (JOUBERT, 1974). The rest of the antelopes follow without regard to rank. The adult male accompanies and guards the herd.

Studies by various authors (JOUBERT, 1974; WILSON & HIRST, 1977; HAVEMANN ET AL., 2016) show that roan antelopes in southern Africa are usually found in stable social groups of 10-30 individuals. Each group is predictably found in a well-defined geographic area that includes habitats usable in dry and wet season.

Fig. 5: *Fight between two roan antelopes at Port Lympne Zoo (2010)*
© Port Lympne Zoo

Intra-specific social interactions

When it comes to fighting, both sexes show the same behavioural sequences. They sink to their knees and start pushing the opponent away with the help of their horns and head. At the same time, they whip their tails and twitch their ears.

To deter non-resident roan antelope, male roan antelope patrol the boundaries of their territories and mark them with dung piles. Other marking methods include marking with secretions from glands in the intermediate claws and beating the vegetation with the horns. If male roan antelopes come into conflict, the comment fighting - the ritualized fight with low risk of injury - is different depending on the constellation. If two unequal bucks meet, the opponent is intimidated by ritualized threatening and imposing behaviour. In the process, the stronger male stretches his head and lifts his tail. He stands in frontal position to the opponent and presents his horns. The inferior male lowers his head, tucks his tail and walks toward and past the dominant buck. In the case the bucks have equal strength, the animals initially strut side by side and then circle around each other. Then both fall to their knees and begin to press their horns against each other. The inferior lowers his head, pulls in his tail and opens his mouth without making a sound.

An adult buck tolerates only young males in his herd until they are three years old. After that, they leave the herd and join bachelor groups. Older animals eventually leave the bachelor groups to take over a herd when the opportunity arises. (WALTHER, 1988)

Inter-specific social interactions

Unlike other ungulates, such as impala or wildebeest, roan antelope do not cohabit with other larger ungulates, such as zebra. They seem to tend to avoid other grazing species to exclude food competitors (JOUBERT, 1976; WILSON & HIRST, 1977; BROWN & ALLEN, 1989; HARRINGTON ET AL., 1999; KINGDON, 1982). Therefore, roan antelope are absent from areas of high herbivore density.

In the Kgalagadi Transfrontier National Park, roan antelope occur with Western hartebeest (*Alcelaphus buselaphus major*) or with the korrigum (also known as Senegal hartebeest, *Damaliscus lunatus korrigum*). In the Central African Republic, they may co-occur with giant eland (*Taurotragus derbianus*) and with Lelwel hartebeest (*Alcelaphus buselaphus lelwel)* They can be observed together especially at salt lick sites. In other regions of Africa, roans can be seen with blue wildebeest, African buffalo, plains zebras and ostrich. (DELVINGT ET AL., 1989)

In the Waza National Park in Cameroon, roan antelopes live in a relatively high density on an area of 1.7 km². JOUBERT (1974) sees a main reason for this in the absence of the plains zebras, since these represent the largest food competitor. Since part of the habitat of the roan antelopes in Waza National Park consists of an extensive flood area, their competitors here are the Uganda kob (*Kobus kob thomasi*) and the topi (*Damaliscus lunatus*).

2 MANAGEMENT IN ZOOS

The following text passages are closely based on ENGEL & MÜLLER-SCHILLING (2004, 2009), who wrote the chapter "Haltung von Antilopen" (engl.: antelope husbandry) in the book "Säugetiere - Zootierhaltung – Tiere in menschlicher Obhut" (engl.: mammals - zoo animal husbandry - animals in human care; PUSCHMANN ET AL., 2009). That book chapter, and thus this present chapter, is based on the experience and communications of multiple European zoos. The author MÜLLER-SCHILLING is one of the authors involved in these guidelines.

2.1 Outdoor enclosure

2.1.1 Enclosure size

The enclosure for three to four adult female roan antelopes should have an area of at least 1000 m². In enclosures larger than 2000 m², female roan antelopes can be kept together with an adult male roan antelope or with other ungulates. Larger enclosures of 3000 m² or more are even better. In such enclosures, roan antelopes can be kept with other large antelopes. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009)

2.1.2 Boundary

The distance between roan antelopes and zoo visitors may vary. In drive-in safari parks, the animals can be right next to the cars. In zoos with animal enclosures and walkways for visitors, the distance between animals and visitors is at least 1.5 metres, usually more, with boundaries such as fences and/or moats in between. This distance minimum prevents visitors from touching the animals and thus serves both an animal welfare and safety purpose (ENGEL & MÜLLER-SCHILLING, 2004 & 2009; experience based on a survey among all EAZA ROAN HOLDERS, 2023).

Fig. 5: *Enclosure boundary with handrail (a) and Cotoneaster hedge (b) at Zoo Hannover. The distance between humans and roan antelopes ranges from 2-5 meters and the enclosure is separated from the visitor area by knee-high fences and moats. © Erlebnis-Zoo Hannover*

Water moats

A water moat creates an effective barrier for roan antelopes but is rare in the current roan holdings. According to a survey among all EAZA ROAN HOLDERS 2023, only two zoos use water moats as a barrier for roans. Serengeti Park Hodenhagen has a water moat that is 1.6 meters deep and 6-10 meters wide. At Zoo Hannover, the water moat is approximately 400 cm wide and is designed as a natural river. Physical barriers in the form of rocks are located at the side of the enclosure. At some places, however, the animals can approach the water directly to drink and cool down.

If the water in a moat is accessible for the animals, there must be bollards, preferably with rounded heads, below the water surface. Since roan antelopes can swim, these bollards secure the boundaries. They are set up at distances less than the width of the animal's body such that the animals cannot climb or swim over them. From the edge of the enclosure to bollards, there is a steep slope. The waterbed itself should consist of a rough, non-slip material. The water depth is between 80 cm and 180 cm. At these depths, the animals can no longer stand.

Fig. 6: *Enclosure boundary with river course, due to winter without water, in Zoo Hannover*
© Erlebnis-Zoo Hannover

Dry moats

Dry moats (see ***Fig.***) are another effective option used by several zoos that hold roan antelopes (survey among all EAZA ROAN HOLDERS, 2023). Dry moats should be at least 200 cm wide and 110 to 160 cm deep. The walls must be very steep on both sides. On the enclosure side in front of the moat, there may be an electric fence, or a strip of soil material up to 150 cm wide and strikingly different from the rest of the enclosure surface, serving as a visual boundary. On the visitor's side, it is advisable to have at least knee-high fences or handrails, and plantings (bushes, shrubs, but also rocks or deadwood would work) between the fences and the moat. Together with the height of these plantings, the barrier on the visitor side, measured from the moat bottom, should be higher than on the enclosure side. This prevents roan antelopes from jumping over the moat. In rare cases, conflicts between animals may result in an individual falling into the dry moat. The dry moat should include a ramp allowing animals to exit back into the enclosure. A gate at the bottom of the moat, opened only in special cases, prevents animals from accessing the moat from the enclosure. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009)

Fig. 8 *Dry moat at Zoo Hannover*
© Erlebnis-Zoo Hannover

Fig. 9: *Boundary with bar mesh fence at Zoo Hannover*
© Erlebnis-Zoo Hannover

Fences and walls

In addition to water and dry ditches, roan antelopes can also be kept behind fences with a minimum height of 200 cm. At several zoos, the animals are kept behind fences of this height (EAZA ROAN HOLDERS, 2023). The fences are either made of metal or wood. For metal fences, mainly spot-welded steel is used. In this context, however, it must be pointed out that a female Greater Kudu (*Tragelaphus strepsiceros*) jumped over a 200 cm high steel wire mesh fence at Magdeburg Zoo (MÜLLER-SCHILLING, pers. comm). Due to the similar size, this could also be possible for roan antelopes.

Roan antelopes can also be kept behind walls (also 200 cm high), such as at the mixed antelope enclosure at Rostock Zoological Garden. Other options for barriers are large stones or dead wood, piled up in lines at the enclosure boundary or, in the case of dead wood, structured as a Benjes hedge. All in all, the enclosure boundaries are often a combination of different options. For example, in addition to fences, walls or moats, some holders partially use electric safety installations, such as electric grasses, to minimise the risk of larger animals escaping, especially in mixed animal enclosures. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009; survey among all EAZA ROAN HOLDERS, 2023)

2.1.3 Substrate

According to ENGEL & MÜLLER-SCHILLING (2004 & 2009) should be ensured that the soil in the enclosure is not too wet. Soil that is too wet can lead to medical complications, such as hoof disease. Furthermore, dry ground does not freeze as easily in winter as soaked ground; this reduces the risk of accidents in winter. Therefore, as enclosure surface, a standard water-bound structure as found on paths intended for vehicles is recommended. The surface should be well drained to prevent the enclosure from muddying up. In addition, a convex camber of the surface can ensure that rainwater is quickly drained away. Particularly in grassed and mossy parts of the enclosure, one needs to ensure that the substrate does not become too slippery and muddy, to prevent hoof problems and the risk of injury from slipping. That said, the main flooring in large and less heavily used enclosures can be grass. For smaller or heavily used enclosures, a hard surface made of a mineral soil mixture, or a water-bound path surface is recommended, possibly sown with rough grass or strewn with soft sand. In principle, an enclosure should have different floor coverings so that the animals can choose:

- hard surfaces are suitable on **close to the stables and along the enclosure boundary** (ideally concrete or paving to help hoof abrasion).
- on **elevated areas**, grass is recommended (the elevation increases rain runoff, so the ground stays firm)
- water-bound surfaces are suitable for **areas away from stables**.
- **areas to lie on** should be firmly bordered. Fine, rounded sand 80 cm deep and well drained to ensure that surface water can drain.

Caution: Pebbles should not be added, as they can cause temporary lameness between the hooves at grain sizes of 2-4 cm. Sand that is too sharp or too deep can also cause inflammation in the hoof gap in various antelope species.

2.1.4 Furnishings and maintenance

Porch enclosure

Large outdoor enclosures should have a fenced, partly roofed porch enclosure with a hard surface and/or isolation areas with or without a contact zone to the main enclosure (as for example at Chester Zoo (see ***Fig. 9***: *Hardstand at Chester Zoo/ UK (2018)*. Isolation areas can be used for bucks, females with newborns, newcomers, or individuals expelled from the herd, and also as winter areas when the communal enclosure is muddy or icy.

Weather protection

The outdoor enclosure must provide weather protection and shaded areas to meet the natural needs of the roan antelope. Shaded areas are especially necessary during the summer months. Trees are ideal as shaded areas and, as part of the enclosure design, can also be used as room dividers. The trees in the enclosure should be protected: They can be enclosed with wood/wooden tree protection sleeves. Wire mesh as tree protection cannot be advised. From experience, roans can hook or underhook the wire with their horns and tear off the wire protection. Rain protection is advantageous; it allows a prolonged stay in the outdoor enclosure. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009)

***Fig. 7**: Wooden tree protection*
© Erlebnis-Zoo Hannover

***Fig. 8**: Wire mesh tree protection*
© Erlebnis-Zoo Hannover

***Fig. 9:** Hardstand at Chester Zoo/ UK (2018)*
© Chester Zoo

Design elements

Modern roan enclosures should be diverse and well-structured with trees, plant islands and groups of bushes (protected against heavy browsing). As the roan is a woodland antelope living in savannas with trees and high grasses, it should have visual barriers and areas shaded by trees in the outdoor enclosure. In addition, chafing areas in the form of dead wood and

rocks are required. Furthermore, a sand bed and, if possible, a water basin is beneficial. Sand baths are important for the well-being and body care of the antelopes and should be available in every facility. Access to water allows the animals to cool down during hot weather and provides an opportunity for the antelopes to engage in enriching natural behaviours such as wading, or even bathing. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009)

Further recommended elements are rocks or large stones and other space dividers and visual barriers such as piles of dead wood, large roots, etc. These elements offer a retreat from the view of visitors and can be hiding places for offspring: young animals can lie in piles of branches and can be cared for by their mothers during the day. Moreover, such structures are crucial for individuals to find refuge in case of stressful situations within the group, especially for less compatible females in the herd or for females harassed by aggressive bucks. It is essential that the enclosure design prioritizes elements and areas where females can withdraw from males, ensuring their well-being and promoting a low-stress environment. To achieve this, elements in the outdoor enclosure should also be placed in such a way that allows the animals to move freely around them, avoiding dead ends. Thus, animals can chase each other in circular or elliptical patterns around the structures. In larger enclosures, hills may allow the animals to evade each other parallel to height lines. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009)

2.2 Indoor enclosure

In most zoos, roans are housed in individual boxes of 6 to 14 m² (survey among all EAZA ROAN HOLDERS, 2023). Group stables are not recommended for the horn-bearing roans, unless the indoor area is particularly large and offers opportunities for evasion. The Zoo Dvůr Králové (Czech Republic) is such a case. There, the roan antelopes are kept together in stables of 70 or 120 m², depending on the size of the group. In any case, it is recommended to keep the buck separated whilst the animals are in the indoor enclosure.

The walls of the stable should have a minimum height of 200 cm (survey among all EAZA ROAN HOLDERS, 2023). They should be made of at least 2 cm thick wooden boards, or at least be covered with wood. The upper third may consist of a metal grid. As far as the floor of the indoor facility or stable is concerned, a level screed, asphalt or concrete floor has proven to be suitable. However, the floor should be covered with hay and/or wood shavings and a thick straw bed should be offered so that the animals can lie down comfortably. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009; survey among all EAZA ROAN HOLDERS, 2023)

2.3 Environment

Roan antelopes can also spend time in the outdoor enclosure during the cooler half of the year if the enclosure is not iced over. At temperatures below 12 °C or in wet cold weather, the antelopes should only use the outdoor enclosure only for approximately an hour (ENGEL & MÜLLER-SCHILLING, 2004 & 2009). Ideally, the roans should be able to choose for themselves whether to remain in the outdoor or indoor enclosure. This is already common practice at some zoos. As a minimum temperature for indoor enclosures and stables, the German mammal report recommends 10 °C (BMEL 2014). The temperatures at which various zoos keep roan antelopes indoors ranges from 8 °C to 18 °C, with an average of 10 °C (survey among all EAZA ROAN HOLDERS, 2023). 10 °C is therefore recommended as the minimum indoor temperature.

2.4 Examples of enclosures

Fig. 10: *© Port Lympne/ UK (2010)*

Fig. 11: *© Wien-Schönbrunn/ Austria (2009)*

Fig. 12: *© Zoo Szeged/ Hungary (2009)*

Fig. 13: *© Zoo Dvůr Králové/ Czech Republic (2008)*

Fig. 14: *© Zoo Dvůr Králové/ Czech Republic (2008)*

Fig. 15: *© Chester Zoo/ UK (2019)*

Fig. 16: *© Rostock/ Germany (2018).*

Fig. 17: *© Arnhem Safari/ Netherlands (2019).*

Fig. 18: *© Arnhem Safari/ Netherlands (2019)*

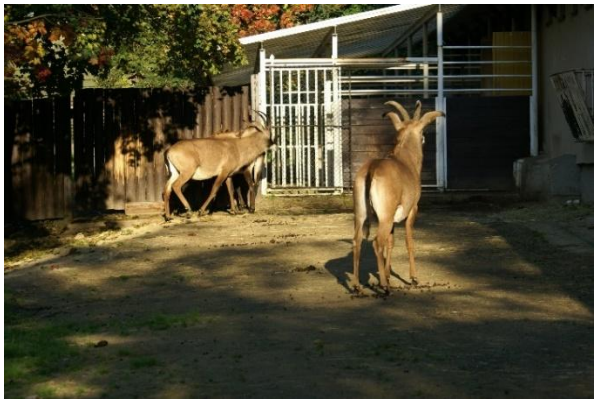

Fig. 19: *© Zoo Liberec/ Czech Republic (2008)*

Fig. 20: *© Serengeti Park Hodenhagen/ Germany (2018)*

Fig. 21: *© Safari Pombia/ Italy*

2.5 Feeding[1]

2.5.1 Diet composition and forage management

Drinking water should be freely available day and night.

Roan antelopes are ruminant grazers and should therefore be fed a diet high in fibre and high in structural fibre. This is achieved by feeding grass hay (ideally from mixed pastures), fresh grass, fresh browse and high-fibre pellets. Ideally, a grazer diet regime is characterized by

- several batches of **grass hay of different nutritional qualities** (e.g. a late cut that is rough to the touch, with a high proportion of stems and low leaf content—thus high in fibre and low in energy—and an early cut that is soft to the touch, with more leaves and thus lower fibre and higher energy)
- and a **high-fibre pellet.**

Both the amount of pellets and the nutritional quality of the hay should be used to regulate the animals' body condition. Generally, lucerne hay should not be required for grazers, especially not if several different batches of grass hay are available.

Grass hay is offered for ad libitum consumption, meaning there should always be access (inside and outside, day and night), and there should be leftovers. Leftovers should be replaced, not added on.

[1] *This section was developed with the valuable input and feedback of Prof. Dr. med. vet. Marcus Clauss, Head of Research and Co-director of the Clinic for Zoo Animals, Exotic Pets and Wildlife at the University of Zurich.*

Fresh grass is usually available seasonally. Any dietary change, such as the seasonal addition of fresh grass, should be introduced through a gradual, incremental increase over a period of 14 days before the new item is offered for ad libitum consumption. On grassed enclosures, the antelopes can also feed on the fresh grasses that grow there. In some safari parks, this can provide enough food so that no supplementary feeding is required.

According to the survey among all EAZA ROAN HOLDERS (2023), zoos typically adhere to 60-70% grass hay and fresh grass, combined with pellets and vegetables. However, the feeding of energy-dense concentrates (grain-based pellets, grains, bread) and of domestic fruit and coloured vegetables is not recommended. Grain products and fruit have higher levels of easily fermentable carbohydrates (i.e. starch, sugar) than the natural diet of grazing herbivores. If a facility feels an attractive 'fresh' or 'juicy' feed is needed, green leafy vegetables or leafy herbs can be used. Examples include large parsley leaves, dandelion, celery leaves, and carrot tops. Caution: Do NOT feed lettuce and cabbage as they may cause diarrhoea and bloat (ENGEL & MÜLLER-SCHILLING, 2004 & 2009).

2.5.2 Pellets

Whereas previously, the supplementation of so-called 'concentrate' pellets that were low in fibre needed to be restricted, modern high-fibre pellets for zoo herbivores (with a crude fibre level of approximately 20% in dry matter or higher, which will prevent rumen acidosis; and with a buffer such as sodium bicarbonate, which will additionally prevent acidosis), reasons for limiting access to such pelleted food are less physiological and more financial in nature. A minimum of 20-30% of the estimated total intake should consist of such a pellet, to be on the safe side in terms of mineral provision (as hay batches may be, by chance, deficient in a mineral).

However, in animals that have been gradually habituated to the ad libitum presence of such pellets, they can be used in higher proportions—particularly in individuals with increased energy demands (e.g., during lactation) or in older animals requiring additional energy.

2.5.3 Vitamin E and minerals

Roan antelopes, like all ruminants kept in zoos, should receive an adequate supply of vitamin E in the diet (DIERENFELD, 1994; DIERENFELD u. TRABER, 1992). Typically, this is provided in high-fibre herbivore pellets. These pellets will also ensure sufficient mineral provision; nevertheless, offering a salt lick and a copper-containing mineral lick is considered good practice and can help give specific enclosure sections a specific meaning.

2.6 Acclimatization

After an import/transfer of roan antelopes, the acclimatization phase at the new institution can usually take three to four weeks. If a new female roan antelope arrives at the zoo, the animal should be placed in an adjacent box to the calmest existing female roan antelope. Experience shows that the calm behaviour is transferred to the new arrival. The new animal also gets to know the outdoor enclosure in the presence of the calmest female. To show the new animal the enclosure boundaries, either a mobile fence is erected, or the enclosure is delineated with white and red barrier tape. This is important so that the new animal memorizes the enclosure boundaries. Gradually, the other females of the herd follow, and in the next steps – if applicable – animals of other species. Thus, the new roan antelope gets to know the boundaries of the enclosure, its conspecifics and the animals of other species within the enclosure gradually and over several days. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009)

An indication of completed acclimatization is when the antelope lies relaxed in the enclosure or even grazes. Only then is a roan antelope buck allowed into the enclosure. After that, the barrier tape or the temporary fence can be removed.

When a new adult male is acclimated, the same procedure is followed, except that the buck should be placed next to the most dominant female.

Fig. 22: *Acclimatization of a roan antelope with temporal fencing on the mixed large enclosure at Zoo Hannover (2018)*
© Erlebnis-Zoo Hannover

Fig. 23: *Getting to know animals of other species in the mixed enclosure at Zoo Hannover (2018)*
© Erlebnis-Zoo Hannover

2.7 Social structure

2.7.1 Group size and composition

Usually, a herd of roan antelopes in human care consist of one adult male and two to six females. In most EAZA zoos that house roan antelopes, this group composition is maintained. The number of females depends on the size of the enclosure, the space available in the stables and, in some cases, the temperament of the buck. The ideal situation is to keep one adult male with several females of different ages. It is also important to maintain an appropriate number of young animals within the herd. This corresponds to the natural structures of a herd (KINGDON, 1997). Usually, young males can remain with the herd until they are 1.5 to 2.5 years old and reach full sexual maturity. After this age, group dynamics may be disrupted due to dominance behaviors exhibited by the adult males. The larger and more structured the enclosures are, the better the animals can avoid each other, which helps to minimize conflict and stress.

Due to the reduction of populations in zoos and limited breeding, same-sex groups are increasingly coming into focus. Thus, an all-female group has been kept in Zoos in Italy as well as within a large mixed-species enclosure at Zoo Hannover. These females are socialized with Rothschild's giraffes (*Giraffa camelopardalis rothschildi*), white bucks (*Damaliscus pygargus phillipsi*) and springboks (*Antidorcas marsupialis*). Bachelor groups are possible, but when it comes to aggressive behaviour between the males, castration of at least part of the group might become necessary (MÜLLER-SCHILLING, pers. comm).

2.7.2 Sharing enclosure with other species

Keeping antelopes in mixed enclosures with other species provides behavioural enrichment and is preferable to keeping a single species, especially since most species that are kept with roan antelopes also occur in their natural habitat. In smaller enclosures, roan antelopes can be kept with flightless birds, or with small antelopes. When kept with such birds, however, suitable refuge areas must be provided to allow the birds to retreat quickly from the roan antelopes. At Zoo Hannover, good experience has been made with roan antelopes with offspring and Kirk's dik-diks. At Szeged Zoo, Hungary, an attempt was made to keep a group of roan antelopes together with hussar monkeys. Unfortunately, the attempt failed due to the intrusiveness of the primates, which sat on the antelopes and were able to leave the enclosure from the back of the animals. As a result, the experiment was abandoned. In the following table, some (partly former) mixtures are presented.

Zoo	**Species**	**Number**	**Enclosure size**
Burgers Zoo Arnhem (NL)	Roan antelope *(Hippotragus equinus*) Grant´s zebra *(Equus quagga boehmi)* Rothschild's giraffe *(Giraffa camelopardalis rothschildi)* Eastern white-bearded wildebeest *(Connochaetes taurinus albojubatus)* Common waterbuck *(Kobus ellipsiprymnus ellipsiprymnus)* East African oryx *(Oryx beisa)* White rhino *(Ceratotherium simum)*	4.4 7.10 4.10 2.4 2.5 1.1 3.5	4 ha
Longleat Safari (UK)	Roan antelope *(Hippotragus equinus*) Ankole cattle Scimitar oryx *(Oryx dammah)* Bactrian camel *(Camelus bactrianus)* Common ostrich *(Struthio camelus)* Pere David´s deer *(Elaphurus davidianus)* White rhino *(Ceratotherium simum)*		14 ha + 95 m²
Rostock Zoo (Germany)	Roan antelope *(Hippotragus equinus*) Lowland nyala *(Tragelaphus angasii)* Lechwe waterbuck *(Kobus leche)* Thomson gazelle *(Eudorcas thomsonii)* Kirk dik-dik *(Madoqua kirkii)* Marabou stork *(Leptoptilos crumenifer)* Crowned crane *(Balearica spec.)*	2.1 1.1 1.4 1.0 0.2 1.0 2.0	7.100m²
Pombia Safari (Italy)	Roan antelope *(Hippotragus equinus*) Addax *(Addax nasomaculatus)* Scimitar oryx *(Oryx dammah)* Common eland *(Taurotragus oryx)* Lesser kudu *(Tragelaphus imberbis)* South African oryx *(Oryx gazella)* White rhino *(Ceratotherium simum)* Barbary sheep *(Ammotragus lervia)* Giraffe (?) Common ostrich *(Struthio camelus)*	3.2 0.3 3.0 1.3 1.1 1.0 1.1 4.4.3 4.0 0.5	8.6193m²

Dortmund (Germany)	Roan antelope *(Hippotragus equinus*) Common eland *(Taurotragus oryx)* Grant´s zebra *(Equus quagga boehmi)*	0.3 2.3 1.3	5.500m²
Serengeti-Park Hodenhagen (Germany)	Roan antelope *(Hippotragus equinus*) Reticulated giraffe *(Giraffa camelopardalis reticulata)* South African oryx *(Oryx gazella)* Black wildebeest *(Connochaetes gnou)* Common ostrich *(Struthio camelus)* Guinea fowl	2.6 1.3 2.0 1.3 0.0.10 0.0.10	1.1 ha
Zoo Hannover (Germany)	Roan antelope *(Hippotragus equinus*) Blesbok *(Damaliscus pygargus phillipsi)* Springbok *(Antidorcas marsupialis)* Rothschild's giraffe *(Giraffa camelopardalis rothschildi)*	0.3 0.5 1.7 0.2	2.900 m²
Knowsley Safari	Roan antelope *(Hippotragus equinus*) White rhino (*Ceratotherium simum simum*) Common waterbuck (*Kobus ellipsiprymnus ellipsiprymnus*) Blue wildebeest (*Connochaetes taurinus taurinus*) Common eland (*Tragelaphus oryx)*	1.3 1.6 0.6 1.4 9.12	12 ha

2.8 Enrichment

As with many ungulates, roan antelopes are kept busy primarily with food and branches to feed on, which are distributed around the enclosure. For the same reason, hay and other food is offered in the stables. Keeping the roans with other species also provides good enrichment opportunities. Another enrichment tool could be target training. Target training for medical examinations is a practiced tool in various zoos, especially with giraffes, elephants, marine mammals and carnivores. Target training with roans would be conceivable with an appropriate training wall. For further guidance regarding animal training in general please see the EAZA's Animal Training Guidelines.

2.9 Handling

2.9.1 Safety

Roan antelopes are considered dangerous simply because of their size and physical strength. Where applicable, national regulations, such as in Germany, exist for handling the animals. Special care must be taken when handling adult bucks and females caring for their young. Entry into an enclosure or stables in the presence of the animals should always be done only by instructed personnel, after prior assessment of possible hazards. (ENGEL & MÜLLER-SCHILLING, 2004 & 2009)

2.9.2 Catching and restraining

Catching and restraining young animals is possible up to a maximum age of four to six weeks. If longer actions such as blood sampling, sex determination, transponder, ear tagging and initial care are planned, the young animal should be placed in a lying position, if possible (GÜRTLER ET AL., 2012). After capture, the animal's eyes should be covered with a cloth as darkness calms the animal. Older animals must be sedated or anesthetized for any kind of manipulation, unless target training has been done.

2.9.3 Transportation

Roan antelopes can be transported in containers or on trailers.

Container

In principle, roan antelopes are only to be transported individually. The IATA (International Air Transport Association) has detailed specifications on antelope containers (IATA 2021).

The container should

- be lightweight, but at the same time strong and escape-proof.
- not have protruding nails, screws, bolts or splinters in the interior, as these can cause injury.
- if necessary, to avoid injury, be padded.
- be constructed only with wood that has not been chemically treated and without synthetic materials or adhesives.
- have carrying handles on the sides for safe handling of the container (spacer bars can also be used as carrying handles).
- have two sliders; depending on the structural or loading situation, through-going or 2-part sliders can be advantageous.
- have non-slip material as floor, e.g. rubber floor or crosspieces.

IATA (2021) also requires air holes on all four sides and in the roof, if applicable. Air holes should have a minimum diameter of 2.5 cm. Depending on the size of the holes, they must be covered with wire mesh. The possibility of horns getting stuck in the air holes must be avoided. Uncovered air vents are to be avoided in horn-bearing animals.

Regarding the internal dimensions of the crate, the following must be taken into account (IATA 2021):

- The animal must be able to stand upright.
- It must be able to lift or stretch its horned head.
- The crate dimensions must be restricted so that the animal cannot turn.
- The animal should not be able to jump, take a running start or kick.
- Square crates in which the animal can turn comfortably are generally not an option due to the size of the animal.

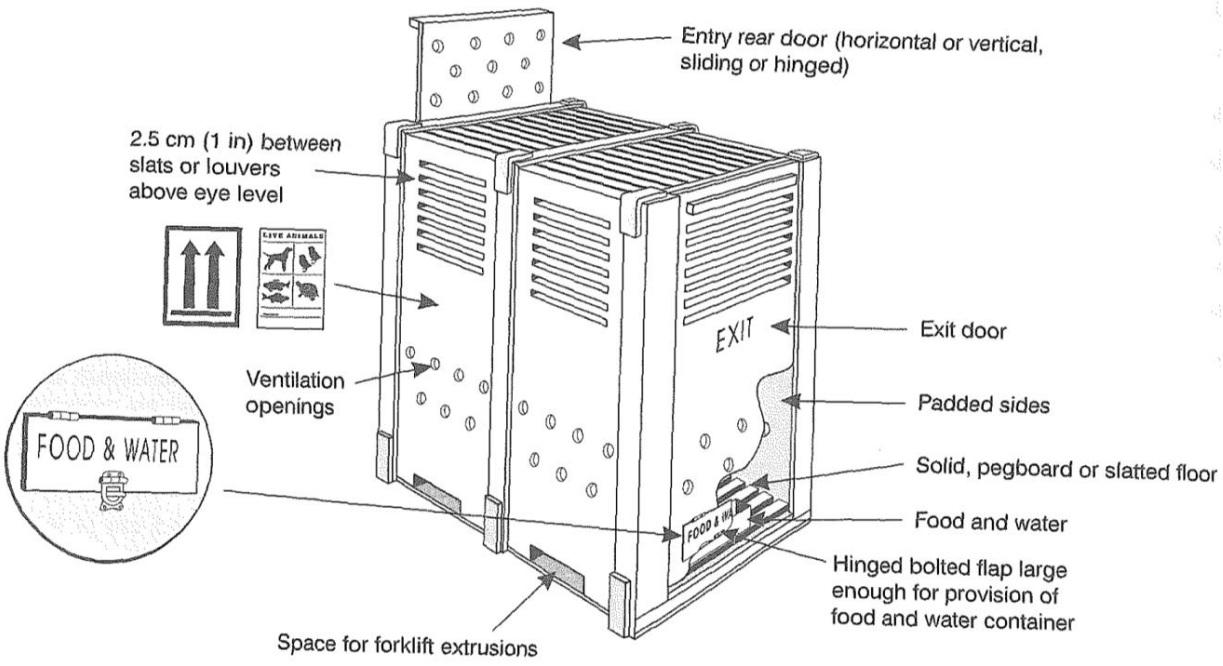

Fig. 24: *Transport crate according to IATA-Regulation*
© IATA

Trailer

For the trailer or the trailer compartment in which the animal is transported, only slightly different conditions apply as for the crates.

- The hanger must be sufficiently stable.
- The trailer must be well ventilated.
- There must be no risk of injury, for example from protruding objects.
- The floor must be non-slip. A metal floor with a bedding surface may be too slippery under certain circumstances. If necessary, additional rubber mats or similar must be used.
- There must be no light source (such as in the form of an opening to the outside) that will cause the animal to jump toward the light.
- The size should allow the animal to turn comfortably. But it should not be too large - to minimize the risk of injury.
- The trailer should be easy and safe to close after loading the animal.

Loading and Unloading

When loading roan antelopes, greatest care and tranquillity is required. There are two options for loading roan antelopes:

1. The animal is loaded ("pressed") into the container or onto the trailer **without anaesthesia**. If there are any gaps, for example in the ramp of the hanger or to the sides, these are to be closed. Attention must be paid to any foot traps (tripping hazards). If gangways are required, they should be narrow and as short as possible. Loading into a container can be trained. The advantages are a calm, stress-free loading where the animal does not panic. If crate training is not possible, the separation of the animal to be loaded, the walking routes or certain procedures can be practiced in advance of the actual loading.

2. The animal **is anesthetized** for loading. The antelope is carried into the container or onto the trailer where it is brought back out of anaesthesia with an antidote. Blood samples can be taken, and veterinary treatments (such as a worming treatment) can be administered during this type of loading. It is important to keep a close eye on the recovery process. Breathing must be controlled. The position of the head must ensure that the airways remain clear. If the animal is not yet standing, the vital signs can be measured. According to the experience of Zoo Hannover, roan antelopes do not tend to re-narcotize.

Loading can be facilitated by sedatives such as perphenazine, acepromazine, or haloperidol so that the animal enters the transport vehicle without agitation. It may also be useful to administer long-term tranquilizers so that the animal is more relaxed during transport in the container and arrival and the first few days in the new enclosure. Tranquilizers should only be selected and used by a veterinarian. (GÜRTLER ET AL., 2012).

2.10 Breeding

2.10.1 Mating

Theoretically, births at zoos are possible all year round (ZIMS, 2024). In temperate zones, however, births in the cold winter should be avoided by appropriate breeding management, for example by separating the sexes from late fall to spring. Preferably, mating should occur in summer and early fall so that births occur in spring or early summer. This has the distinct advantage that the young animals can be let out into the outdoor enclosure after a few weeks, where it is then sufficiently warm. This allows them to benefit from exercise and daylight (including vitamin D3 production on sunny days during the summer months). Births are not a surprise in modern zoos. Usually, mating records are collected, and the average gestation period of 268 to 286 days is used to determine the approximate date of birth (ZIMS, 2024).

2.10.2 Birth

The first signs of parturition in the pregnant female are restlessness and the beginning of separation from the herd. Aggressive behaviour towards caretakers, conspecifics or associated species is also common. Highly pregnant antelopes should therefore be closely monitored. To avoid giving birth in the outdoor enclosure, the animal should be separated in the birthing stable one to three days before the suspected birth. However, care should be taken to keep the stable time as short as possible prior to parturition.

The stable intended for the birth is not mucked out for a good three weeks before the birth. Additional layers of a straw bedding are applied regularly so that a "mat" is formed. This is done to cushion the calf's fall and prevent straddling. Environmental changes are perceived as a disturbance. Grids, for example, should therefore be secured with wire mesh - so that calves cannot force their way through - before the birthing stable is occupied.

Shortly before birth, a bagging-up (udder movement/development) can be observed. As a rule, births occur while the female is lying down at night or in the early hours of the morning. It takes about two hours from the first contractions to the expulsion. In case of a longer duration of birth (more than 3 hours), birth assistance is required according to experience at the Zoo Hannover. During birth the female is very restless, with frequent changes between lying down, standing up and walking around. The expulsion phase is short, usually less than 30 minutes. The mother

stands up immediately after expulsion, thereby rupturing the umbilical cord. The amniotic membrane and the afterbirth are then eaten. Attempts of the new-born to stand up often occur in the first 20 minutes after birth. The young animals then stand very shakily and try to reach the mother's teat. The first feeding of a calf should take place within the first 48 hours (see ***2.12.1 Initial care of a newborn***).

2.10.3 Development and care of young

After birth, the calf should remain in the stable at least until it follows the mother, i.e., for four to eight weeks. UV light can be provided with a lamp during this time. The mother can leave the stable during the day. She comes back in after a few hours to nurse. Some holders recommend leaving mother and calf together in the stable for about two to three weeks to achieve an improved mother-child bond. After this period, mother and calf are let out onto the enclosure. In mixed enclosures or with aggressive conspecifics, it may be advisable to let the dam and calf onto the enclosure alone at first, and only after a few days with the other females, then with the buck and other species. Usually, this phase lasts four to five days. It has been observed that other adult females attack the roan antelope offspring. Therefore, it may be advisable to let the lowest-ranking female join the herd first and then continue to build up the herd until the buck is finally allowed onto the enclosure.

2.10.4 Hand-rearing (not recommended)

Especially in young, inexperienced mothers, there may be insufficient mother-child bonding, resulting in a lack of interest in raising the offspring. In general, hand rearing is not recommended, as it can lead to inappropriate conditioning, resulting in behavioural issues in social or sexual contexts. If hand rearing must occur, it should only be practiced after consultation with the EEP coordinator, and the following aspects must be considered.

In the case of hand rearing, calf and lamb milk replacers are usually used. In the Zoo Dvůr Králové (Czech Republic), supplements of human infant rearing are also used. The roan antelope milk consists of:

- 19,51% Dry substance
- 6,55% Fat
- 6,45% Protein
- 5,62% Carbohydrates
- 1,04% Ash (minerals)

The milk should always be prepared with boiled water according to the preparation instructions. Initially, hand-reared animals receive 20 to 40 ml of replacement milk per meal. The amount is later increased to 100 ml. Bottle-feeding is done every two hours during the day and later every three hours. The daily amount should be spread over five to seven meals. In addition, the time interval between the last and first feeding should not be too long.

Cow's milk, which is lower in fat and protein, can be fortified with unsweetened condensed milk, milk powder and cream. For weaker animals, it can also be fortified with serum protein in the first few days.

Further:

- Suckers should only be used with a small hole; this reduces food aspiration.
- Young animals should also not be fed to full satiety. Overfeeding can lead to severe intestinal disorders.
- During the first few days, urination / defecation should be stimulated by anal massage.
- The food should be diluted with black tea, rice or linseed mucilage only in compelling cases, e.g. digestive disorders (diarrhoea ...). In fact, it is more advisable to replace a daily meal with tea or infant formula.
- At Zoo Hannover, the replacement food in artificial rearing was enriched with melting flakes or cereal gruel from the 12th day.

From the second week onwards, hand-reared calves are fed meadow or mountain hay, dry lucerne leaves, rolled oats, crisp breadcrumbs and fresh green fodder consisting of leaves, grass, lucerne or clover stalks, dandelions and other herbs. The food should be offered only briefly, and wilted food should be removed. It is advisable to increase the food slowly to solid food until normal feeding. At the same time, bottle feeding should be reduced.

2.10.5 Contraception

Contraception of males is a vital tool for the population management of roans, as balanced sex ratios at birth often lead to surplus males. This surplus occurs because adult roans should be maintained in their natural herd structure, which typically consists of one male with multiple females—a configuration essential for preserving social stability. In countries where culling is not permitted, contraception becomes a necessary method for managing these surplus males, as they can only coexist in bachelor groups when not all of them are fertile and dominant. By implementing effective contraceptive strategies, zoos can ensure optimal welfare for all animals involved. There are three established methods of contraception for roan antelopes:

Surgical castration

This is the surgical, non-reversible procedure to remove the testicles (orchiectomy) or, for females, the ovaries (ovariectomy). Usually, only roan males are castrated for population management purposes. The earlier the castration is performed the less male hormones are released. It is advisable to castrate before the age of 1. However, these males develop horns that remain small, and they are more feminine in their habitus. In rare cases, adult males may be castrated upon the advice of the EEP coordinator to prevent a herd from breeding.

Sterilization

Another surgical solution is sterilization. In the male animal, the spermatic ducts (ductus deferens) located in the spermatic cord are cut in the area of the scrotum above the epididymis.

Hormonal contraception

A reversible method can be hormonal contraception. The animal is either given a hormone implant or the function of the ovaries or testicles is suppressed by regular hormone administration. In pigs, this form is used as a common method. Improvac is the drug of choice here. The disadvantage is the regular repetition or, in case of prolonged use, the risk of infertility of the animal. Hormonal contraception is currently not widely used in roans and only few female individuals have been hormonally contracepted so far. The effectiveness and reversibility need to be tested before recommendations can be made.

2.11 Population management

According to the IUCN assessment, the roan antelope population in the wild (in situ) is not considered threatened, but it shows a significant trend toward population decline and is locally extinct in some parts of its former range, a few with reintroduction potential. The zoo population (ex situ) is stable, with tendencies to increase in holders and animals. In 2021, the zoo in Paris (France) and the zoo in Krakow (Poland) were added as new holders.

Today (as of 08/2026), the population is holding around 140 animals in more than 20 Zoos. The age pyramid is developing well, with a broad base of young animals. The population trend is upward after a dip in 2003. If conditions remain the same, an increase to about 200 animals would be reached within 10 years. One problem regarding the reintroduction potential, however, is the comparatively high degree of unknown relationships before 2000, as well as the low genetic diversity of the population.

Accordingly, the EAZA Antelope and Giraffid Taxon Advisory Group (AGTAG) with its **Regional Collection Plan (2022)** envisions the following roles for the EAZA population of roans:

- INSURANCE: with biobanking and genetic profiling for the EAZA population required
- RESTORATION: with potential for reintroduction, but that needs follow-up and confirmation
- EXHIBIT: with recommendation to educate about roans as a large antelope species and reintroductions that have happened in Eswatini

Furthermore, in the view of the AGTAG and as detailed in the **Long-term Management Plan (LTMP) for the Roan antelope (2024)**, the EEP would benefit from recruiting new holders to allow the population to grow. In particular, new and current roan holding facilities willing to implement a controlled “breed-and-cull” strategy are essential for fostering genetic diversity and thereby enhancing the population’s future reintroduction potential. This approach also alleviates the social stress that arises when too many males remain within a herd, and it mirrors natural dispersal patterns, in which mature males leave their natal groups. Bachelor groups with one fertile, genetically valuable male and several castrated males may serve as a temporary management tool by providing space for males that cannot yet, but are intended to be, integrated into breeding herds, and for males that cannot be culled due to national legal restrictions or institutional policies. However, castration should be regarded as a temporary management solution rather than a long-term population-management strategy. The EEP should aim to use the available holding space primarily for breeding males and females rather than for castrated males, in order to maintain a sufficiently large and genetically diverse breeding population and to support a broad age structure. Accordingly, the LTMP and AGTAG recommend that, in the longer term, an increasing number of holders adopt controlled culling to further support genetic health and natural population dynamics.

2.12 Veterinary considerations

2.12.1 Initial care of a new-born

The initial care of a calf should take place within the first 48 hours, because after that it becomes difficult to fixate the young animal. This period provides an opportunity for sexing, navel checking and individual marking (tattoo/ear tag/transponder). Transponders are particularly suitable for individual marking. In larger groups, where individual identification of the animals is difficult even for experienced keepers, ear tags can also be used but have an unnatural appearance. Tattoos may be difficult to read.

Even though equine antelopes do not belong to the particularly sensitive species for vitamin E deficiency/capture myopathy/white muscle disease, it makes sense to carry out a one-time injection of a vitamin E/Se preparation during initial care, since it is known that many wild animals have too low a vitamin E level in their blood. At Zoo Hannover, each young antelope receives an injection solution of vitamin E-Selenium ad us. vet. (150 + 1.1 mg/ml, 1 ml contains all-rac-alpha-tocopherol acetate 150.0 mg, sodium selenite 1.1 mg, benzyl alcohol 40.0 mg, macrogol glycerol ricinoleate-35 160.00 mg).

2.12.2 Health challenges

For this section, experience from Zoo Hannover, veterinary publications on diseases and disease progression in roan antelopes, and necropsy reports of roan antelopes between 1950 and 2020 from Hannover were evaluated, with the intention of expanding to include insights from other zoos in future updates.

In the wild:

- According to WALTHER (1988), roan antelopes are highly sensitive to anthrax. As soon as this disease appears in the range, they become infected quickly and are the first species to die in the area. This is not known to occur in human care.
- Protozoan diseases are known from Africa; ticks transmit various species of *Theileria*. There are no publications on this from zoo husbandry.

At the zoo:

- Especially in older animals, various dental diseases may occur, including uneven abrasion of the molars resulting in hook formation or step formation, or a completely worn, senile dentition. Dental problems should be suspected if difficulties with chewing occur, hay wraps are observed, or the animal shows a loss of body condition.
  - ➔ Tooth correction can be performed under anaesthesia. In older animals, however, it should be considered that repeated revisions and veterinary interventions may be required over time. For such animals, regular health assessments are recommended to evaluate body condition, feeding ability, dental status and overall quality of life. Where dental disease is advanced and cannot be adequately managed, euthanasia should be considered to prevent prolonged suffering. Such welfare-based decisions may also contribute to responsible population management within the EEP by avoiding the long-term maintenance of animals with poor welfare prospects.
  - ➔ If necessary, feeding can also be adjusted, for example by adding soaked hay cobs if the roughage intake is otherwise insufficient, and by adding a little oil to the feed. At Zoo Hannover, the body condition of a 16-year-old animal was significantly improved in this way. Here, older equine antelopes and those with known, irremediable dental anomalies (wavy dentition, step dentition, senile dentition) are generally given 1.3 kg of soaked hay cobs (dry weight), three times a day as a roughage substitute.

- Occasionally, non-specific diarrheal diseases occur. These can possibly be traced back to feeding or eating of enclosure-adjacent plants.
  - ➔ In most cases, it helps to leave out the fresh feed and, if necessary, also the concentrated feed for a few days. In addition, preparations such as Stullmisan, oak bark powder, charcoal powder or fresh oak branches can be given.

- Occasionally, lameness may occur. Causes may be falls, chasing by the buck or by other species in mixed enclosures.
  ➔ Stable rest and the use of NSAID (Non-Steroidal Anti-Inflammatory Drug) via feed or injection will bring improvement in most cases. If there is no improvement or if the lameness is severe, the animal must be examined under anesthesia and x-rayed (at least two levels). Analogous to diseases and therapies in horses/cattle, an injection of long-term cortisone at or into the joint (under sterile conditions) can also bring about a good improvement in the case of joint involvement and chronicity and if infectivity has been ruled out.

- Injuries such as fractures or similar occur rather rarely.
  ➔ Distal limb fractures in young animals may be treated with cast bandaging in selected cases. The severity and prognosis of the fracture, the duration of immobilisation, the individual's genetic value and the welfare implications, including separation from the social group, should be considered. Where there is a prospect of complete healing and reintegration into the herd, treatment may be justified.
  ➔ When the corneal sheath is torn off, bleeding occurs briefly but is quickly stopped. If there is no fracture of the bony horn cone and no germs or flies can penetrate, healing occurs, and a new horn sheath usually grows back. If myiasis (fly maggot infestation) is suspected or needs to be prevented, a repellent can be applied to the wound environment or ivermectin can be administered by injection.

- Rarely, endo- and ectoparasites may occur.
  ➔ Treatment is carried out with commercially available medications, which are also used for domestic ruminants.

- Rarely, infectious diseases can occur. In Zoo Hannover, there has been a single case of pneumonia and endometritis with spread of an abscess to the cervical spine.

2.12.3 Sedation and anaesthesia protocol

Experiences from Zoo Hannover:

Anaesthesia	**Antidote to anaesthesia**
60 (young animals) or 70-80 (adults) microg/kg Medetomidine + 1,5-2 mg/kg Ketamine IM	Atipamezole (Revertor®) in µg/kg bw and in total dose, the recommended dosage is 5 times the previously administered medetomidine.
w, adult 1,3 ml TD Immobilon® + 0,1 mg/kg Xylazine IM (corresponds to 1,2 ml TD Rompun® 2%) Juv. 9-12 months 0,9-1,1 ml Immobilon + 1,0 ml Rompun® 2%	Revivon® 1.5-2 times the amount of Immobilon® in ml and Revertor® 1 mg Atipamezole/10 mg Xylazine

Long-Acting Tranquilizers (long-acting sedation) used at Zoo Hannover are:
- Perphenacine-enanthat/Perphenacine-decanoat 100 (-150 mg), lasts 7 days
- Haloperidol 20 mg/one year old animal, lasts 1 days

Additional LAN and Sedativa:
- Zuclopenthixol acetat 100 (-150 mg) lasts 3 days
- Azaperone (Streßnil®) (80-100mg for outdoor animals)

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