

EAZA Best Practice Guidelines for the striped hyena (*Hyaena hyaena*)

1st Edition, January 2025



EAZA Best Practice Guidelines

For the striped hyena

(*Hyaena hyaena*)

Canid & Hyaenid Taxon Advisory Group

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Published by: EAZA, 2025

Reviewed by: Diogo Laneiro (EAZA EO), EAZA Canid & Hyaenid TAG, EEP Committee BPG review subgroup

Edition 1

Recommended citation: Houssaye, F., J. Heftman, R. Gohe, M. Blin and A. Rives (2025). EAZA Best Practice Guidelines for the Striped hyena (*Hyaena hyaena*) – First edition. European Association of Zoos and Aquariums, Amsterdam, The Netherlands.

DOI: 10.61024/BPGStripedhyaenaEN

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Cover Photo: Female (Studbook n°10378) & puppies in front of the den © Sir Bani Yas, U.A.E.



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EAZA 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.

Preface

The first EAZA Husbandry Guidelines for Hyaenidae has been edited in 2008 by Schelvis T. & Spijkman. These Husbandry Guidelines has been made available for all species of Hyaenidae and so were not specialised for striped hyena (*Hyaena hyaena*). Because the management of striped hyenas has been difficult in the previous decades, the need to write Best Practice Guidelines specifically for striped hyenas has been highlighted. Since 2012, several students have worked on husbandry surveys sent to zoological institutions all over the world in order to compile important data to know more about the best management of captive striped hyenas.

Acknowledgements

We would like to thank Jessica Heftman, Romain Gohé, Marine Blin and Albane Rives, who put lots of effort in compiling information on striped hyenas. We would also like to thank all zoological institutions for sharing their information, data and pictures. This document shows the world that zoological institutions are able to work closely to better understand our species kept in our collection.

We would like to thank the contributing authors who were very helpful with regards to their speciality. They bring their experience and their very useful advice allowing us to enhance the quality of these Best Practice Guidelines:

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Introduction

Despite its wide distribution's area, the striped hyena is classified as Near Threatened by the IUCN (AbiSaid. and Dloniak, 2015). It is already extinct in many areas of its former range and its population is decreasing (Mills and Hofer, 1998) because of several causes. In the past, this species was persecuted in Caucasia and central Asia as it was thought responsible for the disappearance of children. In the 20th century, it was poisoned by strychnine used to kill carnivores during rabies eradication programmes (Jaffré, 2007). Over much of its range, striped hyena populations are limited by a lack of carrion, due to the reduction in the population of large carnivores and their prey, and changes in livestock practices (Mills, 1998).

Due to the lack of research on this species, it is difficult to estimate the current total population of striped hyenas, but it is thought that in Africa there are between 2450 and 7850 individuals and that the African population represents about half of the total worldwide population of this species (Mills and Hofer, 1998). For the same reason, far less is currently known about the striped hyena than its famous cousin: the spotted hyena (*Crocuta crocuta*).

Based on pelage characteristics and body size, five subspecies of striped hyena were defined by Pocock (1934): *Hyaena hyaena barbara* (North-West Africa), *H. h. dubbah* (East & North-East Africa), *H. h. hyaena* (India & Pakistan), *H. h. sultana* (Arabian Peninsula) and *H. h. syriaca* (Syria & Asia Minor to the Caucasus). It should be noted that because of insufficient morphological measures and genetic analyses from populations of these proposed subspecies, Jenks and Werdelin (1998) specifically stated that "At present it is clear that the population status of the recognised subspecies cannot form an acceptable basis for possible conservation measures". Hence a detailed phylogenetic analysis of striped hyena subspecies is required, and zoological institutions can participate in this much needed research. Currently, zoological institutions within the EAZA Ex-situ Programme hold 7.5 *H. h. dubbah* in 8 zoos, 14.21 *H. h. sultana* in 7 facilities, 1.2 *H. h. syriaca* in 2 zoos & 24.25.1 generics in 27 institutions (Houssaye, 2018).

The main goals of this EAZA Ex-situ Programme are education & research. The goal is also to secure a genetically healthy captive population by avoiding inbreeding and conserving the different subspecies. The EAZA Ex-situ Programme is the only captive breeding program focused on striped hyena in the world.

This BPG will allow better understanding of this species with proven experiences in behaviour, nutrition, handling, breeding, enclosure design, etc....

The goals of the EAZA Ex-situ Programme for striped hyenas are:

Education and research

- ✓ To provide educational resources to the public, to promote hyena conservation by enhancing knowledge about their ecological importance and interesting behaviour
- ✓ To determine the main threats to the long-term viability of hyena populations.
- ✓ To attract the visitors to this misunderstood species.
- ✓ To contribute to research in order to identify the different subspecies

Husbandry and welfare

- ✓ To improve methods of breeding in captivity
- ✓ To develop methods to enhance the likelihood that mothers rear their litters successfully,
- ✓ To describe the best methods for hand-rearing cubs when necessary.

Population management

- ✓ To ensure zoos populations are self-sustaining and genetically viable in the long-term,
- ✓ To contribute to the conservation of *H. h. sultana* subspecies, and all pure subspecies,
- ✓ To work more closely with all zoological institutions keeping striped hyenas in order to improve their management,
- ✓ To work on better genetic with international transfers, and importation of new founders from other regions.

Bibliography:

AbiSaid, M. & Dloniak, S.M.D. 2015. *Hyaena hyaena*. The IUCN Red List of Threatened Species 2015: <http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T10274A45195080.en>. Downloaded on 13 December 2016.

Houssaye, F. 2018 EAZA studbook for striped hyena (*Hyaena hyaena*). CERZA Zoo Lisieux.

Jaffré, N. 2007. La reproduction des Hyénidés et du Lycaon : Etude bibliographique. Veterinary Doctorate thesis for the Ecole vétérinaire d'Alfort.

Jenks, S. M. & Werdelin L. 1998. Taxonomy and systematics of living hyaenas (family Hyaenidae). In: Hyaenas: Status Survey and Conservation Action Plan. Mills MGL & Hofer H (compilers), pp. 8-17. IUCN/SSC Hyaena Specialist Group. Gland, Switzerland.

Mills G 1998. The comparative behavioural ecology of hyenas: the importance of diet and food dispersion. *Carnivore behaviour, Ecology & Evolution*. Cornell University Press, 125-141.

Mills M.G.L., Hofer, H., 1998, Hyaenas. Status Survey and Conservation Action Plan, IUCN/SSC Hyaena Specialist Group, Gland, Switzerland and Cambridge, UK

Pocock, R.I. 1934. The races of the striped and brown hyaenas. *Proceedings of the Zoological Society* p 799-825.

Section I - Biology & field data



Striped hyena © Utica zoo.

1.1 Taxonomy

The name « hyena » comes from Greek word “hys” meaning hog, pig (Gotch, 1979; Liddell and Scott, 2016). Many pigs have manes of stiff hair that extend down their necks. When the ancient Greeks first saw hyenas, they thought the animals' manes looked like the manes of pigs. Thus, they called these strange animals “hyaina”. *Hyaena* is the Latin form, which was converted in English to *hyena* (Figure 1). The striped hyena’s name refers to the vertical black stripes on its fur.

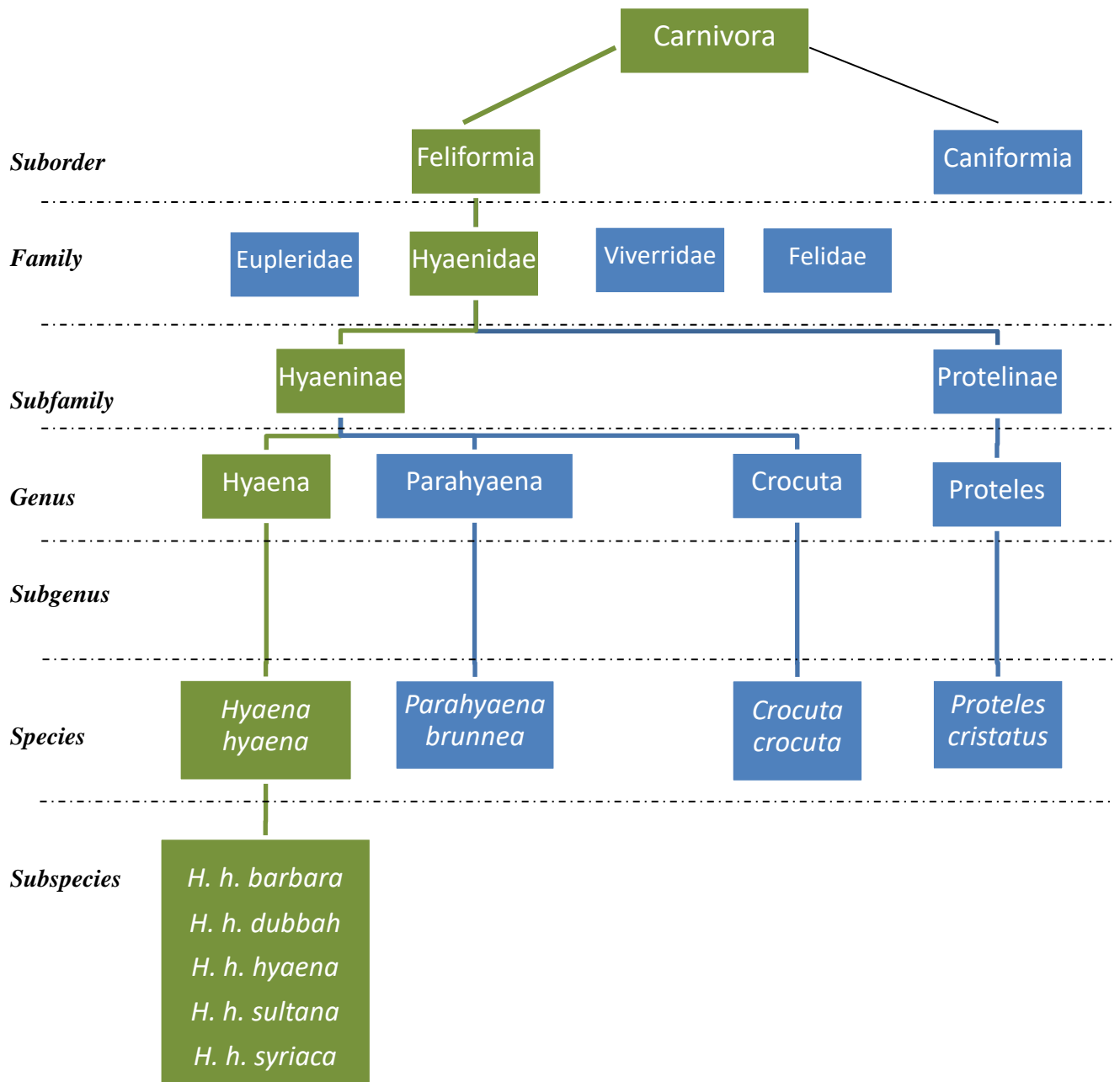


Figure 1: Classification of the Hyaenidae family, adapted from Mills and Hofer, 1998 and Nowak, 2005.

1.1.1 Order

Hyenas belong to the Suborder Feliformia (Figure 2) in the Order Carnivora (Schelvis et Spijkman, 2008). The Feliformia (“cat-like” carnivores) includes the families Felidae, Hyaenidae, Herpestidae, Viverridae, Percrocutidae (extinct hyena-like forms), and Nimravids (extinct cat-like forms) (Van Valkenburgh, 2007). One of the main characteristics of Feliformia is a double-chambered auditory bulla (Figure 2), which is not present in Canidae (Wesley-Hunt and Flynn, 2005).



Figure 2: Double-chambered auditory bulla © Myers et al., 2016.

1.1.2 Family

Currently, the family Hyaenidae contains two subfamilies: the Hyaeninae & the Protelinae.

1.1.3 Genus

The taxonomic relationship between the species in the family Hyaenid has altered over time, and will no doubt change as more detailed genetic analyses is undertaken. Results of analyses based purely on morphological data (Hendey, 1974, Werdelin and Solounias, 1991) are not entirely congruent with those from more recent studies that incorporate genetic data (Koepfli et al., 2006). Using morphological characteristics Werdelin and Solounias (1991) failed to generate conclusive results on the relationship between the four extant species, but their results placed the brown hyena in the separate genus *Parahyaena*, hence its name *Parahyaena brunnea* and the spotted hyena and striped hyena were placed in the genus *Hyaena*. Combining genetic data from both the mitochondrial cytochrome b gene and several nuclear genes, Koepfli et al. (2006) found that the striped hyena and the brown hyena were more closely related to each other than to either the spotted hyena or aardwolf. Their analysis suggests that the genus *Proteles* diverged at approximately 10.6 MYA, the genus *Crocuta* at 8.6 MYA, and both *Hyaena* genus and *Parahyaena* genus at approximately 4.2 MYA (Figure 3).

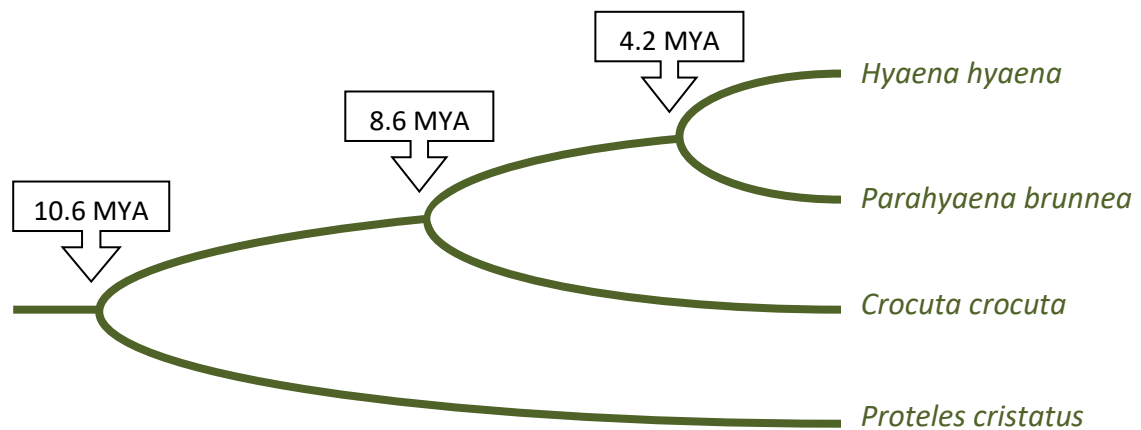


Figure 3: Interrelationship and divergence times of hyaenid lineages adapted from Koepfli et al., 2006.

1.1.4 Species

The Hyaenidae family contains four extant species: the spotted hyena (*Crocuta crocuta*), the striped hyena (*Hyaena hyaena*), the brown hyena (*Parahyaena brunnea*), and the aardwolf (*Proteles cristatus*). These are the remnants of a diverse group of medium to large hyaenid species, which first appeared in the fossil record during the Miocene period, approximately 5 million years after the formation of the land-bridge between Eurasia and Africa. Approximately 100 hyaenid species have been described from fossils (Bothma and Walker, 1999). Results of a recent study suggest that the striped hyenas, together with the 3 extant species originated in Africa between 7 to 15 MYA (Koepfli et al., 2006), which is earlier than the estimate of 18-20 MYA of an earlier study (Werdelin and Solounias, 1991).

1.1.5 Subspecies

Several striped hyena subspecies have been proposed but the validity of these subspecies needs to be established using improved morphological data combined with genetic data (Jenks and Werdelin, 1998), ideally including sequence data from both the mitochondrial cytochrome b gene and several nuclear genes (Koepfli et al., 2006). The striped hyena is the only species in the Hyaenidae which has subspecies, purely defined by body size and pelage characteristics (Mills and Hofer, 1998):

- *H. h. barbara* from North-West Africa
- *H. h. dubbah* from Northeast Africa
- *H. h. hyaena* from India
- *H. h. sultana* from Arabian Peninsula (Figure 4)
- *H. h. syriaca* from Syria, Asia Minor and Caucasus



Figure 4: Picture of *Hyaena hyaena sultana* © Sir Bani Yas, 2014.

1.2 Morphology

1.2.1 Body size

Adult striped hyenas have a head-body length between 100 and 115 cm long with the tail, and a height to the shoulders around 66-75cm. There is no sexual dimorphism in body size and the weight of adult striped hyenas is about 34 ± 7 kg for a male and 30 ± 4 kg for a female (Figure 5). The 3 northern subspecies (*H. h. barbara*, *H. h. hyaena* and *H. h. syriaca*) are larger than the 2 southern subspecies (*H. h. dubbah* and *H. h. sultana*) (Bothma and Walker, 1999; Rieger, 1979a).



Figure 5: general view © CERZA Zoo.

1.2.2 General description

The under-fur colour varies between white, pale grey to beige and the body bears long vertical striped. The black dorsal mane can be erected (Jaffré, 2007). The longest hair is 200mm in length and falls along the mid-dorsal line (Wagner 2013). Its guard hairs are from 10 to 15 cm long. The throat has broad black patch. The ears are long, pointed, and rarely ended with a little brush. The muzzle is pointed and furred, and the tail is long (30-45 cm) black and white and covered with long and silky hairs (Mills and Hofer, 1998; Bothma and Walker, 1999). The feet have four toes, and non-retractable claws (Mills and Hofer, 1998).



Figure 6: anal pouch protruded © La Barben zoo.

All hyenas have an anal-pouch whose secretions are used for scent-marking (Figure 6). The gland can be protruded when animals are pasting scent on vegetation and during social interactions (Rieger, 1977, 1979a). Although many authors described two or three pairs of teats (Figure 7), Rieger (1979b) found that only the two caudal pairs produce milk. The effect of litter size on the number of functional teats should be further investigated.



Figure 7: Young striped hyena suckles its mother © La Barben zoo.

The dental description (Figure 8) of the striped hyena is; incisors: 3/3, canines: 1/1, pre-molars: 4/3 and molars: 1/1 with a total of 34 teeth. Milk dentition: incisors: 3/3, canine 1/1 and premolars 4/4 (Rieger, 1981). The skull bears a high sagittal crest to which is attached the powerful temporal muscle and masticatory muscle used when seizing prey and crushing bone (Buckland-Wright, 1969).



Figure 8: Striped hyena skull; Left: dorsal view; middle: ventral view; right: lateral view © Myers et al 2016

1.3 Physiology

1.3.1 Blood values

Select haematological values		
<i>Parameters</i>	<i>Striped hyena</i>	<i>Spotted hyena</i>
Packed cell volume (%)	27.0-57.6 (41.0)	29.9-54.1 (42.3)
Red Blood cell x10 ³ /microliter (μL)	4.35-9.77 (7.06)	5.08-9.83 (7.56)
Haemoglobin gram per deciliter (g/dL)	- (13.6)	9.3-18.5 (14.0)
Mean corpuscular volume (fL)	- (57.7)	46.3-63.9 (56.8)
Mean corpuscular haemoglobin picogram (pg)	- (19.6)	15.7-21.4 (18.8)
Mean corpuscular haemoglobin concentration (g/dL)	- (33.5)	29.7-37.3 (33.2)
Leukocytes (x10 ³ /μL)	5.30-15.34 (10.52)	6.2-19.59 (11.98)
Neutrophils (x10 ³ /μL)	3.00-11.65 (7.50)	3.71-15.29 (8.52)
Band neutrophils (x10 ³)	0.00-0.50 (0.14)	0.03-0.14 (0.05)
Lymphocytes (x10 ³ /μL)	0.00-4.31 (2.19)	0.59-6.35 (2.45)
Eosinophils (x10 ³ /μL)	-	0-1534 (667)
Monocytes (x10 ³ /μL)	0-1179 (464)	79-1550 (483)
Basophils (x10 ³ /μL)	-	0-285 (42)
Platelets (x10 ³ /μL)	-	72-466 (267)
Select biochemical values		
<i>Parameters</i>	<i>Striped hyena</i>	<i>Spotted hyena</i>
Total protein, gram per decilitre (g/dL)	- (6.0)	5.7-8.4 (6.8)
Albumin (g/dL)	- (2.4)	1.9-3.4 (2.6)
Globulin (g/dL)	- (3.6)	2.9-5.7 (4.1)
Total bilirubin, milligram per decilitre (mg/dL)	- (0.2)	0.0-0.4 (0.2)
Direct bilirubin (mg/dL)	-	0.0-0.2 (0.0)
Indirect bilirubin (mg/dL)	-	0.0-0.3 (0.1)
Aspartate aminotransferase international unit per litre (IU/L)	32-108 (73)	51-139 (87)
Alanine aminotransferase (IU/L)	- (49)	50-206 (105)
Alkaline phosphatase (IU/L)	0-86 (37)	13-75 (32)
Glucose (mg/dL)	34-192 (116)	67-282 (143)
Cholesterol (mg/dL)	125-327 (231)	103-355 (220)
Urea nitrogen (mg/dL)	13-29 (21)	15-43 (25)
Creatinine (mg/dL)	0.4-1.7 (1.1)	0.8-2.4 (1.5)
Calcium (mg/dL)	8.8-11.6 (10.2)	8.8-11.8 (10.1)
Phosphorous (mg/dL)	- (4.8)	2.1-5.4 (3.6)
Sodium milliequivalent per litre (mEq/L)	- (145)	131-155 (145)
Chloride (mEq/L)	- (115)	103-127 (115)
Potassium (mEq/L)	-(4.3)	3.9-5.3 (4.5)

Table 1: Haematological and biochemical values for Striped hyena (Hyaena hyaena) and Spotted hyena (Crocuta crocuta) from Teare JA edition 2013. Proteles cristata, Crocuta crocuta, Hyaena hyaena in ISIS physiological reference interval for captive wildlife. Mean values are putted in brackets.

1.3.2 Digestive system

Hyenas' digestive system seems to be closed to the canids digestive system (Ordonneau, pers. com, Figure 9).

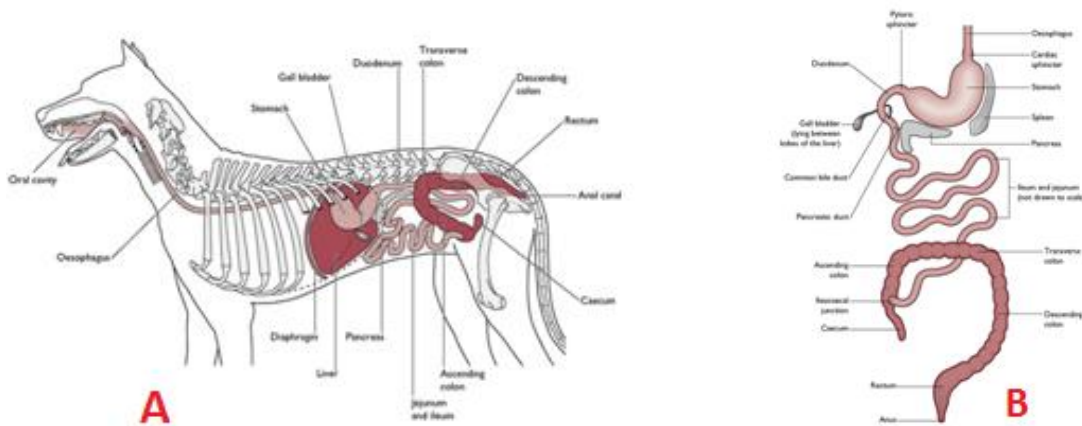


Figure 9 : Organs of the digestive system of the dog, left lateral view (A) and the digestive tract removed from the body.(B). From: <https://veteriankey.com/digestive-system/>

However, the digestive system of the striped hyenas is adapted to allow the digestion and extraction of nutrients from the teeth and bones. Bones are crushed with the use of considerable force generated by contraction of the large muscles attached to either side of the skull and lower jaws (Kingdon, 2003). The forelegs and neck are strong, permitting them to carry heavy mammal carrion (Bothma and Walker, 1999).

1.3.3 Reproductive physiology – female

Sexual intra-abdominal organs are classical for a mammal: 2 ovaries accommodated in separated capsules. Each ovary is followed by a Fallopian tube and a uterine horn. The uterus has two parts (Jaffré, 2007). External genitals are classical for mammals (Raynaud, 1969).

Ovaries are egg-shaped, 1.6 x 1.2 cm in size (Wells, 1968) and located in an ovarian sac, which is surrounded with adipose tissue (Figure 10) in the proximal extremities of the uterine horns.

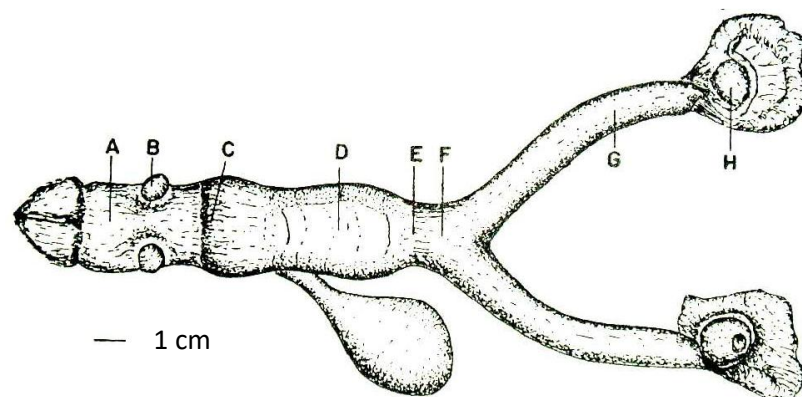


Figure 10: Dorsal view of a female striped hyena reproductive system. A: vestibule; B: vestibular gland; C: hymen folds; D: vagina; E: uterine cervix; F: short uterine body; G: uterine horn; H: ovary in its sac surrounded by fat. © Wells, 1968.

The vestibule is 4 cm long until the beginning of the clitoris and has two vestibular glands which are 8 x 6 mm in size and situated on the dorso-lateral side of the vestibule. The vulva has a pair of wrinkled, hairy labia. The clitoris is small and 4 mm long when stretched (Wells, 1968).

1.3.4 Reproductive physiology – male

The male reproductive system was first described by Wells in 1968: testicles are egg-shaped, measure 3 x 1.5 cm, and contained in a spherically shaped scrotum situated between the inguinal region and the anus. The epididymis extends over a large part of the middle dorsal side of each testicle and is strongly attached alongside it. The vas deferens leads to the lateral side (Wells, 1968) of the testicle, is 15 to 22 cm long, without a bulb, and opens into the urethra on it's summit of a small developed colliculus seminalis. The prostate gland is well-developed and is approximately 2.5 x 2 cm in size. The bulbous urethral glands are a pair of organs measuring 3.5 x 1.8 cm. Their secretory conduits are each 1 cm long and enter via the dorsal side of the ureter. The penis is well-vascularized; it measures between 15 and 20 cm from the top of the glans to the hamstring-cavernous muscle.

The glans is 3-4 cm long and covered with spicules; its distal part is smooth, and the 2.5-3 cm long proximal part is covered with a large number of spicules on the dorsal and lateral side (Figure 11). Hyenas have no penial bone (Bothma and Walker, 1999).

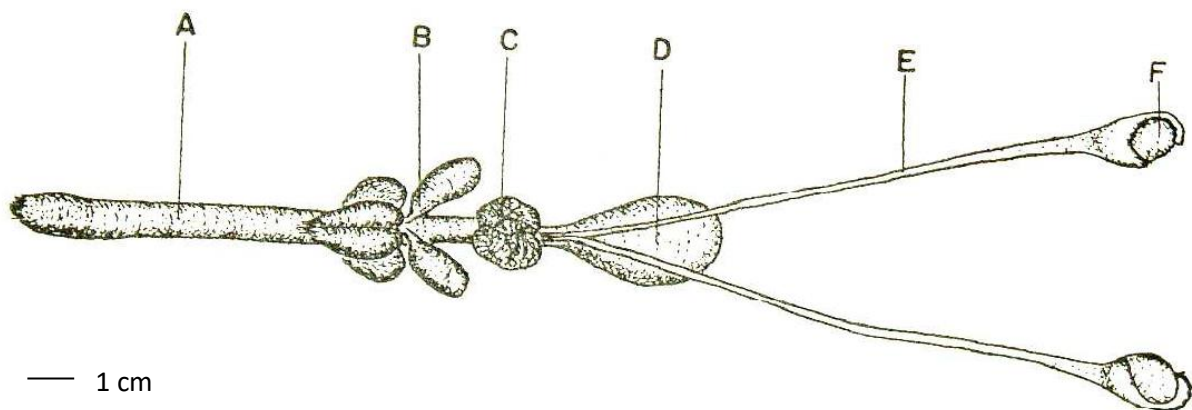


Figure 11: Dorsal view of male reproductive system. A: penis; B: Cowper gland; C: prostate; D: bladder; E: deferential conduit; F: testicle. © Wells, 1968.

1.4 Longevity

Striped hyenas have a lifespan of about 10-12 years in the wild, and the oldest animal in captivity was 24 years old (MacDonald, 1984; Nowak, 2005). In fact, at the end of the year 2024, the oldest living male in captivity in Europe was 23 years old and the oldest living female was 21 years old (data extracted from ZIMS checked by the EEP Coordinator in 2024).

1.5 Zoogeography and ecology

1.5.1 Distribution

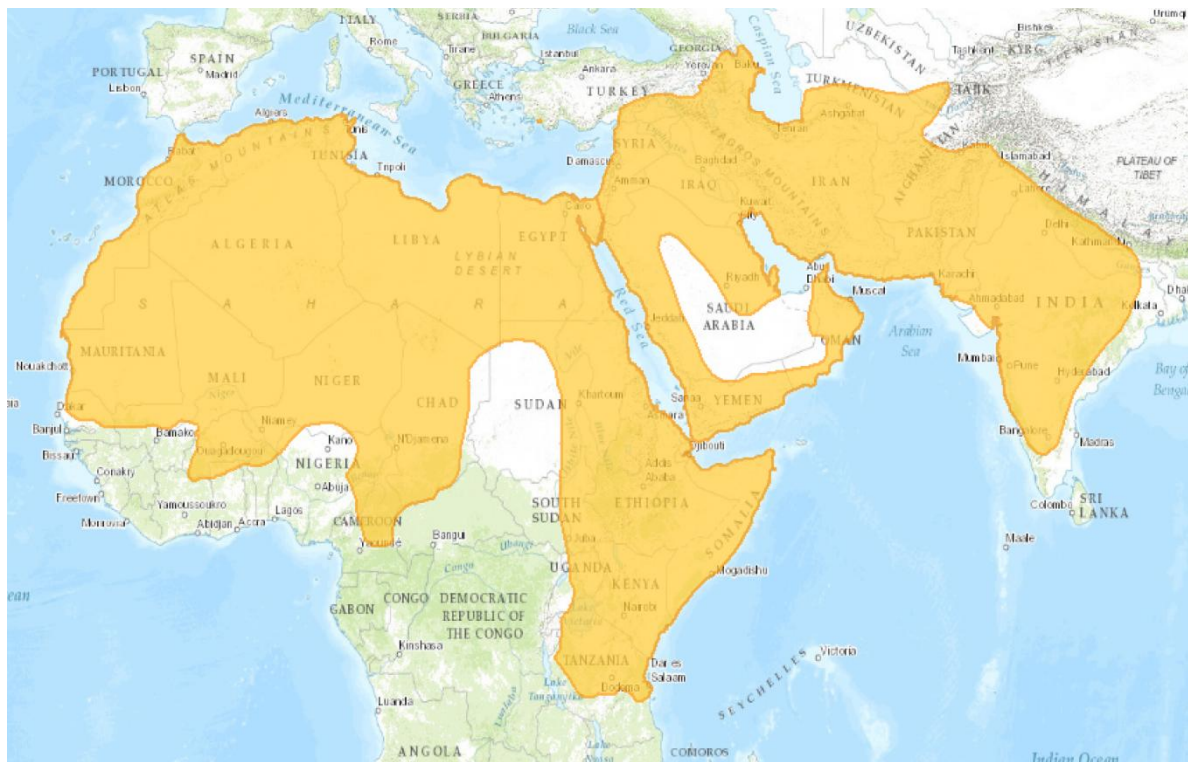


Figure 12: Striped hyena global distribution © AbiSaid & Dloniak, 2015.

The striped hyena has the most widespread distribution of any species in the hyena family, as it is the only species in this family that occur outside Africa (Figure 12). The current range of the striped hyena includes Africa, the Middle East and Asia, and there is a small population in the extreme South-East of Caucasia. In Africa, striped hyenas occur in several North African countries, the Arabian Peninsula and in East Africa as far south as Tanzania, with reported sightings from Ruaha National Park in central Tanzania. Densities are lowest in the desert, Sahara, Sudan or Chad (Mills and Hofer, 1998). The population in Israel has been in decline for several years. In Asia, striped hyenas are present in several countries: Iran, Afghanistan, Turkmenistan, India, Pakistan, Uzbekistan, Tajikistan and Nepal (Mills and Hofer, 1998). The current status of the species in several countries is not known due to an absence of verified sightings.

1.5.2 Habitat

Striped hyenas typically inhabit dry habitats such as steppe, savannah, dry bush, desert and mountainous regions, up to an elevation of 3.300 meters above sea level (Mills and Hofer, 1998). The species doesn't need to drink frequently and is reported to cope with drinking only once every 48 hours, which may necessitate travelling considerable distances (10 km) to a source of water, and there are reports that this species can drink saline water (Mills and Hofer, 1998). The striped hyena mostly rests

during daylight hours in caves or thick bush (Mills and Hofer, 1998). Because of its limited capacity to thermo-regulate, the striped hyena does not occur in areas where temperatures fall below -20°C, or where there are more than 120 days of frost per year occur (Heptner and Sludskij, 1980). Striped hyenas can live close to cities, as in the hill near Tel-Aviv in Israel (Mendelssohn, 1985; Mills and Hofer, 1998).

Striped hyenas occur at low population densities. For example, two studies in East Africa report densities of 0.02-0.03 animals/km² (Kruuk, 1976; Wagner 2006). Densities are at their lowest in very dry habitats, such as those in Sudan or Chad (Mills and Hofer, 1998). Female ranges do not overlap whereas several male ranges may overlap the range of one female (Wagner et al., 2008). In the Serengeti ecosystem, in East Africa, reported range sizes were 44km² for a female and 72km² for a male (Kruuk, 1976), and in the Negev desert in Israel the range size for one female was 61km² (Van Aarde et al., 1988).

Striped hyenas cover between 7-27 km per night (mean 19 km) to track prey or to zigzag cross-country at a speed of 2 to 10 km/h (Kruuk, 1976; Rieger, 1977), investigating the base of trees, dense shrubs, clumps of grass, old holes, etc. It is probably able to remember the location of fruiting trees and other feeding location (Mills, 1998). In East Africa, it lives in bushy regions as well as half-desert zones (Rieger, 1979b).

1.5.3 Population and conservation status

Since 2004, the striped hyena is classified on the IUCN Red List as a Near Threatened (NT) species (Figure 13) (AbiSaid and Dloniak, 2015).

As most large carnivores, striped hyena populations are declining and becoming increasingly fragmented. This decline is mostly driven by human activities that degrade, destroy and fragment the habitat required by striped hyenas, and the striped hyena is extirpated from much of its historical range. Striped hyenas populations are already extinct in many localities (Mills and Hofer, 1998).

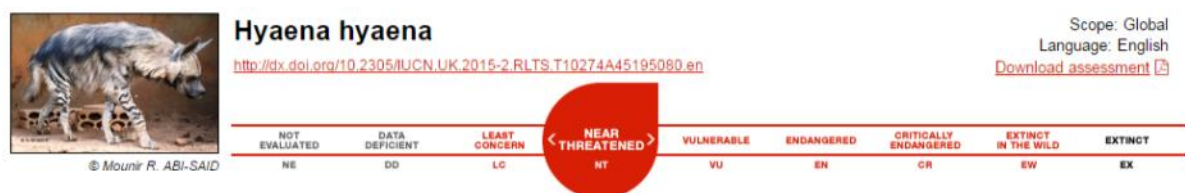


Figure 13: IUCN classification. © AbiSaid & Dloniak, 2015.

1.5.4 Threats

The striped hyena faces many threats. In the past striped hyenas were hunted for sport (Bird, 1946) even if they didn't make good trophies because of their coward's reputation (Ognev, 1962). Farmers persecute striped hyenas that are thought responsible for crop damage and predation of small livestock which can lead to retaliatory killing by livestock owners (Mills and Hofer, 1998). Those animals inspire fear and superstitions; as a result, they are killed for body parts transformed into talisman

(for example, mane hairs in North Africa; Fitter, 1968) and for traditional medicine (Mills and Hofer, 1998, Table 2).

Countries	Organs	Use
Afghanistan	Various	Amulet and aphrodisiac
Egypt	Nasal hair and eyeball	Anti-evil eye protector
	Heart	Courage
India	Tongue	Decreasing of tumours
	Fat	Rheumatism
Iraq	Foreskin	Protection during trips
	Various organs	Traditional medicine
	External female genital system	Treatment against male impotence
Arabian Peninsula	Left parts	Poison
	Right parts	Curative properties
Northern Africa	Meat	Semi-domesticated for farming and consumption of meat by people from Sinai
	Hairs	Talisman
	Brain	Aphrodisiac
Turkmenistan	Scratch fur touching female genital system	Talisman
	Tail	Magic power
	Male genital system	Aphrodisiac

Table 2: Traditional use of striped hyenas in different countries (Mills and Hofer, 1998).

Road accidents can impact hyenas' populations (Figure 14). For example, in the 1990's about 15-20% of the striped hyena in Israel were killed by cars every year (Mills, 1998), possibly because they often scavenge carcasses of animals killed on road (H. Mendelsohn pers. comm., in Mills, 1998). In the past, mass poisoning of carnivores, particularly during campaigns to control rabies, caused high mortality in some striped hyena populations.



Figure 14: Road sign of hyena in Namibia. From <https://fr.dreamstime.com>, 2015.

Striped hyenas live at relatively low densities and hold large ranges and hence they are susceptible to habitat fragmentation leading to isolated relatively small populations, which in the long-term may prove to be non-viable. Preventing habitat degradation and fragmentation and ensuring connectivity between populations are thought to be the main challenges for the future conservation of this species (Mills and Hofer, 1998).

1.5.5 Conservation actions

The striped hyena is protected within many national parks and reserves throughout its range. However, because it occurs at lower densities, is nocturnal and is not important for either sports hunting or wildlife tourism, there are few countries in which this species occurs that have laws to specifically protect it. One exception is Algeria where a decree (N° 83-509 from August 20th 1983; Bendjedid, 1983) should protect the striped hyena in the wild. In order to better understand the species, more ecological research is required throughout its range.

1.6 Diet and feeding behaviour

1.6.1 Food preference

The striped hyena has a diverse diet. They are efficient scavengers, locating the carcasses of animals that have died and those killed by other predators (wolf, spotted hyena, cheetah, leopard, lion, and tiger). They also eat fruits and vegetable, vertebrate and invertebrate (Kruuk 1976; Rieger 1979a; Heptner and Sludskij, 1980; Osborn and Helmy 1980; Kerbis-Peterhans and Horwitz 1992) and small livestock, which increases human-hyena conflicts (Mills, 1998). Rieger (1979) suggested that only the three bigger subspecies (*H. h. barbara*, *H. h. hyaena* and *H. h. syriaca*) are able to kill larger livestock, but this idea has been questioned, thus more information is required on livestock predation to resolve this issue. Diet can differ between localities: in Turkmenistan striped hyenas feed on wild boar, porcupine, and particularly tortoise (Mills and Hofer, 1998). In Caucasia, during the season, grasshoppers are an important dietary item (Heptner and Sludskij, 1980). In Israel, striped hyenas that live near cities, feed on household waste, carrion and fruits, particularly melons and dates (Macdonald, 1978; Mendelsohn, 1985; Mendelsohn and Yom-Tov, 1988), and in Eastern Jordan, the main sources of food are carcasses of horses, water buffaloes, and household waste (Al Younis, 1993). They will hide excess food for later use (Kruuk, 1976; Mills and Hofer, 1998). Striped hyena can drink fresh and salt water (Schelvis and Spijkman, 2008) or fulfil their water needs by eating melons (Heptner and Sludskij, 1980).

1.6.2 Feeding

Few details are known about the foraging behaviour of striped hyenas. They are known to primarily be solitary foragers in habitats where food resources are highly dispersed, even though several individuals may be part of a spatially associated group of animals (Wagner et al., 2008). In Turkmenistan, there is an influx of striped hyenas to areas through which domestic livestock and wild ungulates migrate (Heptner and Sludskij, 1980). This may indicate that in such areas, striped hyenas are periodically nomadic or alternatively, they undertake long-distance trips to forage well outside their normal range in areas containing a high abundance of food resources. It is unlikely that either nomadic behaviour or long-distance foraging would be profitable for striped hyenas in migratory Africa

ecosystems because spotted hyenas would out-compete striped hyenas for available food in such settings. Rieger (1979a, 1981) argued that the two subspecies, *H. h. dubbah* and *H. h. sultana*, are mostly solitary and rarely kill larger wild or domestic herbivores whereas *H. h. syriaca*, *H. h. hyaena* and *H. h. barbara*, which are thought to be the three larger subspecies may kill larger herbivores when foraging in small groups.

Striped hyenas regularly carry food to their dens or resting sites, leading to an accumulation of bones and other items in the vicinity (Ilany, 1975; Kruuk, 1976). Food carrying behaviour is interpreted by Ilany in 1975 as a way to avoid competition for food with other carnivores (lion, leopard, and wolf). When excess food is available, striped hyenas cache food in tall grass or under bushes (Kruuk, 1976). Animals typically feed alone (Rieger, 1981), but several adults may be attracted to a large carcass (Wagner et al., 2008; Wagner, 2013), even though they may not feed together (Macdonald, 1978). In Israel, Kerbis-Peterhans and Horwitz discovered in April 1986 a den containing 2370 bones of various species from snake, lizard, sand rat to domestic camels and equids (Kerbis-Peterhans and Horwitz, 1992). Mothers start to bring solid food to their cubs when the cubs are around 30 days old (Rieger, 1979c). Striped hyena cubs are fully weaned when they are 10-12 weeks old (Schelvis and Spijkman, 2008).

1.7 Reproduction

1.7.1 Sexual maturity

The age at which striped hyenas reach sexual maturity is probably dependent on the quality of their diet during development and more information is required on when animals attain sexual maturity in the wild. McFadden et al. (2006) reported that sexual maturity occurs at the age of two years in males and two and a half to three years in females in the wild. In 1985, Mendelsohn reported the observations of three free-living 15 months old females pregnant. In captivity, the youngest male to father a litter was a 1 year and 2-month-old male at Augsburg Zoo. Most females in captivity give birth to their first litter between two to three years of age (Houssaye, 2017; Rieger, 1979c).

1.7.2 Seasonality of cycling

Striped hyenas are non-seasonal breeder (Rieger, 1979c; Wagner, 2006), hence mating and births can occur throughout the year, even if a small birth peak has been reported in some populations in Africa (Bothma and Walker, 1999). There is little data available on this subject in the wild, but data collected in zoo also indicates that females are polyoestrous and can mate throughout the year (Figure 15).

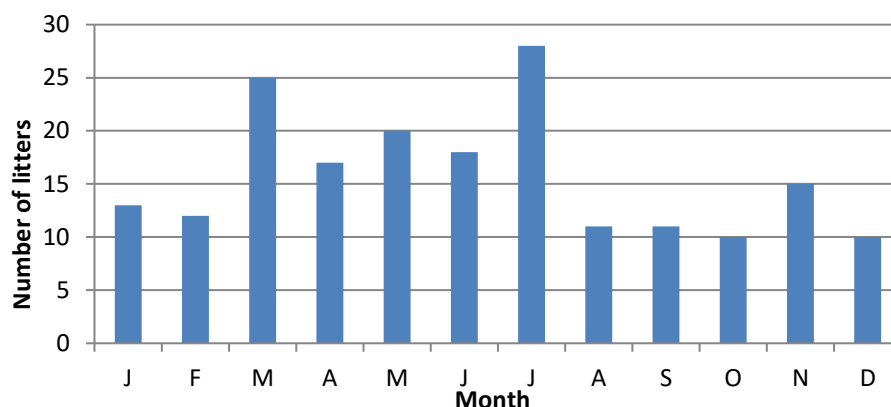


Figure 15: Number of litters by month in European zoos. Compiled by Houssaye F. (CERZA Zoo). Reproductive Parameters Report SPARKS data current thru 26 May 2017. European Studbook

1.7.3 Reproductive cyclicity in females

Females are polyoestrous (Drea et al., 1998), and oestrus last for 1 day (Rieger, 1981; Mills and Hofer, 1998; Bothma and Walker, 1999; Drea et al., 1998). This means that males will have several occasions to mate with the female throughout the year, except if the female is pregnant during the year. Post-partum oestrus occurs 20 to 21 days after litter’s birth (Rieger, 1979c; Mills and Hofer, 1998; Bothma and Walker, 1999). The average interval between two litters is approximately 14 months (Drea et al., 1998). Oestrus cycles last between 40-50 days and gestation for 90-91 days (Pocock, 1941; Ronnefeld, 1969; Heptner and Sludskij, 1980).

1.7.4 Reproductive hormones in males

There is no available data on this subject.

1.7.5 Birth

After the gestation period of around 90 days, litter size varies from one to four (mean = 3) in the wild (Pocock, 1941; Ronnefeld, 1969; Heptner and Sludskij, 1980), and from one to five (mean = 2) in captivity (Rieger, 1979c, Table 3). Parturition is preceded by an intensive digging by the female (Rieger, 1981) in order to create a den where she can give birth to cubs. In the wild, dens are quite small and not spacious. Mean size are 40 cm high, 50 à 150 cm width and several meters deep (WSI, 2009; Gajera & al., 2009; Rieger, 1979b).

Litter Size	Number of litters	Percentage
1	57	29%
2	81	41%
3	51	26%
4	10	5%
5	1	1%

Table 3: Data on litter size of striped hyena in European zoos. Compiled by Houssaye F. (CERZA Zoo). Reproductive Parameters Report SPARKS data current thru 26 May 2017. European Studbook.

1.7.6. Development

When born, cubs weigh between 660-700g, are blind, with closed ear tubes, white to grey fur and clear black stripes. Eyes open at 7-8 days age. Teeth erupt at about 21 days of age and cubs start begging to eat solid meat around 30 days of age (Rieger, 1981). Mothers may dig dens in which they give birth and raise their young. Alternatively, they may take-over dens dug by another species or may give birth and raise their litter in cave or simple depressions in rocky habitats (Wagner, 2013).

In captivity, weaning occurs 8 weeks after birth (Heptner and Sludskij, 1980). In the wild, cubs have been seen suckle when four to five months of age (Rieger, 1981), and to 10-12 months (Kruuk, 1976; Schelvis and Spijkman, 2008). Both parents have been seen bringing food to their litter (Kruuk, 1976; Davidar, 1985, 1990). In South Kenya, Wagner observed one case where juvenile from previous litter routinely provisioned and interacted extensively with cubs (Wagner, 2013).

1.8 Behaviour

In the Middle East, the striped hyena is known as a grave robber (Kruuk, 1976). When attacked by domestic dogs or humans, it uses “shamming”, pretending to be dead, even if it is repeatedly bitten (Mills, 1998), the bad reputation of this species inspires fear to people, even if it is not particularly aggressive.



Figure 16: Striped hyena sleeping like a dog © Bratislava Zoo.

1.8.1 Activity

Striped hyenas are crepuscular. They have been reported to accompany large migrating herd of domestic and wild ungulates in Turkmenistan which may suggest that some individuals are nomadic during this period at least (Heptner and Sludskij, 1980). Alternatively, this observation might indicate that migrating herds are accompanied by a succession of different striped hyenas as the herd travels through the ranges of different individuals. In Egypt, several of them were seen on road used by camel caravans, where the probability of find a dead camel was high (Osborn and Helmy, 1980).

1.8.2 Locomotion

Hyenas look like canids, particularly sleeping postures and maintenance behaviour: scratching, shaking, licking and nibble-grooming (Figure 16). They squat to defecate and urinate like most carnivores, with the tail straight up. Striped hyenas often move at a trot (Estes, 1991).

1.8.3 Prey related competitor

In Israel, the striped hyena may encounter wolves, red foxes and caracals at carcasses. Competitors in Central Asia include leopards, wolves, golden jackals, red and corsac foxes (Heptner and Sludskij, 1980). In India, the striped hyena can encounter over carcasses with leopards, tiger cubs, and

domestic dogs (Pocock, 1941). In East Africa, the striped hyena is dominated by spotted hyenas and sometime the leopards (Kruuk, 1976). Hyenas have no predators as they are considered themselves a top-predator (Schelvis and Spijkman, 2008) but they can have conflicts with larger carnivores which live in the same environment, e.g. leopards (Mills, 1998; Shelvis and Spijkman, 2008).

1.8.4 Social behaviour

Striped hyenas are mainly solitary, and the typical group size is one to two animals (Rieger, 1979a; Wagner et al., 2008); however, groups consisting of up to seven animals have been reported for the subspecies *H. h. dubbah* in Libya (Hufnagl, 1972). In Israel, several animals (*H. h. syriaca*) of both sexes or females with their large cubs have been observed feeding together on a carcass. (Macdonald, 1978). This same subspecies was reported to be monogamous in central Asia (Heptner and Sludskij, 1980). In Serengeti ecosystem in Tanzania the territory size for one female was 44km² and for one male was 72 km² (Kruuk, 1976). Van Aarde et al. (1988) reported that one female in the Negev desert in Israel held a territory of around 61 km² during a period of seven months that partly overlapped with two other individuals.

Across the different subspecies, differences in body size, proportion of killed items in the diet and sociality co-vary: the smaller subspecies *H. h. dubbah* and *H. h. sultana*, currently sympatric with spotted hyena, are known to be more solitary and to kill smaller herbivores (wild or domestic) (Mills and Hofer, 1998). It has been reported that the larger subspecies *H. h. barbara*, *H. h. hyaena* and *H. h. syriaca* may occasionally kill larger herbivores when hunting in small groups (Mills and Hofer, 1998).

Animals frequently scent mark in their territory using a behaviour termed ‘pasting’, in which vegetation is dragged over the protruded anal scent pouch. This behaviour deposits a fatty secretion from the anal gland on vegetation, stones or any protruding objects (Figure 17).



Figure 17: Striped hyena marking his territory (left) and the result of the marking (right) © Tallinn Zoo

When striped hyenas fight, they bite the throat and the legs, not the mane. When striped hyenas meet, they investigate and lick the mid-back area, where the mid-dorsal crest is (Rieger, 1981). As noted by field researchers, social interactions have been not so often recorded in the wild (Wagner, 2013).

Kruuk (1976) has noted a meeting ceremony (Cf 1.8.5 Sexual behaviour). In 1978, Rieger described the social behaviour of captive striped hyena at Zurich Zoo which corroborate field observations done by Kruuk a year later. Meeting hyenas sniff at the mane and the anal pouch of another hyena which presents by turning its tail up and extruding its anal pouch (Fox, 1971). When agonistic behaviour appears, striped hyenas will attack another by biting the black throat patches and the legs (Rieger, 1978).

In 1979, Rieger wrote “the hair along the back is elongated up to some 20 centimetres whereas that of the rest of the body is some 7 centimetres long. The hair tips of the region near thoracal and lumbar vertebrae are black. This area has two different functions. First, an aggressive hyena erects exactly this part of its mane. Second, meeting striped hyenas investigate and even lick the mid-back region of a conspecific” (Rieger, 1979a). Striped hyenas use a small variety of calls (Kruuk, 1976; Peters, 1984).

1.8.5 Sexual behaviour

During its oestrus day, females vocalise and can be followed by two to three males. When in oestrus, females emit the major part of their vocalisation for sexual appeal. Females in oestrus are apparently dominant and appear to exercise mate-choice. Kruuk observed in 1979 the meeting ceremony between pairs which involved mutual sniffing of the face, neck and anal regions. The anal pouch was protuded during sniffing and either both hyenas were standing, or one would lie down while exposing the anal region. In captivity, just before mating, the male puts its front legs on the female’s mane, scratches the ground with its front leg, and licks the female’s neck (Rieger, 1993) Cf Section 2.4 Breeding.

1.9 Bibliography

AbiSaid, M. & Dloniak, S. M. D. 2015. *Hyaena hyaena*. The IUCN Red List of Threatened Species 2015: <http://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T10274A45195080.en>. Downloaded on 09 December 2016.

Al Younis, J. S. 1993. Hyenas in eastern Jordan. IUCN Hyaena Specialist Group Newsletter, 6: 15-25.

Bendjedid, C. 1983. Décret n° 83-509 du 20 août 1983 relatif aux espèces animales non domestiques protégées. Journal officiel de la République Algérienne.

Bird, F. W. 1946. The hyena in Palestine. Jerusalem Nat. Club Bull., 21:1.

Bothma J. du P., Walker, C. 1999. Larger Carnivores of the African Savannas, Springer-Verlag, Berlin, 274 pp.

Buckland Wright, J. C. 1969. Craniological observations on *Hyaena* and *Crocuta*. Journal of the Zoological Society of London 159:17-29.

- Davidar, E. R. C., 1985. Den full of hyenas. Sanctuary Magazine, 4:336-341.
- Davidar, E. R. C., 1990. Observations at a hyena *Hyaena hyaena*. Linn. den. Journal of the Bombay Natural History Society, 87:445-447.
- Drea, C., Weldele, M., Forger, N.G., Glickman, S. 1998. Androgens and masculinization of genitalia in the spotted hyaena (*Crocuta crocuta*). Journal of reproduction and fertility, 113: 117-127.
- Estes, R. D. 1991. The Safari companion: a guide to watching African Mammals including Hoofed Mammals, Carnivores and Primates. Chelsea Green Publishing.
- Fitter, R. 1968. Vanishing wild animals of the world. F. Watts, Inc., New York, 144pp.
- Fox, M. W. 1971. Behaviour of wolves, dogs and related canids. Harper and Row, New-York.
- Gajera, N., Dave, S.M. & Dharaiya, N. 2009. Feeding patterns and den ecology of striped hyena (*Hyaena hyaena*) in North Gujarat, India. Tigerpaper, Volume 36 n°1 p13-17.
- Gotch, A.F. 1979. Mammals - Their Latin Names Explained, a Guide to Animal Classification. In: The Quarterly Review of biology, Vol.55. The university of Chicago press journal.
- Hendey, Q.B. 1974. The late cenozoic Carnivora of the south-western Cape Province. Annals of the South African Museum 63:1-369.
- Heptner, G-V. & Sludskij, A-A. 1980. Die Säugetiere der Sowjetunion – Band III Raubtiere (Feloidea). Gustav Fischer, Jena.
- Houssaye, F. 2017. Reproductive Parameters Report Sparks data current thru 26 May 2017. European Studbook Striped hyena (*Hyaena hyaena*). CERZA Zoo.
- Hufnagl, E. 1972. Cats (Felidae). In: Libyan Mammals. The Oleander Press: 41-44.
- Ilani, G. 1975 Hyenas in Israel. Israel—Land and Nature, pp. 10-18.
- Jaffré, N. 2007. La reproduction des hyénidés et du lycaon : étude bibliographique. Veterinarian thesis.
- Jenks, S. M. & Werdelin, L. 1998. Taxonomy and systematic of living hyaenas (Family Hyaenidae), Pp 8-17, in Hyenas: Status Survey and Conservation Action Plan (G. Mills, and H. Hofer, eds) IUCN/SCC Hyaena Specialist Group. I. U. C. N., Gland, Switzerland, 154 pp.
- Kerbis-Peterhans, J. & Horwitz, L. K. 1992. A bone assemblage from a striped hyaena (*Hyaena hyaena*) den in the Negev Desert, Israel.
- Kingdon, J. 2003. The Kingdon field guide to African Mammals, Christopher Helm/A & C Black Publishers Ltd., London.
- Koepfli, K. P., Jenks, S. M., Eizirik, E., Zahirpour, T., Van Valkenburgh, B. and Wayne R.K. 2006. Molecular systematics of the hyaenidae: relationships of a relictual lineage resolved by a molecular supermatrix. Mol Phylogenet Evol 2006 Mar; 38(3): 603-620.
- Kruuk, H. 1976. Feeding and social behaviour of the striped hyaena (*Hyaena vulgaris* Desmarest). Serengeti Research Institute publication No. 189.

- Liddell, H. G. & Robert Scott, a Greek-English Lexicon, on Perseus.. Downloaded on 15th December 2016.
- MacDonald, D. 1978. Observations on the behaviour and ecology of the striped hyena (*Hyaena hyaena*) in Israel. *Israel Journal of Zoology* 37: 189-198.
- MacDonald, D. 1984. The encyclopaedia of mammals. Greenwich Editions, London.
- MacFadden, D., Pasanen, E. G., Weldele, M. L., Glickman, S. E., Place, N. J. 2006. Masculinized otoacoustic emissions female spotted hyenas (*Crocuta crocuta*). *Hormone and Behaviour*, Volume 2: 285-292.
- Mendelssohn, H., 1985. The striped hyena in Israël. *IUCN/SSC Hyaena Specialist Group Newsletter*, 2: 7-14.
- Mendelssohn, H. & Yom-Tov, Y. 1988. Changes in the distribution and abundance of vertebrates in Israel during the 20th century. In: Y. Yom-Tov & E. Tchernov (eds). *The zoogeography of Israel*. Dr. W. Junk Publication: 515-548.
- Mills, G. 1998. The comparative behavioural ecology of hyenas: the importance of diet and food dispersion. *Carnivore Behavior, Ecology and Evolution*. Cornell University Press, 125-141.
- Mills, M. G. L., Hofer, H. 1998. Hyenas Status Survey and Conservation Action Plan, *Hyaenas*. IUCN/SSC Hyaena Specialist Group, Gland, Switzerland and Cambridge, UK.
- Myers, P. R., Espinosa, C. S., Parr, T., Jones, G. S., Hammond, and T. A. Dewey. 2016. The Animal Diversity Web (online). Accessed at <http://animaldiversity.org>.
- Nowak, R. M. 2005. *Walker's carnivores of the world*, the Johns Hopkins University Press, Baltimore and London.
- Ognev, S. I. 1962. *Mammals of Eastern Europe and Northern Asia*. Jerusalem, II, pp 1-590.
- Osborn, D. J. & Helmy, I. 1980. The contemporary land mammals of Egypt (including Sinai). *Fieldiana Zoology New Series* 5: 1-579.
- Peters, G. 1984. On the structure of friendly close-range vocalizations in terrestrial carnivores (Mammalia : Carnivores : Fissipedia). *Zeitschrift fur Säugetierkunde*, 49: 157-182.
- Pocock, R. J. 1941. *Fauna of British India Mammal Volume 2*.
- Raynaud, A. 1969. Organes génitaux, Famille des Hyénidés. In : GRASSE PP, *Traité*.
- Rieger, I. 1977. Markierungsverhalten von Streifenhyänen, *Hyaena hyaena*, im Zoologischen Garten Zürich. *Z. Säugetierk.*, 42: 307-317.
- Rieger, I. 1978. Social behavior of striped hyenas at the Zurich zoo. *Carnivore*, 1:49-60.
- Rieger, I. 1979a. A review of the biology of striped hyaenas (*Hyaena hyanena*). Sonderdruck aus saugtierkundliche mitteilungen. BLV Verlagsgesellschaft mbH Munchen 40, 27 Volume 2: 81-95.
- Rieger, I. 1979b. Beobachtungen zur Aufzucht von Streifenhyänen, *Hyaena hyaena*. *Vierteljahresschr. Naturf. Ges. Zürich*, 124:169-183.

- Rieger, I. 1979c. Breeding the Striped hyena. International Zoo Yearbook vol.19.
- Rieger, I. 1981. *Hyaena hyaena*. Mammalian Species No.150 pp.1-5, 3figs.
- Rieger, I. 1993. Mitteilungen über die Aufrucht von Streifenhyänen, *Hyaena hyaena*. Der Zoologische Garten N. F. 63: 166-188.
- Ronnefeld, U. 1969. Verbreitung und lebensweise afrikanischer feloidea (Felidae et Hyaenidae). Säugetierkundliche Mitteilungen 17: 285-350.
- Schelvis, T. & Spijkman, E. 2008. Brown, spotted and striped hyena husbandry guidelines (DRAFT).
- Teare, J. A. 2013. *Proteles cristata*, *Crocuta crocuta*, *Hyaena hyaena*: ISIS physiological reference interval for captive wildlife. In Fowler's Zoo and Wild Animal Medicine, Volume 8 p512.
- Van Aarde, R. J., Skinner, J.D., Knight, M.H. and Skinner D.C., 1988. Range use by a striped hyena (*Hyaena hyaena*) in the Negev desert, Journal of the Zoological Society 216, pp. 575-77.
- Van Valkenburgh, B. 2007, Déjà vu: the evolution of feeding morphologies in the Carnivora, Department of Ecology and Evolutionary Biology, University of California, Los Angeles, USA.
- Wagner, A. P. 2006. Behavioral ecology of the striped hyena (*Hyaena hyaena*). Montana State University, Bozeman, Montana.
- Wagner, A. P., Creel, S., Frank, L. G. and Kalinowski, S. T. 2007. Patterns of relatedness and parentage in an asocial, polyandrous striped hyena population. Molecular Ecology, 16, 4356–4369.
- Wagner, A. P., Frank, L. G., Creel, S. 2008. Spatial grouping in behaviourally solitary striped hyenas, *Hyaena hyaena*. Animal Behaviour, 75, 1131-1142.
- Wagner, A. P. 2013. *Hyaena hyaena* Striped hyenas. In: Mammals of Africa Volume V: Carnivores, pangolins, equids, rhinoceroses (Eds. J. Kingdon & Hofmann). Bloomsbury Publishing, London. Pp 267-272.
- Wells, M. 1968. A comparison of the reproductive tracts of *Crocuta crocuta*, *Hyaena*.
- Werdelin, L. & Solounias, N. 1991. The Hyaenidae: taxonomy, systematics and evolution. Fossils and Strata 30:1-104.
- Wesley-Hunt, G-D. & Flynn J. J. 2005. Phylogeny of the Carnivora: basal relationships among the carnivoromorphans, and assessment of the position of 'miacoidea' relative to Carnivora. J. Syst. Palaeontol., 3:1-28.
- Wildlife Society of India, 2009. Status Ecology and Conservation of Striped hyena (*Hyaena hyaena*) in Gir National Park & Sanctuary Gujarat India. Annual Progress Report 2008-2009.

SECTION II - Zoo management



Figure 18: Female (Studbook n°10335) carrying her cub in the mouth © P. Roux, Obterre Zoo

Introduction

This section suggests best practice zoo management for striped hyenas. The topics are divided into the following chapters: enclosure, feeding, social structure, breeding, behavioural enrichment, handling and veterinary. The following information comes from two main sources: firstly, bibliography on hyena's management in captivity (every reference will be found in the text), and the answers to husbandry questionnaires sent in 2013 (Blin and Houssaye) and 2016 to zoos which maintain striped hyenas.

This review updates data collected in 2013, 2016 or 2018 in various subjects like: enclosures, outdoor, enrichments, diet or husbandry. We would like to thank the following institutions for contributing to the questionnaires:

- Augsburg Zoo (Barbara Jantschke and Thomas Lipp)
- Belfast Zoo (Julie Mansell)
- Berlin Tierpark (Florian Sicks)
- Bratislava Zoo (Marina Adamova, Sylvia Piroskova)
- Breeding Center of Endangered Arabian Wildlife (Cyrintha Joubert and Paul Vercammen)
- Jihlava Zoo (Jan Vasak)
- Kaunas Zoo (Milda Pedzeviciene)
- La Barben (Adeline Godefroy)
- Le Cornelle Zoo (Nadia Beneditti)
- Lisieux (Xavier Michel, Dorothée Ordonneau)
- Magdeburg Zoo (Konstantin Ruske)
- Night Safari Singapore (Anand Kumar)
- Nikolaev Zoo (Yuri Kirichenko, Victor Diakonov and Tatiana Bondarenko)
- Obterre Zoo (Patrick Roux)
- Olmense Zoo (Robby Van der Velden)
- Olomouc Zoo (Jitka Vokurkova)
- Rabat Zoo (Abderrahim Essalhi)
- Safaripark Beekse Bergen (Lars Versteeg)
- Sir Bani Yas (Aymee Cokayne, Abid Mehmood, Ibrahim Al Nassam)
- Tallinn Zoo (Kadri Ashford)
- Tbilissi Zoo (Georgi Darchiashvili)
- Terre Natura Murcia (Manuel Gonzalvez)
- Twycross Zoo (Zak Showell)
- Utica Zoo (Alexandra Weaver and Pearl Yusuf)

2.1 - Enclosures



Figure 19: Outdoor enclosure for striped hyena © Sir Bani Yas



Figure 20: Indoor accommodation with visitor's view, with a window of 24 millimetres of thickness © Augsburg Zoo

2.1.1 Indoor enclosure

It is important that hyenas are used to entering indoor enclosures regularly to facilitate vet control, animal separation, vaccination etc. To facilitate the intervention of the vet, a squeeze cage can be added in the indoor enclosure or in the outdoor enclosure if there is no space for an indoor one.

Moreover, if the outdoor enclosure has mature trees near the perimeter fence, strong wind conditions could forbid putting the animals outside during the night for safety condition because of the risk of trees falling on the fence.

Although hyaenids originate from tropical climates, some populations of all species encounter hot (over 37°C) or cool (to 0°C) temperatures during some parts of the year. As a result, most individuals are tolerant of a wide range of daytime temperatures. Regardless, animals kept outside should always have access to shade, especially during warmer parts of the year. When acclimated, most species without young require only minimal shelter at night if temperatures are only expected to reach 0°C, although heated shelters or indoor enclosures are needed for animals kept in northern regions. If the zoo is situated in a particularly cold region, it would be beneficial to the animals to have access to a large indoor enclosure for their comfort. This would also increase the visitors viewing, as animals would be viewable throughout the year (Figure 20). The humidity is a parameter to take into account: hyenas come from countries where humidity is relatively low; therefore, in indoor enclosures, a humidity level of 30-50 % would be appropriate and can avoid skin problems (Shoemaker & al., 2006).

Indoor boundary

The recommendation is to build an enclosure for 1.1 animals, with a minimum of three indoor areas so each animal can be separated and managed effectively and safely while both animals are in the house, e.g. in case of aggressiveness during feeding or pregnancy, medical treatment or management of offspring. If animals need to be separated, it is less stressful for both animals to keep in olfactory, auditory and visual contact. This can be done using mesh doors. It is recommended that there is an option to use a solid door if visual separation is needed between animals. The third indoor enclosure can be used as a “breeding den”.

The breeding den must be separated from the visitor viewing area to protect the animals from stress and disturbance (particularly through noise and visual contact). It has been shown that disturbance (by visitors or zoo staff) can stress the female and lead her to abandon her litter (Roux, pers. comm.; Rieger, pers. comm.).

The boundary between animals and keepers must be strong and secure weld mesh, bars, wire rack or glass. Bars and glass panels give the possibility for keepers to check the animals’ health, and to accustom animals to keepers. Bars or wire mesh facilitate veterinary treatment. The separation between indoor enclosures must be strong enough to avoid that animals can hurt each other but should also allow for the option of visual barriers between individuals.

Materials used for the building of the indoor enclosure

Walls are mostly made of concrete or thick wood due to the chewing behaviour of striped hyenas. Bars are usually made of horizontal and vertical steel; they must be tight enough to prevent cubs going through and the possibility of being hurt by other hyenas. The mesh should be 5 cm x 5 cm. If the building is made of wood, it may be necessary to add metal sheets to the wood to prevent the animal chewing and damaging it. Moreover, metal sheets are easy to clean. Wire rack between two rooms should be strong enough to prevent deterioration by hyenas. (Figure 21)



Figure 21: mesh between indoor and corridor © Zoo Le Cornelle

Security in the indoor enclosure

The gate which allows locking the animal inside or outside has to be strong enough to prevent hyenas damaging or moving it. This door must be operated from outside the enclosure, with good visibility to avoid any accidents. All gates must be firmly secured and built in such a way that the animals cannot open them.



*Figure 22: Indoor security with the color code
© CERZA zoo*

Colour code is used for all boundaries. **Red** colour for opening the gate between indoor and outdoor enclosures. **Blue** colour is used for opening the gate between the individual boxes (Figure 22).



Figure 23: Indoor security © CERZA zoo

A metal axis blocks the opening of a double door and is maneuvered by the **red** handle (Figure 23).



*Figure 24: View from a box with a double gate
© CERZA zoo*

A double door is employed as a security to avoid animals to go outside while the keeper is in the outdoor (Figure 24).



Figure 25: Red circle handle to open the gate © CERZA zoo

To move the animals into the indoor enclosures, keepers must pull the handle down, opening the gate. The red handle can be locked in the open or closed position (Figure 25).



Figure 26: Security system to allow keepers to go in the outdoor enclosure with padlock and unique key © CERZA zoo

This handle unlocks the second door, on the outdoor side. This security system is made for keepers to go safely into the outdoor enclosure after animals are locked in the indoor enclosure. This red handle is blocked by a padlock with a unique key. Only the keeper who locks this door will keep the key with him while working in the outdoor enclosure. If somebody else comes in the indoor facility, it is not possible to put animals outside, because the second door would be closed and locked (Figure 26).



Figure 27bis: Meat hatch for the young © CERZA Zoo

A “meat hatch” is a safe way to feed carnivores as it reduces risk (Figure 27). However, young animals can climb through the meat hatch so additional safety features must be added (Figure 27bis). Shifting the animals to an empty indoor enclosure to feed is another safe way of feeding hyenas in their indoor enclosures.

This locked door system is linked to a light (Figure 28), which illuminates green in front of the indoor boundary gate when all the boxes are locked (Figure 29).



Figure 28: Boxe's gate connected to an electric security system © CERZA zoo



Figure 29: Green light on when all the boxes are well locked up © CERZA zoo

There is another system to improve the security when doors have to be operated: the system of conditional keys. The objective of this system is to not be able to open an animal access door while a keeper access door is open, which would cause contact between keepers and animals (Figure 30).



*Figure 30: Latch of the door locked (on the left) and turn the "unique key" to release the latch (on the right)
© P. Roux, Obterre zoo*

A “unique key” (the only other key is available to the head keeper in case of emergency protocol) allows the keeper to operate the system. In order to open a keeper access door into an animal area, the keeper must lock the animal access doors into that animal area. This unique key will then be used to unlock the keeper access gate, at which point the key is retained in the lock until the gate is closed and locked again, releasing the key. Only then can the keeper use this same unique key to unlock the animal access gates... Thus, there is a unique key to open all doors inside or outside which can only be used by one keeper and cannot be used to open other gates until the key has been used to lock the current keeper access gate.



Figure 31: Secure system for the animal access hatches at Obterre zoo © P. Roux

There is a colour code for the hatches: **blue** for the gates between dens and **red** for the gates given to the outdoor enclosure (Figure 31).

This means that whatever animal access door has been opened by the keeper, the unique key remains in that corresponding lock which makes it physically impossible for the keeper to open the keeper access door and enter an animal area while the animal access hatches are also open.

A warning light, above each safety device, reinforces this procedure by visually signalling the keeper if a door or hatch is not closed. It can also be seen from the outside through the double gate at the entrance of the building.

Indoor substrate

Concrete is mostly used to allow keepers to clean easily. However, visitor view or not, it is recommended to have an area with sand, straw and/or bark where the animals will lay down and rest instead of laying only on concrete (Figure 32).



Figure 32: Indoor enclosure with sand (on the left) and with concrete (on the right) © Schwerin Zoo

Furnishings and Maintenance

Cleaning of the indoor areas should be done daily (removal of faeces, leftover food, cleaning of water bowls and adding fresh water). Cleaning regimes may need to change if a female is preparing to give birth or is in a den with pups. It is recommended that once a week straw or other bedding materials are removed and fresh bedding added. The frequency of washing and disinfecting depends on the management of hyenas, the weather and outside enclosure substrates: if they are always in free access between the indoor enclosure and the outdoor enclosure, the indoor enclosure will not become as dirty as the hyenas will spend more time outside.

Indoor environment

This species is not particularly sensitive to low temperatures (Ordonneau, pers.com.; Lécu, 2000) so there is no need to heat the indoor enclosure at all times. For cubs, a heating lamp can be used with caution because there is a risk of overheating. It is better to use natural substrate such as soil, bark or sand, which is less cold and more comfortable than concrete. To avoid cold weather and drafts entering the house, plastic curtains can be used behind the door, e.g. if animals have free access between outdoor/indoor facilities. However, hyenas can destroy plastic curtains. When outside temperatures are below 0°C, it is strongly advised to give the striped hyenas free access to their indoor enclosure.

Striped hyenas need a daylight cycle; natural light is surely the most adequate. However, if animals need to be held inside for a period longer than twelve hours (injury, cold, wind, etc...) artificial illumination must be added during the day, or sufficient natural light needs to be able to penetrate through windows to stimulate their natural circadian cycle.

Water access must be available in each indoor area. An automatic water dispenser can be used. The best water dispensers for hyenas are metallic ones to avoid them destroying it (Figure 33).

A ventilation system may or may not be used but the indoor area needs to have sufficient air change for the health and hygiene for animals and keepers.



Figure 33: Metallic water dispenser in indoor enclosure © Rabat Zoo

Indoor dimensions

Institutions have different area sizes for indoor facilities, from 5m² to 70m². The minimum size recommended to keep striped hyena indoor is 7 m². However, in Northern countries, where hyenas have to spend a lot of time inside during the colder months, it is recommended an area large enough to allow for natural behaviours. The functional shape of the indoor enclosure should be like A or like B. (Schelvis & Spijkman, 2008, Figure 34).

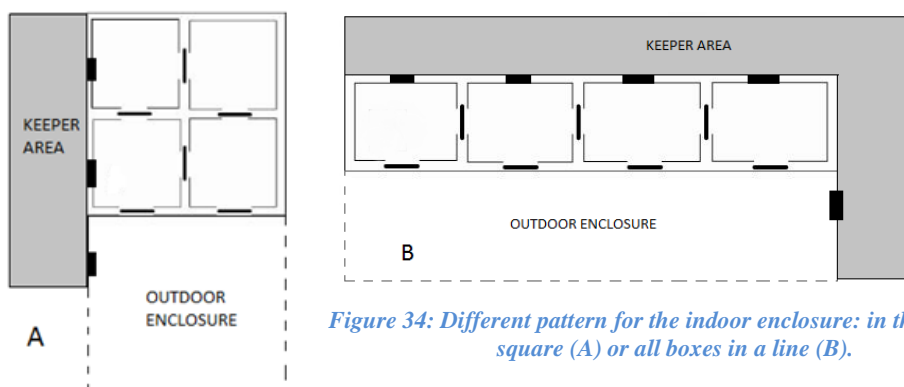


Figure 34: Different pattern for the indoor enclosure: in the form of a square (A) or all boxes in a line (B).

The keeper area is connected with the indoor animal areas and the outdoor enclosure with secure lockable double-doors systems.

All animal access doors, either between indoor animal areas or between indoor and outdoor animal areas must be operated from the safety of the keeper area with clear visible access when operating the doors.

2.1.2 Breeding den

Indoor breeding den

The indoor breeding den should be a private box isolated from the male, with privacy from keepers and not disturbed by the public. It is advisable to maintain the option of keeping the male and the female together; it depends if the female tolerates the male and if the male is not too aggressive. Keepers must not disturb the hyenas too often when they are breeding; not more than once a day just for feeding and observations before the female gives birth. It is recommended to leave the female alone for a few days after giving birth and before any attempt is made to carry out a quick clean of the indoor areas and to feed. At Obterre Zoo, a den was built with a 40cm gap between the den and the house floor. Once the cubs opened their eyes, they preferred to be in this tiny and secure area under the den (figure 35).



Figure 35: Inside breeding den at Obterre zoo, with den 40 cm up the floor, to protect from humidity and cold © P. Roux

The keepers servicing the house after a hyena has given birth in the indoor enclosure need to be staff the hyenas are accustomed to.

For example, at Obterre zoo, keepers waited two weeks before entering the indoor breeding den to clean faeces and add straw bedding. There, a special shoot or pipe system was created to feed the female without disturbing her (Figure 36).



Figure 36: Food distribution gutter system on the keeper side (on the left) and in the enclosure (on the right) at Obterre zoo © P. Roux

Outdoor breeding den

In the wild, hyena dens are quite small. The man size is 40 cm high, 50cm to 150 cm wide and several meters deep (WSI, 2009; Gajera & al, 2009; Rieger, 1979b). Females give birth to their cubs in the den. The female will either use a den abandoned by other species or will create one herself. For example, at Augsburg Zoo, the male dug a den. The opening of this den is in an easterly direction and measures between 80cm to 1m in diameter. It is 1.5m deep and the structure is maintained by tree roots. After the male finished digging, the female took his place, rejected the male and gave birth (Figure 37).

A special breeding den not visible to the public can be added to the enclosure. Animals must be protected from excessive disturbance from visitors; therefore, hidden and shaded places are recommended. To decrease stress for the animals, only two sides of the enclosure should be open to public view. The use of glass does not raise problems for the animal welfare (Lécu, 2000).



Figure 37: Pictures of a breeding den dug by the male © Augsburg Zoo

2.1.3 Outdoor enclosure

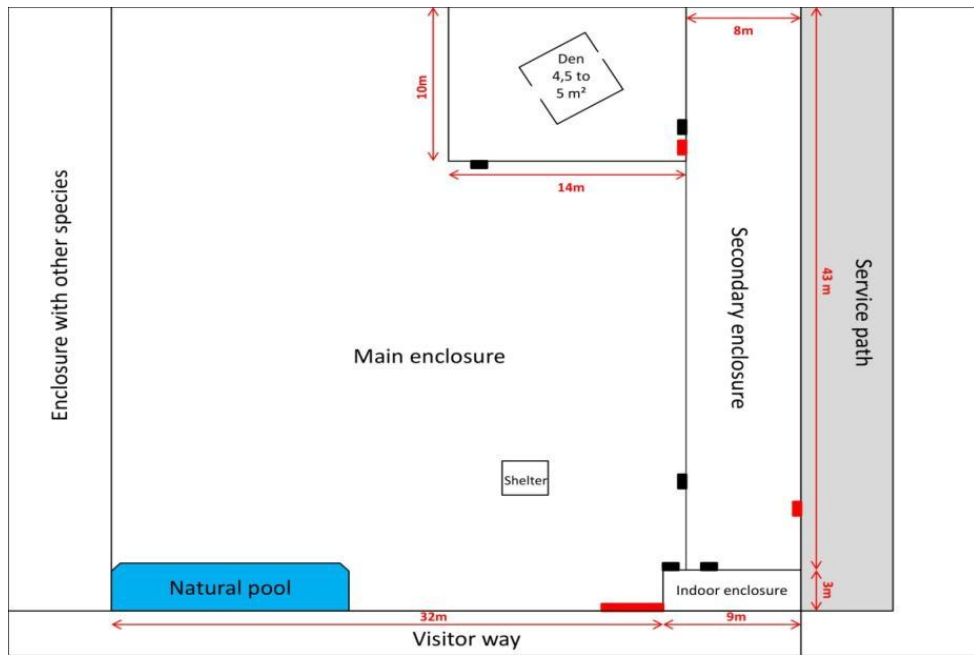


Figure 38: Outdoor enclosure at CERZA zoo.

The black rectangles in Figs. 38 and 39 are animal access doors which allow keepers to move hyenas according to their needs. All these doors (except in the indoor enclosure) can be opened by a keeper who is outside of the enclosure. Red rectangles in Fig. 38 are doors for keeper access.

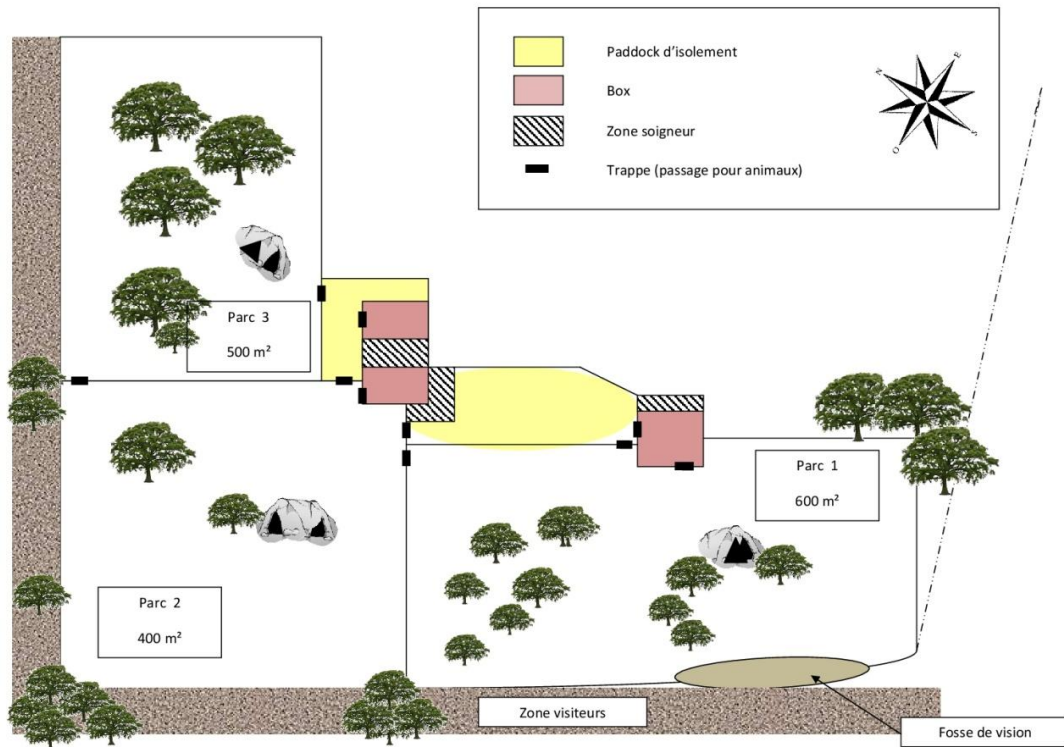


Figure 39: Outdoor enclosure at La Barben zoo © A. Godefroy

It is strongly recommended to have two outdoor enclosures connected to each other. As striped hyena pairs are not always compatible with each other, it is important to allow individuals to be isolated from their partner. A second enclosure can be useful to separate pairs when the female is aggressive (e.g., prior to or after giving birth). This second enclosure is also important to separate the pair from their offspring when the young are ready to be separated for the parent or when aggression occurs between the young (meaning they are ready to be sent to another institution following EEP recommendations).

Boundary

The configuration of the fence depends on its height: if the fence is 2m high, the overhang must be from 50cm to 1m at an angle of 45-90° to the fence along the inner edge. If the fence is higher than 3m, it is not necessary to have an overhang. The fence must be tense enough to prevent injury to the animals and prevent escape. The wire mesh should not be larger than 5cm x 5cm to prevent climbing or placing body parts through the mesh (Figure 40).

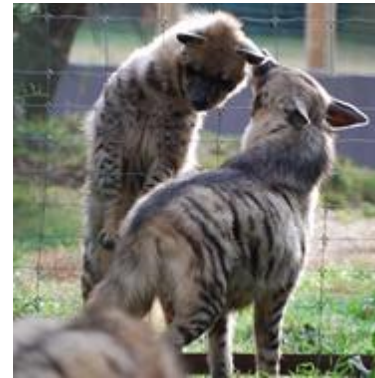


Figure 40: Striped hyena stuck on the fence © La Barben zoo

The use of electrical cables along the inside of the fence is strongly advised. Moreover, as for all dangerous animal enclosures, a second fence on the visitor side must be set up for additional safety, with a minimum gap of 1m between the animal boundary and the visitor fence. (Figure 41).



Figure 41: electric cables along the fence © CERZA Zoo

As striped hyenas dig a lot (Figure 42), wire mesh or concrete should be included in the boundary design under the fence, about 1m deep to avoid animals digging out of the enclosure (Schelvis and Spijkman, 2008).



Figure 42: Hole dug by striped hyenas © Nikolayev Zoo

A pool can be dug in each enclosure, allowing hyenas to have natural access to water for drinking, bathing and refreshing. The enclosure should have sufficient bushes and trees, allowing animals to hide from each other and to provide refuge from the public. Shelters must be provided in each enclosure to give the animals protection from the weather.

If animals have to be separated for a period, it is better for the second enclosure to be adjacent to the first one, keeping an olfactory and visual contact between animals.

Outdoor substrate

Soil, vegetation, sand and stone dust have been used successfully as outdoor substrate. An enclosure where different substrates are available is ideal for hyenas (Figure 43 & 44).

Hyenas must have the opportunity to dig their own dens in natural substrate. This is a natural behaviour that hyenas enjoy, and birth is always given in a breeding den dug by parents in the wild.

Outdoor furnishing and maintenance

The way the enclosure is furnished can make a big difference to the welfare of striped hyenas. Like other large carnivores, hyenas can develop stereotypic behaviours, especially if they are housed in small or inadequate enclosures (Schelvis and Spijkman, 2008). An area without visitors' view can reassure animals and allow them to rest without disturbance. Free access to shaded or sheltered areas is essential for hyena welfare, as are shelters against sun and rain. The shade of a building as well as trees or other vegetation must equally be provided.



Figure 43: Enclosure with stones and sand. © Tallinn Zoo



Figure 44: Wooded enclosure with grass. © Augsburg Zoo

Access to fresh water must be accessible at all times. Water bowls or troughs must be constructed to prevent damage by hyenas. Water bowls must be situated where both adults and pups can access them, positioned where they are not contaminated and can easily be cleaned. Natural pools must be designed and constructed to prevent injury or drowning. These pools are enjoyed by hyenas and provide behavioural enrichment. The pools can be as little as 90cm deep. Sometimes hyenas bring meat or piece of wood into the water which can create problems or blockages at the drain. Regular cleaning should occur to avoid algal and bacterial growth.

It is recommended to clean the outside enclosures once a week, removing faeces, uneaten food, and other waste. Because striped hyenas need to mark their territory on a regular basis it is advised not to clean too often as they lose their olfactory marks which can be stressful to them (Shoemaker & al., 2006).

Ideally, enclosures should include the possibility of video monitoring indoors and outdoors; this is especially useful for monitoring mating, birth and parent's behaviour.

Outdoor environment

Striped hyenas can be outside at almost any temperature, but precautions must be taken when temperatures are at 0°C or below. Animals can be locked indoors at night but it is recommended that animals have free access to both indoor and outdoor facilities.

Outdoor dimensions

Appropriate dimensions would reduce or eliminate stereotypic behaviour, but enrichment is also very important. Indeed, a big empty enclosure is less recommended than a smaller one with a lot of enrichment. The minimum area size is 1000m² for 1.1 animals. Most important is to have several enclosures with connections between them as the male and the female must sometimes be separated. Allowing an animal to go far away from the other is often sufficient (i.e. it is then not necessary to close the door between enclosures). It is necessary to have at least two animal access doors between each enclosure to avoid an animal blocking the access of the adjacent enclosure to another animal. A separation could be permanent or just for some special circumstances, as when the female has cubs. When males and females are introduced for mating, the meeting might not be successful and aggression and injuries can occur, so it is very useful to have adjacent enclosures to allow the animals to keep sufficient distances to reduce aggression and/or to move away from each other.

2.1.4 Enclosure attractiveness

Striped hyenas, as all hyaenid species, have bad reputations. It is our goal to make sure that this reputation is not increased with poorly designed enclosure or unacceptable management. It is highly recommended to have enclosures that allow animals to fulfil natural behaviours. Only in that case we can have animals performing natural behaviours and experiencing good welfare.

Thus, concrete should be avoided in the outdoor enclosure to allow animals to dig. Enrichment should be given frequently to increase natural behaviours such as foraging, scent marking, etc... By having such enclosures, zoos will manage to fulfil their educational role by displaying animals in a natural and engaging way.

2.2 - Feeding



Figure 45: Striped hyena eating a bone © La Barben zoo

A well-adapted diet is essential for animal welfare, being as close as possible to their natural diet. An adult hyena eats around 4% of its body weight per day (Divers, 1986).

Even if striped hyenas are able to live in a small family group, it is advised to separate the animals when feeding. If animals are fed in the indoor enclosure, food can be put in before the door is opened to hyenas or through a meat hatch, which guarantees keeper safety. Feeding the animals indoors will allow keepers the opportunity for close observation of the hyenas while eating.

Basic diet

As mentioned in paragraph 1.3 Physiology, the hyena's digestive system looks like a dog's. A few examples of daily diet in a zoo are presented below (Table 4 to 7).

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Chicken (morning)	400 g	400 g	400 g				400 g
Chick (morning)	5	5	5	5	5		5
Rats middle (morning)				3			
Beef (morning)					400 g		
Bear kibbles (meat)	150g	150g	150g	150g	150g		150g
Fruits and vegetables (afternoon)	500 to 700 g	500 to 700 g	500 to 700 g	500 to 700 g	500 to 700 g	500 to 700 g	500 to 700 g
Fresh bones						1	

Table 4: Feeding protocol for one animal at La Barben Zoo - France

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Sweet potato or apple (before 9 AM)	100g	100g	100g	100g	100g	100g	100g
Nebraska Feline diet	700g-1100g	700g-1100g	700g-1100g	700g-1100g	700g-1100g	700g-1100g	700g-1100g
Chicken (after 4PM)					1/2		1/2
Horse tail			1				

Table 5: Feeding protocol at Utica – USA

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Meat on bones	2 kg	2 kg		2 kg	2 kg	2 kg	2 kg
Fruits	200g	200g	200g	200g	200g	200g	200g
Watermelon	500g	500g	500g	500g	500g	500g	500g
Tomato	300g	300g	300g	300g	300g	300g	300g
Milk	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml
Cottage cheese	200g	200g	200g	200g	200g	200g	200g
Egg	1	1	1	1	1	1	
Rabbit			1				

Table 6: Feeding protocol at Nikolaev Zoo - Ukraine

Most zoos propose one or two fast or lighter/no meat days for the feeding protocol because hyena's digestive system is short, as in the majority of carnivores except in African wildcat and marten species. For "no meat" days, vegetables can be given or bones for healthy gums and chewing muscles.

- **Chicken:** whole chicken should be given, with viscera and head if possible. Providing whole carcasses is a more natural way of feeding and should be encouraged. Leaving feathers on chickens also provides enrichment.
- **Meat kibbles:** Kibbles can be kept at room temperature.
- **Sweet potato:** This is a starchy, slow-burning sugar, which can give energy to animals.
- **Nebraska Feline diet:** Industrial food with beef, which contains vitamins. Composition in *Appendix 1*.
- **Horse tail:** Rich in bone and cartilage, good for chewing muscles and gums (can be replaced by beef tail)
- **Beef heart:** Fat should be left on the heart so the animal can eat it. It can be important to include fat in the diet as it is the only way for carnivores to have it.

Hyenas are highly adapted to consume bones, so it is important to include them in the diet several times per week (Berger et al., 1992). Bones from beef and sheep are best, but those from pig or wild cervids can also be used.

Supplement: May or may not be useful depending on the food given:

- Carnizoo® (St Laurent) on meat (see composition in Appendix II):
 - 10 g per day are used at Sharjah; in general, it is recommended to add 1.5% of the daily ration to meat when the animal doesn't eat any bones. When the animal eats bones, it is recommended to add 0.5% of the daily ration.
- Carmix® (St Laurent): the recommended dose to add to the meat represents 1% of the daily ration (See composition in Appendix III).
- Mazuri Carnivore Supplement: the recommended dose to add to the meat represents 2% of the weight of meat (without bones; see composition in Appendix IV).

In Sir Bani Yas, hyenas live in relative freedom in an outdoor enclosure measuring 41 km², where they can hunt by themselves. When other zoo animals die, the carcass can be a valuable food item for hyenas. A necropsy must be carried out by the vet to be sure that the carcass can't make the hyenas sick. If the necropsy doesn't present any risk to the hyenas' health, the meat must be frozen to kill any bacteria and can then be given to the hyenas safely.

Special dietary requirements

- Pregnant female: Some institutions provide a special diet for pregnant females. Increasing the daily diet by 100g and not giving any fast days. It is very important to add bones or/and additional calcium to her feeding to avoid bone fragility in offspring.
- Geriatric animal: food must represent 2% of the animal's body weight (Shoemaker et al., 2006).
- Lactating animal: no fast days. The mother should be given additional calcium to avoid bone problems in cubs (for example, use of Petphos and dog food enriched in calcium at La Barben zoo).
- Cubs – hand reared: Please report to chapter on hand rearing. When cubs begin to eat meat, a supplement of calcium can be added (calciforte for example).
- Sick animal: the dietary requirement depends on the illness of the animal; the diet should be adjusted in consultation with the vet.

Method of feeding

Two feeds per day is sufficient, but from time –to time small enrichment feeds can take place at different intervals and in different areas (few bones, piece of meat, chicken wings...). If institutions must lock animal inside for the night, food is given indoors to facilitate the animals' timely return to the indoor area. For the keepers' safety, meat could be added to the indoor area before the gates are opened, or through a meat hatch.

If several animals are maintained together, it is recommended to separate them for feeding to avoid conflicts and injuries or dominant/dominated behaviour where the dominated animal will only eat after the dominant one has finished.

Water

Clean, fresh water must be available at all times (Clum et al., 1996) in a drinker or pool.

2.3 - Social structure



Figure 46: Pair of striped hyenas © Tallinn zoo

The social organization of striped hyena in the wild is described in chapter 1.8.4 Social behaviour. The following chapter describes the social structure and introductions in captivity.

Basic social structure

Striped hyenas should be kept in pairs. Keeping them in temporary larger groups is possible when cubs are young and not yet sexually mature (Figure 47).



Figure 47: Parents with cubs during feeding © La Barben

However, this possibility varies with the capacity of both indoor and outdoor enclosures and the behaviour of each individual. The management of striped hyenas depends on the presence of cubs and young of previous litters too. An example of management of the family group of La Barben zoo is summarized in Appendix V.

The optimum group composition is 1.1, i.e. a compatible pair. If male and female don't match, this can lead to stress and injuries. Protected visual contact between two no-compatible animals is recommended, depending on stress levels. In some cases, pairs can be put together only when the female is in *oestrus*. Keepers should monitor for signs closely and then introduce them. Because pair compatibility is sometimes difficult, it is important to study and document the success of pairings (age at pairing, age when separation with parents, etc...).

Changing group structure

The arrival of a new animal needs special attention. It is important that animals have auditory, olfactory and visual contact before being introduced for the first time. Introductions (in the same enclosure) should be made after careful acclimatization of animals. The new animal needs time to discover the outdoor enclosure alone for a few days, so they will be able to mark their territory without aggression. Keepers must be very careful and be present during first introductions and be able to separate animals if things go wrong (the keepers should be able to close a door between the two outdoor enclosures or between indoor and outdoor enclosures). It is always recommended to separate animals during the night, at least for feeding, but it is important that animals keep olfactive, auditory and visual protected contact.

Steps in the introduction process - *this applies to all introductions; the animals should be kept separated until step 4.*

1. Animals in the same indoor enclosure or multiple outdoor enclosures should have olfactory and auditory exposure to each other. If the animals are not housed near each other (i.e., enclosures on opposite sides of the zoo, etc.) they should be moved to the same exhibit area, in an adjacent enclosure.

2. Animals should be given visual contact through a mesh door (Figure 48). If at any point during this process the animals display symptoms associated with stress (e.g., pacing, diarrhoea, excessive vocalization) for more than two to three hours, the introduction should return to the previous step.
3. If animals are not already positioned adjacent to each other, they should be moved closer together (e.g., to adjacent stalls or adjacent outdoor enclosures).
4. The actual introduction (full tactile exposure) should take place in the largest enclosure available. Preferably, the enclosure should be familiar to the least the dominant animal and include ample “run-arounds” (Pilgrim and Biddle, 2013). Another solution is to put, in the same outdoor enclosure, one hyena at a time and to give them outside access alternately. Thus, they can mark their territory and get used to their future partner. The introduction of new individuals can be done during the oestrus of the female. The risk of aggression can be less likely during the oestrus because the female is possibly more likely to accept the male. If the introduction is done out of oestrus, the routine has to be adapted: for example, keepers give more food to the hyenas before the two animals meet.

Striped hyenas show their dominance by bristling, growling, having a hunched posture and their ears and tail erect (Schelvis and Spijkman, 2008; Figure 49), and females are usually dominant over males (Shoemaker et al., 2006). Aggression in striped hyenas is easy to recognize; the mane can stiffen up and bites can occur.

The use of tranquillizers to separate animals is not advised as the tranquilized animal can be injured by the other. Different methods will be described in chapter Catching/restraining. When introduction does not work with the previous methods, tranquilizers can be used in the aggressive animal to reduce its aggressiveness, at the time of habituation to each other.



Figure 48: Door between 2 indoor boxes allowing the visual contact between 2 animals at Obterre Zoo © P. Roux



Figure 49: Striped hyena with its mane erected © Schwerin Zoo

2.4 - Breeding



Figure 50: Striped hyena mating © Obterre Zoo

Mating success is especially attributed to pair compatibility in striped hyenas. A compatible pair is one in which male and female don't cause injuries to each other, even if aggression can occur from the female during oestrus. Poor success of striped hyenas breeding can often be attributed to the females' stress over visitors and/or male presence.

Mating

The pair may or may not be separated when the female is not in oestrus, depending on their behaviour. For general information about mixing striped hyenas, please refer to chapter Changing group structure. Shoemaker et al. (2006) suggested that introduction of a pair should be done when they are young – when they are adults there may be compatibility problems. A recent pair compatibility study (2020) suggested the same conclusion.

Striped hyena matings occur for 15 to 45 minutes, four to five times a day (Rieger, 1979c). The females vocalize loudly during mating. The male seems to initiate mating, getting close to the female and then standing on his back legs and wrapping his front legs around the female's body to take position. Penetration occurs a few minutes after the male rubbing his penis against the female's belly (Figure 51).



Figure 51: Striped hyenas' mating A, B, C © Augsburg Zoo; D: © Tallinn Zoo

During penetration, the male doesn't thrust his hips. At the end of the mating, the male puts one of his front legs over the female's back, keeping this position for approximately 15 seconds and then the male takes his penis out several times.

After mating, the male sits and licks his penis intensively to keep it erect. The Female licks her genital area, but not always directly after mating. Between two matings there are 15 to 18 minutes while the male still licks the genital area, back legs and sometimes shoulders. From time to time, the male sniffs the female's anogenital area (Rieger, 1979b). In some institution, the female can be aggressive during oestrus, and mating can be violent with bites from both male and female, more often from the female.

It is not necessarily advised to separate the pair before birth. It is important for future management that the pair can still be in contact (auditory and/or olfactory and/or visual) depending on the behaviour of the pair. The period of separation depends on the behaviour of the parents and the previous litters: some zoos separate the pair only a few days before birth, and others just after mating, as animals start to fight. Some other pairs are not separated at all, but enough space is given to allow the male to stay far from the female during the first few days. Therefore, it is important to keep the pair together with enough space when the female gives birth for the first time. The management should then be adapted considering enclosure design and pair compatibility.

Reproductive endocrinology as a management tool

Faeces can be collected for hormone analysis. As pregnancy is quite short, hormone analysis can be used if the female is regularly coming into oestrus but not getting pregnant/giving birth. In table 7 there is a summary of information on the reproduction of striped hyenas in captivity.

Data	Ages	Zoos
Younger female had first litter at	1 year 11 months	Nikolaev and Berlin Tierpark
Older female had first litter at	14 years	Magdeburg and Leipzig
Older female gave birth at	14 years	Magdeburg
Mean age of first litter for female	4 years	
Mean age of last litter for female	7 years	
Younger male reproduced first time	1 year 2 months	Augsburg
Older male reproduced first time	11 years 10 months	Obterre and Pelissane
Older male reproduced at	15 years 3 months	Obterre
Mean age of first litter for male	4 years	
Mean age of last litter for male	7 years	

Table 7: Information on reproduction, including the age at which female gave birth for the first time and males were known to sire a litter. Compiled by Houssaye F. (CERZA Zoo). Reproductive Parameters Report. SPARKS data current thru 26 May 2017. European Studbook.

Pregnancy

Gestation period is around 90 days, more information about gestation is found in chapter 1.7.5 Gestation period / birth rate. When a pregnancy is suspected, keepers should monitor the female for weight gain and the appearance of teats at around 2 to 3 weeks before parturition (Godefroy, pers. Com.)

The interval between two litters varies between 8 and 26 months (Shoemaker et al., 2006); and depends on whether the litter survives, if the female raises cubs by herself and if other litters are still present in the enclosure.

Birth

The female can show different behaviours which indicate she is about to give birth. This includes refusal to eat, frequent urination and spotty defecation, pacing or licking the vulva (Schelvis and Spijkman, 2008). It has been reported on pregnant striped hyena that the abdomen was “tucked”, and it had blood around its vulva during the day of birth (Schelvis and Spijkman, 2008). The best solution for the female is to let her have a choice of dens: if there are some dens with different substrates or size, she can choose the den where she feels the most comfortable to give birth.

Abi-Said (2004) reported the birth of three cubs: The female gave birth to the first cub and licked it until it was dry. She ate the placenta which was passed 25 minutes after the delivery. The birth of the second cub took place four hours after the first one and the female ate the placenta 20 minutes after the birth. The third baby was born quickly after the second one. The mother was very tired after the parturition and she remained motionless for one and a half hours, in her den, with her eyes closed (Abi-Said, 2004).

Development and care for the cubs

When cubs are born, their weight is around 600g (Abi-Said, 2004; Rieger, 1981). If it is possible, a surveillance camera monitoring the birth is the best way to check the mother’s behaviour without any disturbance or stress. Cubs start to walk at around 15 days old.

It is advised to closely monitor any abnormal behaviour from the mother such as: aggressiveness, frequently moving the cubs in her mouth, stereotypies, neglecting the cubs etc.

If a cub doesn’t suckle for 24 hours, it can be removed (but only with prior agreement from the EAZA EEP coordinator) from its mother to be hand reared (see chapter Hand rearing).

For sleeping, the mother goes into the den to be near her cubs. If the cubs can easily be separated from their mother, daily weights should be obtained to check on the normal growth of the animals. A normal daily weight gain means that diet is adapted to the cubs (Figures 52 to 57). For feeding cubs, please see the chapter ‘Hand rearing’.

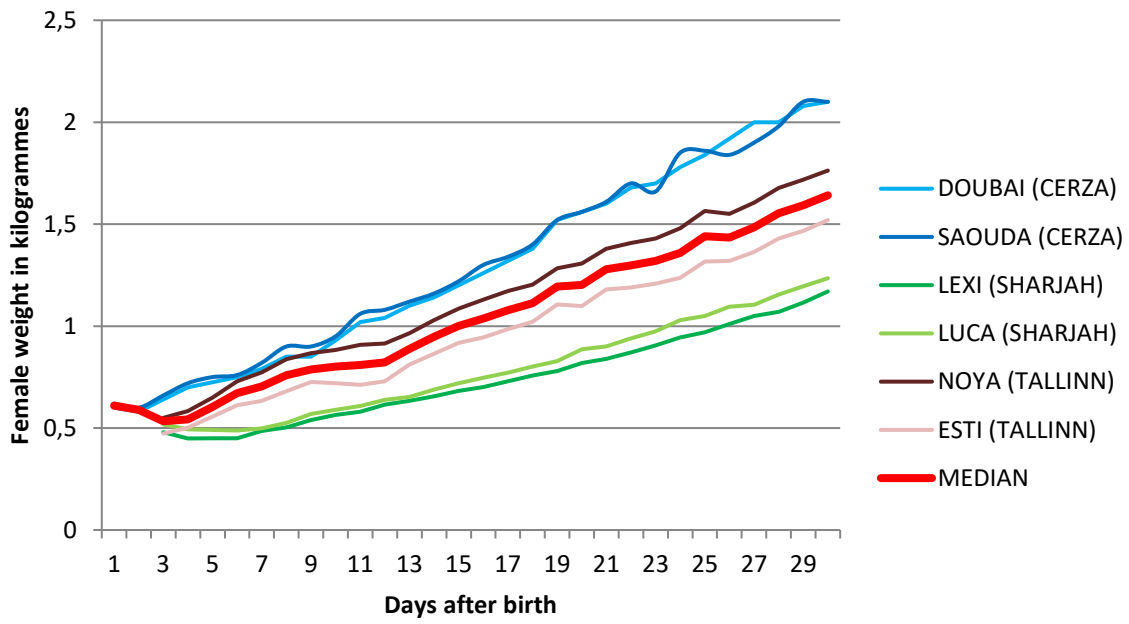


Figure 52: female weight gained during the first month

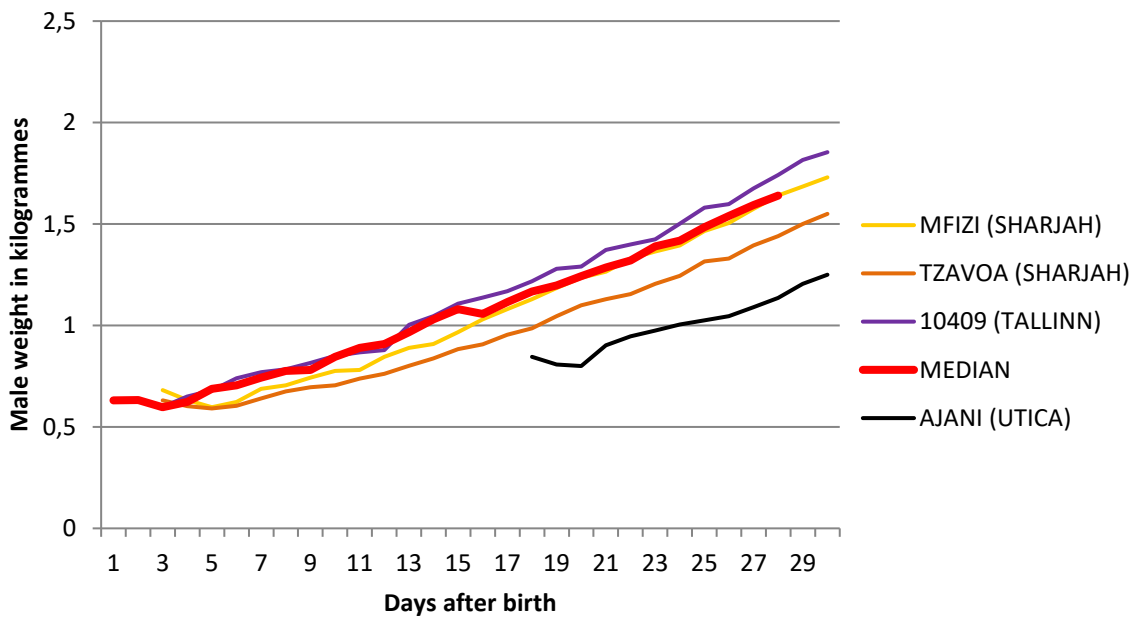


Figure 53: male weight gained during the first month

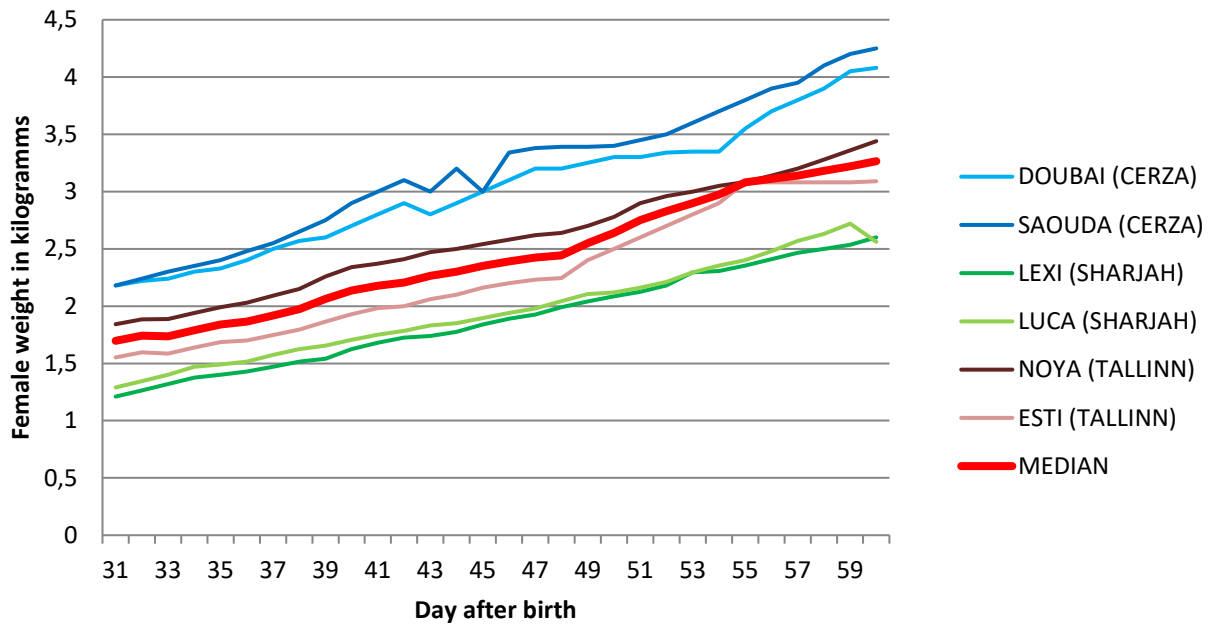


Figure 54: female weight gained during the second month

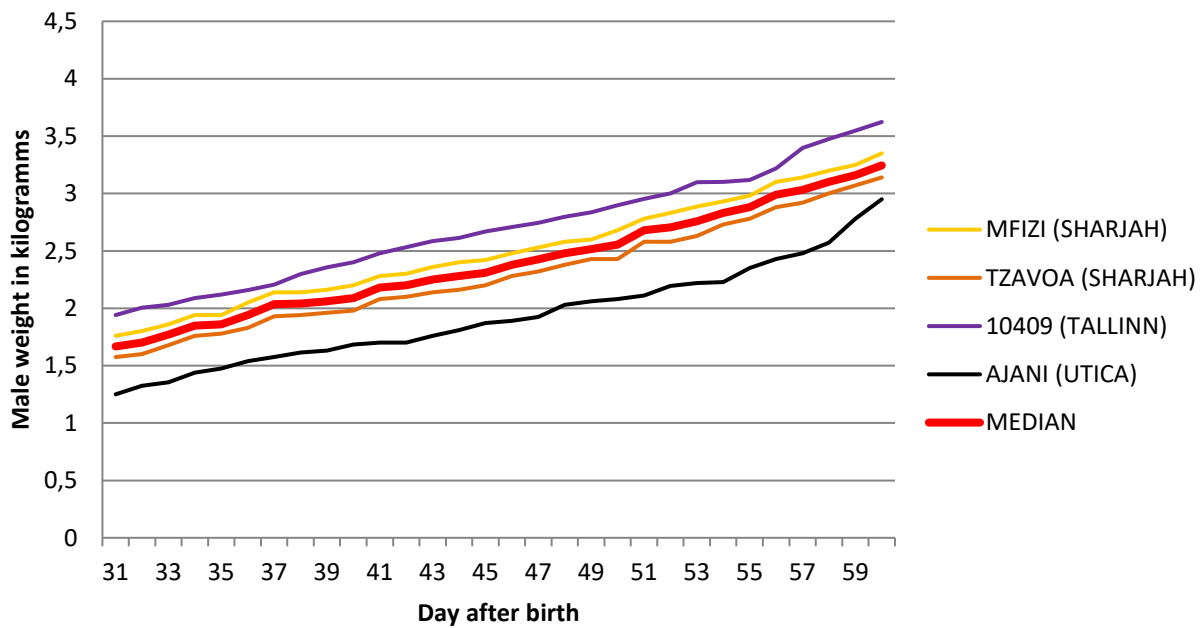


Figure 55: male weight gained during the second month

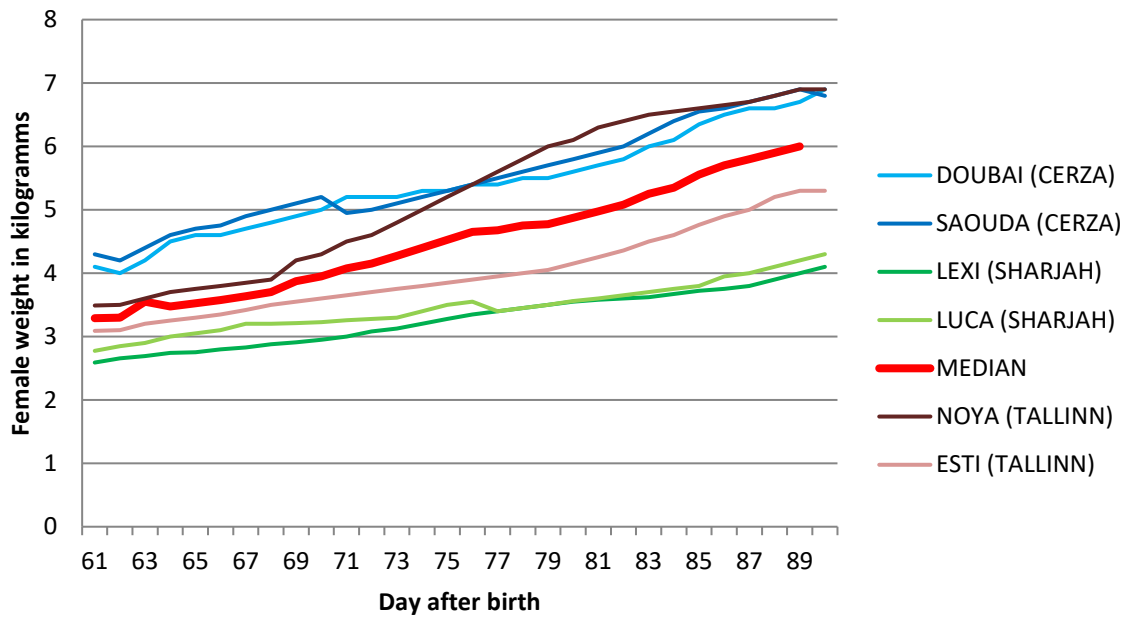


Figure 56: female weight gained during the third month

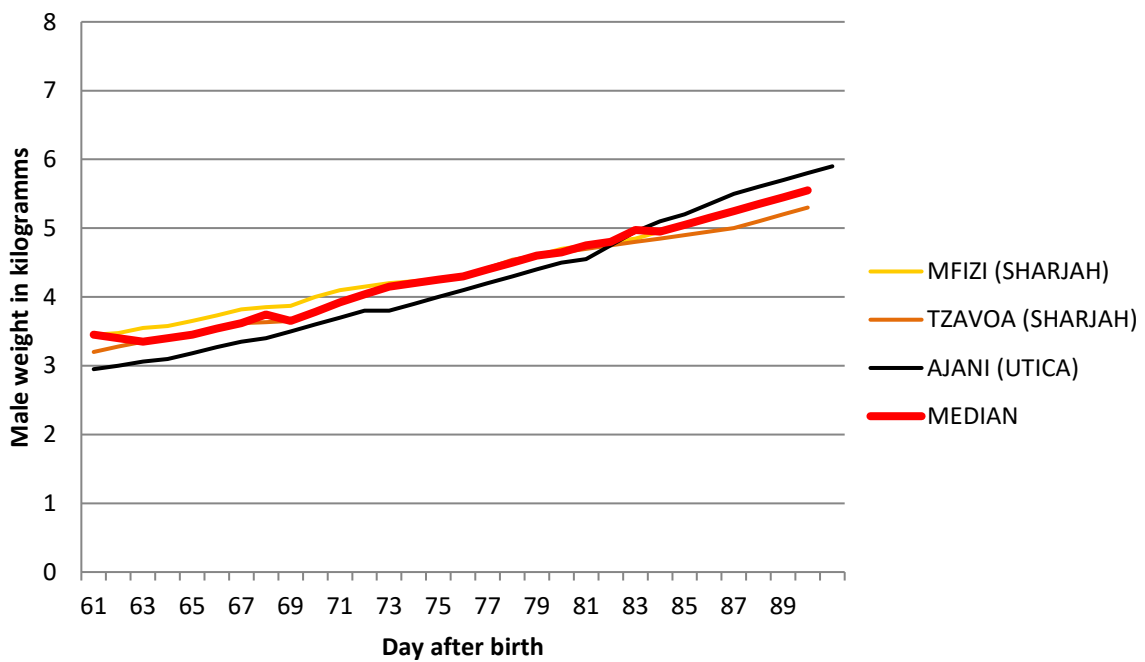


Figure 57: male weight gained during the third month

Hand rearing

Hand rearing should occur only in special cases, and only with prior agreement of the EAZA EEP coordinator. The striped hyena generic population needs to learn how to breed and rear cubs by itself by providing the best conditions to help ensure natural breeding success. For striped hyenas which belong to a subspecies well established, hand rearing can be done to improve and preserve genetic diversity. In all potential cases, please contact the EAZA EEP coordinator to discuss.

- **Record keeping:** it is very important to collect/keep/share data about the cubs' development. Data should be collected daily and include: feeding formula, body weight, body temperature, and consistency of faeces. Body weight should be collected daily at the same time. As the young grow, weighing can be spaced out. After the birth, the cubs loose weight: this is a physiological reaction, but the loss should not be more than 5% of bodyweight. When a cub loses more than 10% of its bodyweight, it is considered undernourished (Blanc, 2007). Noting down behaviour and development changes can be useful too. All observations should be sent to the EEP coordinator.



Figure 58: Cubs under heat lamp © CERZA zoo

- **Housing:** To keep the cubs healthy, the room where they are being kept must be warm enough and without drafts. A heater is not necessary if the temperature doesn't drop below 15°C (day and night). Otherwise, a heat lamp can be used (Figure 58). As substrate, straw and hay can be used. Sand and wood shavings should be avoided due to the risk of ingestion. For physical development, cubs should have a place large enough to move and get up on their feet when they can. Litters should be kept together and not separated. When cubs grow, it is important to have an exercise yard available to encourage them to explore and run.

Toys should also be provided to encourage exercise and develop natural behaviours such as hunting and chewing, as this **cannot** be provided by keepers for safety and animal welfare reasons.

- **Milk composition and formula selection:** we do not have any data on striped hyena milk, but it is known that carnivores have superior needs in lipids over glucids. For hand-rearing, Milkodog™ is used, as the digestive system is the same as a dog's (Appendix VI) and Milkodog™ seems more adapted for hyenas



Figure 59: Striped hyena cub fed with a baby bottle © Terra Natura Murcia

than TVM™, which could contain potentially allergenic elements (Blanc, 2007). Before giving artificial milk, it is recommended to drain the stomach of the potential milk of the mother. To do this, it is necessary to give the cubs rehydrating liquid with electrolytes during the first two feedings. The more the cub grows, the more the milk has to be concentrated but the change has to be very gradual, and the same concentration should be used during several feeds in a row.

Depending on the age of the cub, the number of meals varies. The cub will feed every three hours for the first week and then the frequency of feeds can decrease to every four hours. After five weeks, meat can start being included in the diet. Made-up formula should be refrigerated and replaced every 24 hours.

Each bottle should be heated before feeding to a temperature of around 37°C (Figure 59).

Below are some examples of hand-rearing protocols for striped hyenas at Nikolayev Zoo (table 8), Tallinn Zoo (Table 9) and CERZA Zoo (Tables 10).

- **Urogenital stimulation:** After the first feed, the faeces are yellow/orange in colour. Defecation can be stimulated with a warm moistened glove or cotton swab to mimic the licking of the mother. It has been noted that it is better to stimulate hyenas to defecate before their first meal; it appears to give them some appetite. Hyenas should be stimulated to defecate until the five weeks of age. (Blanc, 2007).

- **Constipation:** If the cub doesn't defecate for a while, any oil can be given to help the intestinal transit. ProBios™ is recommended in hand-reared Cheetah (Grant, 2004). This product contains vegetable oil that may help cubs prone to constipation. The dose is given directly into the mouth of the cub. The goal of ProBios™ is to ensure that there is an adequate population of lactose-consuming bacteria in the gut. When milk represents more than 25% body weight, it seems to start to cause diarrhoea.

Days	Number of feedings per day	Composition of the meal	Details
1 st -5 th	8 to 9	15 to 40g of cow milk per meal (200 to 300g per day)	1 st day: the milk is diluted with 1/5 camomile water
6 th -14 th	7 to 8	30 to 40g of cow milk per meal (300g per day)	
15 th -18 th	6 to 8	50 to 60g of cow milk per meal (350g per day)	
19 th -20 th	6 to 8	50 to 70g of cow milk per meal (400 to 450g per day)	
21 st	5 to 6	Start of the supplemental feeding with semolina cooked in the milk. At 23 th day, only cooked semolina (milk is excluded). 1 calcium gluconate tablet and 1 or 2 drops of Tetravit per day. Start adding (during a fortnight) hen's yolk (from ¼ to the whole egg a day). Semolina recipe: Milk 200g + 1 teaspoonful of semolina+ 1 teaspoonful of sugar.	
21 st -39 th	5 to 6	60 to 80g of semolina per meal (300 to 350g per day)	At the end, hen's yolk is not given anymore
40 th to 60 th	3 to 4	100 to 150g of semolina per meal (400 to 450g per day) + 20-30g of cottage cheese.	The cottage cheese is added in the diet
61 th to 70 th	3	150 to 200g of semolina per meal (400 to 450g per day) + 20-30g of cottage cheese	meat is added in the diet: mix up finely cut boiled chicken meat
From 70 th	2	<u>1st meal</u> : 50g of boiled semolina in 600g milk and 10g of sugar. <u>2nd meal</u> : Meat: boiled chickens with bones. Then, gradually, cubs eat raw chickens. At the end they are accustomed to raw beef and horseflesh	
4-5 month old	1	<ul style="list-style-type: none"> - 300 to 400g of meat per day - 600g milk + 50g manna groats + 10g sugar - 50g cottage cheese, 1 egg, 50g apple - 5g vitamin 	Apple is crumbled and mixed with the cottage cheese and the egg
6 month old	1	The same as during 4-5 month except for the meat (500 to 700g per day) and for the cottage cheese (100g).	
7 month old	1	<ul style="list-style-type: none"> - 1 kg of meat with bones - 500g of milk - 200g of cottage cheese - 200g of fruits, 50g of beet root - 50g of carrot, 50g of cabbage - 10g of vitamin 	Fruits and vegetables are crumbled and mixed with the cottage cheese and the egg

Table 8: Hand rearing protocol at Nikolaev zoo

Days	Number of feedings per day	Composition of the meal	Details
13-14 th	Every 2-2,5 hours	40g of goat milk	
15-17 th	Every 3 hours	50g of goat milk	
18-23 th	Every 3 hours	Yolk of quail eggs added to the diet, one for each cub	
24-26 th	Every 3 hours	Yolk of quail eggs twice a day (12h between both)	
27-28 th	Every 3 hours	50 ml of milk + 10 ml of rice porridge	Night break of 6 hours
29 th	Every 3 hours	Rice porridge + oatmeal 1:1	
30-35 th	Every 3 hours	Calcium in powder is added to the diet	
36 th	Every 3 hours	Pieces of meat are added to the diet (2/day)	
41 th	Every 4 hours	120 ml of porridge	
48 th	Every 4 hours	70g of meat per feeding	
2 month and half old		Chicken is added to the diet	
4 month old		Living animals are added to the diet: chickens, quails or guinea pigs	

Table 9: Hand rearing protocol at Tallinn Zoo © K. Ashford

Days	Number of feeds	Composition of the meal
1		Few ml of Biodiet
	Every 3 hours	25 mL Biodiet + 25 ml Milkodog + X
2	Every 3 hours	17 mL Biodiet + 35 ml Milkodog + X
4	Every 3 hours	17 mL Biodiet + 35 ml Milkodog + X
	Every 3 hours	25 mL Biodiet + 25 ml Milkodog + Y
	Every 3 hours	35 ml Biodiet + 17 ml Milkodog + 1ml Kaopectate if diarrhea
5	Every 3 hours	35 ml Biodiet + 17 ml Milkodog + 1ml Kaopectate if diarrhoea + Y
	Every 3 hours	Increase Milkodog concentration during the day until 17ml Biodiet + 35 ml milkodog + Y
6	Every 3 hours	17ml Biodiet + 35 ml milkodog + Y
	Every 3 hours	13 ml Biodiet + 39 ml milkodog + Y
8	Every 3 hours	13 ml water + 39 ml milkodog +Y
9	Every 3 hours	17ml Biodiet + 35 ml milkodog + Y
10	Every 3 hours	X
12	Every 3 hours	X* + 320 ml water
17	Every 3 hours	If diarrhea : just Biodiet
23	Every 3 hours	Z
28	Every 3 hours	Z + mixed duck heart
36	Every 4 hours	Introduction of dish with few drops of milk
39	Every 4 hours	250 ml feeding bottle: 15 g mixed dog food + milk + 2/3 water
41	Every 4 hours	Z + 1 to 2 tea spoon dog food

Table 10: Hand rearing protocol at CERZA Zoo

- X: 39g butter + 2g petphos + 32g casein.
- X*: butter is replaced by oil.
- Y: no more casein, replaced by mixed chicken.
- Z: 49g Milkodog + 32g oil + 1g petphos + 32g chicken breast.
- **Biodiet®**: Rehydrating product with glucose, which furnish energy and favors the absorption of water (Michel, pers.com, see composition at Appendix VI).
- **Kaopectate®**: Gastric demulcent, to treat diarrhea.
- **Sofcanis®**: Food complement for vitamins and minerals.

Weaning begins at around 20 days old and should be completed at around 60 days. Like most of the carnivores, weaning is a short process, which has to be monitored by regular body weighing.

Problems: Some problems can arise during the feeding of the cubs; they are summarized in the Table 11 (Blanc, 2007).

Problems	Causes	Solving
Diarrhoea		When the first signs of diarrhoea appear, give 1 or 2 bottles with only electrolytes. Come back to 1/3 of water and 2/3 of milk for 2 meals. If the aspect of faeces is better, increase the concentration of milk and observe the development of faeces. If the aspect of faeces is correct, come back to 1/3 of water and 2/3 of milk
Constipation	The milk is too concentrated: the percentage of dry matter is too high	Decrease of the percentage of dry matter. The effect is not immediate: according to the frequency of meals, the effect echoes on the faeces after 2 or 3 meals
Too low growth rate	Too low protein intake	From 2 weeks, add a mix of beef and chicken meat to the milk

Table 11: Summary of problems which can occur during hand-rearing

At the beginning of hand rearing, it is necessary to be very watchful of the composition and the dilution of the milk: this parameter is very important, and it has an influence on the weight gain and the consistency of faeces. The first month is the most complicated, often with a lot of diarrhoea episodes but after one month and the introduction of meat in the food, there is an improvement of the consistency of faeces, (Blanc, 2007).

Population management

In Europe the captive population of striped hyena is managed under an EAZA Ex-Situ Programme (EEP). In Europe, there are mainly four subspecies of striped hyenas kept in zoological collections. The numbers given correspond to the population in 2024:

- 11.14 *Hyaena hyaena sultana* (originate from Arabian Peninsula) which are present in 5 zoos;
- 7.4 *Hyaena hyaena dubbah* (from North East Africa) kept in 8 facilities
- 1.2 *Hyaena hyaena syriaca* (from Syria, Asia minor and Caucasus) kept in 3 zoos
- 3.0 *Hyaena hyaena hyaena* (from Indian subcontinent) in 1 institution.
- 24.23.1 *Hyaena hyaena* ssp (generic, hybrid or with unknown origin) in 26 zoos.

Due to lack of breeding success, it is important for all holders to breed their hyenas. The goal is to keep the population demographically healthy and to then concentrate on the genetics. Breeding generic hyenas will help zoos to gain experience and thus later concentrate on *H. h. sultana*. The reproduction of striped hyena is at this time (2024) not restricted.

Contraception

There is currently (in 2020), no reproductive control in striped hyenas. There are so few births that all striped hyenas (pure subspecies and unknown or hybrid) are allowed to breed.

However, with the creation of the EAZA RMG (Reproductive Management Group) information on contraception is more and more known. There are non-reversible methods and reversible methods (Schelvis & Spijkman, 2008).

- Non-reversible method: Surgery can be used to stop reproduction (Shoemaker et al., 2006; Schelvis & Spijkman, 2008).
 - Ovariohysterectomy of females
 - Male castration

The non-reversible method is not usually used in the EAZA EEP because it is non-reversible – an individual who is not needed for breeding at one time can be interesting in the future, for example to mate with a new animal coming into the programme.

- Reversible method:
 - Contraceptive implant: Different contraceptive implants are known: MGA-implant, Depo-Provera, Norplant, Megace or Ovaban.

They can be used safely but they should not be used for more than 2 years without a pregnancy. The pregnancy reverses possible deleterious uterine effects of the contraception.

- Physical separation: Male and female are separated in two different enclosures.

The social structure can be impacted by this method of contraception; it can lead to a change of dominance, the rejection of an individual or the improvement of conflicts between individuals.

Options of population management such as contraception, sterilisation etc. might be added in a future edition of these guidelines if the population situation would warrant this.

2.5 - Behavioural enrichment



Figure 60: Ice cube with fruits hung on a tree © Bratislava Zoo

Allowing animals to express natural behaviours is very important for their well-being, and it is especially important for hand-reared hyenas which are not able to learn by experiencing adults carrying out these behaviours. It has been proven that zoos that provide enrichment have hyenas that show less stereotypies than other institutions. Some stereotypic behaviours in captivity in striped hyenas has been identified (Schelvis and Spijkman, 2008):

- Pacing: the animal walks continually back and forth or in a circle
- Bar biting: the continual biting of walls, bars or gates in an enclosure
- Over-grooming and self-mutilation: Self-inflicted physical harm, such as biting or chewing tail or leg, or grooming to an excessive extent, pulling out hair, often leaving bald patches, irritated and broken skin.
- Head swinging

Moreover, increasing well-being will decrease the risk of abnormal and injurious behaviour, to have obesity or apathy issues, and to fulfil the natural needs of the animals. It can also be an opportunity to improve visitor's interest in this unrecognized animal, to educate on striped hyena conservation, facilitating potential donations for conservation in nature.

There are different ways to provide enrichment:

- Variety of substrate in the enclosure as vegetation, rocks, wood, topography and shaded places. As hyenas can be aggressive to each other, a place to hide or to be in a quiet place are appreciated and decrease the level of stress (as mentioned in Outdoor furnishing and maintenance).
- Herbivore dung can be thrown in and scattered in different places in the enclosures. Hyenas enjoy it a lot and roll themselves in it.
- Various objects can be used on the condition that they are absolutely safe for the animals.
- Food enrichment: keepers can hide some food around the enclosure; this would stimulate hunting and smelling capacities. Food can also be hung in a tree to make it more difficult for the hyenas to access it (Figure 60). Food items can vary, such as meat, fruits and bones. If little pieces of meat are dispersed in the enclosure, it is necessary to be watchful to place meat at different places to avoid conflicts between animals and to allow dominated individuals to have access to food. When enrichment with meat is provided, the food intake must be adapted to avoid over-feeding.

Generally, when keepers want to provide enrichment to hyenas the most important parameter to take into account is that these animals have a lot of strength in the jaws and that they can destroy most objects they have access to. We must therefore avoid all enrichment which can be broken into little pieces because hyenas can ingest these pieces which can lead to health problems. Environmental enrichment can be achieved with branches, shelves and trunks to allow hyenas to show natural behaviours (e.g., scent marking) as often as possible.

For example, table 12 summarises enrichment provide by keepers to striped hyenas at Utica Zoo.

Enrichment type	Enrichment description	Age group	Comments and pictures
FOOD ENRICHMENT	Apple sauce	A/J	
	Cereal	A/J	In small quantity if it contains
	Food colouring	A/J	Monitor for allergic reactions
	Freeze-dried crickets	A/J	
	Hardboiled egg	A/J	With or without shell
	Honey	A/J	
	Jell-O	A/J	
	Live minnows	A/J	
	Meatball snowman	A/J	
	Molasses	A/J	
	Fish live, frozen or culled	A/J	
	Peanut butter	A/J	
	Pop corn	A/J	Without salt
	Pumpkins	A/J	Piece or whole
	Whole melon	A/J	
	Yogurt	A/J	Low sugar and low fat
	Legs of prey	A	
	Whole chicken with feathers	A	
	Cinnamon Apple Baked	A/J	
	Cooked pasta	A/J	
	Timothy hay	A/J	
	Ice cube with meat or scent	A/J	
	Feathers	A/J	
	Herbivore hay	A/J	
	Wool	A/J	
	Snow	A/J	
	Basil	A/J	
	Cilantro	A/J	
	Cinnamon	A/J	
	Crepe paper	A/J	Hung or scented with food
	Garlic powder	A/J	
	Ground cloves	A/J	
Nutmeg	A/J		
Paprika	A/J		
Parsley	A/J		
Peppermint	A/J		
Vanilla extract	A/J	Diluted, imitation only	
Ball with pellets inside	A/J		
STRUCTURAL ENRICHMENT	Black sewage pipe	A/J	To be used over tree trunks, not free standing
	Coconut with shell	A/J	
	Large barrel	A/J	
	Sprinklers	A/J	Keep hoses out of reach, sprays

	Cardboard	A/J	
	Lure	A/J	
	Egg cartons	A/J	
	Large seamless boomer	A/J	Watch for chewing
	Paper bags	A/J	
	Phone book	A/J	
	Topsoil	A/J	
OTHER ENRICHMENT	Bubbles	A/J	
	Tempura paint	A/J	
	Pine cones	A/J	
	Paper mâché	A/J	
	Animal sounds	A/J	
	Audio of native wildlife	A/J	
	Chalk drawings	A/J	
	Hand puppet	A/J	With keepers
	Perfume	A/J	
	Video	A/J	
	Hay/straw	A/J	
	Straw from ungulate stables in bag	A/J	
	Antlers of ungulates	A/J	
	ENRICHMENT FOR NEWBORNS	Octopus without plastic	NB
Kong wubba		NB	
Teether toys (dog grade)		NB	

Table 12: List of enrichments provided to striped hyenas at Utica Zoo (A: Adult, J: Juvenile, NB: Newborn).

2.6 - Handling



Figure 61: Identification of a young striped hyena with a microchip © La Barben Zoo

General handling

No direct physical contact should be done with striped hyenas. Otherwise, regular visual contact and familiarisation with keepers should decrease the animals' stress. For information about safety precaution, please refer to chapter Safety.

Individual identification and sexing

Methods for individual identification are to note all physical information useful to recognize the animal such as scars, colour, markings, and the use of a transponder. Individual characteristics can be captured by photographs. This information should be sent to the new institution if the animal has to be moved, as well as to the EEP coordinator. Use of transponders is the best way to identify an animal and is obligatory for all institutions; they should be placed between the shoulder blades (Figure 62). Transponder identification number should be communicated to the EEP coordinator and recorded on ZIMS.



Figure 62: Putting in transponder between the shoulder blades (on the left) and reading of the transponder (on the right) © La Barben Zoo

Contrary to spotted hyena cubs, it is very easy to identify the sex of striped hyena cubs. The sexing can be done at the age of 8 weeks. The distance between the anus and the reproductive tract allows to determine the sex of the young hyena: this distance is much greater in males than in females (Figure 63).



Figure 63: A young male (A) with a zoom of the anogenital distance (B) and a young female (C) with a zoom of the anogenital distance (D) © La Barben Zoo

Catching / restraining

For veterinary exams, striped hyenas must be restrained in a safe way to guarantee safety for keepers and animals. The first step is to get hyenas into the inside facilities, as there are bars to separate keepers and animal. Even if the exam is just visual, it can be easier to get the animal into this restricted area, as it can't move too far or too fast. Bars can be made of steel or aluminium. To manage to get the animal inside, they need to get used to the indoor facility by making them going indoors every night or from time to time with a reward.

Cubs less than two months old can be manually restrained for minor procedures. Hyena cubs between 2 and 6 months should be placed in a squeeze cage. If hyenas are older than 6 months, drugs must be administered to the animal to carry out a physical examination. To see a few examples of anaesthetic protocols please refer to section Considerations for health and welfare.

To ensure animal and personnel safety, a few steps should be in place:

- Reversals of the anaesthetic drug are prepared in advance in case it needs to be administered quickly.
- Monitoring of the animal from the moment it is anesthetised (ECG, temperature, auscultation etc...) to detect a potential problem as quickly as possible.

Training

It can be beneficial to accustom striped hyenas to a few keepers for the daily management of this species and for other events like changing of enclosure, contact between new individuals or crating. Some zoological parks train their hyenas to facilitate daily management. For example, at Tallinn Zoo, keepers train their hyenas to come to places where keepers need the animals to be, or to come close to the fence for visual inspection of the animal. Tallinn Zoo has good results with banana as a food reward.

Here are some situations that Zoo de la Barben (France) trains their striped hyenas on:

“Come”: *palm of the hand towards the animal, finger down*. When “come” is said, the animal should come up to the keeper. When the animal arrives to the palm, the keeper must snort and reward (figure 64).

“Target”: *present a target where the keeper wishes the animal to come to*. The hyena should come and touch the target with its nose and stay a few seconds (Figure 65).

“Touch”: The keeper must prepare the hyena that it will be sprayed/touched. Once the hyena is in "target", the keeper can spray the hyena or touch the underside of her legs with his/her fingertips (Figure 66).

“Down”: *outstretched hand, palm facing the ground*. The keeper accompanies the animal's movement by kneeling with it. The hyena must lie down completely (Figure 67).

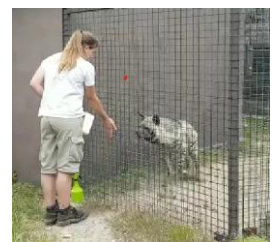


Figure 64: “come”



Figure 65: “Target”

“Stay”: *palm down, hand tilted slightly up.* “Stay” follows the “Down” command. Once the hyena lies down completely the hyena should stay a while, even if the keeper moves (Figure 68).



Figure 66: “Touch”



Figure 67: “Down”



Figure 68: “Stay”

Crate training

Crate acclimatisation usually takes around 1 week, depending on the animal and the trust with its keepers. The best way is to introduce a crate in an empty box adjacent to the box of the animal which must be in the crate. Food should be placed inside the crate, to accustom the animal to going inside without closing it to allow the hyena to get in and out freely. Food can be placed deeper in the crate every day to get the animal used to being inside the crate. Getting the animal used to being inside with the bars shut is not necessary; institutions can close them just on the day of departure. Forcing animals to go into the crate is not recommended.

Transportation

Striped hyenas can be transported by plane or truck in a crate, depending on the duration of the journey and the least stressful means for the animals. Precautions must be taken to avoid problems such as injury, destroying of crate materials and hyper/hypothermia. For transportation periods up to 24 hours, hyenas don't need additional feeding or watering (Shoemaker et al., 2006). If the period is longer, canned dog or cat food can be offered. This provides for fluid needs as well as feeding needs.

Straw must be added to the crate to provide comfort and for absorption of faeces/urine during transportation. Hyenas can be safely transported without staff accompanying them.

Truck: Temperature and conditions inside the truck should be controlled at all times to ensure it is not too hot, too cold, and windy.

Airplane: “The International Air Transport Association (IATA) has made the IATA Live Animals Regulations (LAR). These Live Animal Regulations are a Worldwide Standard for transporting live animals by airlines. The objective of the IATA Live Animals Regulations is to ensure that all animals are transported safely by air, whether it is to transport a pet, an animal for zoological or agricultural purposes or for any other reason” (IATA, 2007).

The IATA LAR works with the Convention International Trade in Endangered Species of wild fauna and flora (CITES) and the Office International of Epizooties (OIE). This programme is

recommended and used by Europe for international transport of farm animals. A bigger number of countries accept these regulations in their national legislation, and shipping become illegal and would be punished by law.

Material and dimensions of the transport box/crate: Materials usually used are solid wood or metal parts bolted or screwed together. If wood is used, the inside must be made of hard metal sheeting with ventilation holes cut into it. If the total weight of the container and animal exceeds 60 kilograms, metal bracings must be added to the frame and forklift space bars provided (IATA, 2007). Crates should be large enough to allow the animal to stand naturally. The height needs to be sufficient for allowing the animal to stand in a natural position with its head extended (IATA, 2007). Animals should be allowed to comfortably lie down and to turn around.

The front of the crate must be made of steel mesh with a diameter straight enough to prevent the animals protruding their nose or paws outside. The door has to be safely locked, so that it cannot be accidentally opened. The total ventilated area must be 20% of the transportation crate (Shoemaker et al., 2006). If the animal is transported by another way other than air, the crate should still mimic the IATA recommendations. Striped hyena can be transported in crates with the following dimensions: 120x60x75cm (LxWxH) see figure 69.



Figure 69: Crate for striped hyena © CERZA zoo

The temperature must not go below 0°C, except if the animal is protected from wind and after a period of acclimatization. Striped hyenas must be transported in individual crates because their aggressive nature does not allow them being transported in groups (Shoemaker et al., 2006).

Safety and stress

To avoid stress of hyenas and increase the safety of keepers, it is advised that hyenas are used to only a few keepers. Even if keepers should not get in direct contact with hyenas, it is important that hyenas are confident with their keepers.

Stress can be shown by excessive aggressiveness toward keepers, a fence, and other hyenas. There are several sources of stress for striped hyenas which should be avoided: non-compatibility of pairs, non-adapted enclosures, environment (public, machinery, other animals...), physiological period (pregnancy, oestrus, and lactation), and total separation of the pair. Stereotypical behaviour is also considered evidence of stress.

2.7 - Considerations for health and welfare



Figure 70: Vet stitches up the ear of hyena © Sir Bani Yas

There are no particular diseases for this species in captivity. A few isolated cases of alopecia and tumour have been reported but it seems to be specific to animal or enclosures conditions. In EAZA institutions, it seems that dental and reproductive disorders are the most frequent medical issues in this species (Vet Survey 2022). Moreover, wounds from conspecific aggressions seem to be also common. Since the EAZA population is aging with a low reproduction rate, geriatric issues will become more common. It is difficult to examine a striped hyena when it is conscious because the animal could be stressed it can have an abnormal posture or be totally prostrated in the presence of a vet. The best way to visually examine the animal is with a camera, which doesn't induce stress for animals. Medical training is more and more used in zoos to get the animal closer and to better see its shape and potential injuries.

Medical procedures

Vaccination

An annual vaccination is recommended against Canine distemper (Joslin et al., 1998). However, some zoos prefer to vaccinate their striped hyenas against Feline distemper. Other vaccinations can be recommended according to the country where hyenas are kept: rabies, adenovirus type 2, parvovirus, parainfluenza...

A combination of canine distemper, adenovirus, parvovirus, parainfluenza and leptospirosis is the most used vaccination protocol in EAZA institutions (Vet Survey 2022). Striped hyena vets should be familiar with the vaccines they administer, and it is better to use only killed or recombinant products, since modified live virus vaccines may cause vaccine-induced disease. Any adverse reactions should be reported to the EEP veterinary advisor so that this information can be disseminated to other institutions housing hyenas.

Dewormers

The majority of zoological institutions use dewormers to protect their hyenas. Some of them use disinfectants in addition to dewormers. Parasite control is recommended at least annually.

Blood collection (Lécu, 2000):

For the striped hyena, sites of blood collection are the same as for other large carnivores:

- Cephalic vein: it is large, a needle of 0.8mm can be used.
- Jugular vein: for this vein, it is recommended to use the caudal 1/3 because in the cranial part, the jugular vein is hidden by hypertrophied brachiocephalic muscles.
- Femoral vein: blood collection is not very easy in this vein but laying the animal on its back and with the posterior paws apart, it is possible to take blood in the inguinal sinus.
- Saphenous vein

Urine collection (Lécu, 2000):

For this manipulation, the catheter has to be between 1.8 to 2 mm of diameter and 40 cm of length.

Anaesthesia protocol (Lécu, 2000):

There are not particular problems for the anaesthesia of Hyaenidae: they tolerate well the active compounds widely used. The best way to inject anaesthetics is with a hypodermic gun, which reduces the stress of the animal. The neck or the shoulders are the best place to inject the anaesthetic. The recommended length of the needle is 30 mm.

A major problem can occur when the animal wakes up: for example, ketamine causes an improvement of reflexes of the hyena which can be dangerous for itself: it could provoke lesions on the face or on the tongue if the animal hits its head on the floor. To avoid this problem, myorelaxants can be used.

Anaesthesia can also be done orally, by adding an anaesthetic in meat bait. The time of induction and the stage of anaesthesia are not the same depending on the protocol used.

In EAZA institutions, the combination of Ketamine, Medetomidine and Butorphanol is the most common used protocol with great success (Vet Survey 2022). Examples of different anaesthesia protocol for striped hyenas are summarized in the table 13.

Products	Doses	Comments
Telazol® (Tiletamine Hydrochloride + Zolazepam Hydrochloride)	0.85 to 7.14 mg/kg	Use for « ketamine reactors »
Xylazine Ketamine	0.33 to 3.2 mg/kg 3.2 to 13 mg/kg	Reversion of the xylazine by yohimbine or atipamezol (Hahn and al. 2007)
Zoletil® (1mg Zolazepam/1mg Tiletamine)	4 to 6 mg/kg	Non reversible 12mg/kg had been used without problems
Xylazine	8mg/kg	
Phencyclidine Promazin	1 mg/kg 0.5 mg/kg	
Ketamine Telazol®	1.36 to 11.42 mg/kg 1.95 to 4.66 mg/kg	
Zolazepam hydrochloride	4 to 10 mg/kg	
Ketamine Medetomidine	8 mg/kg 2 mg/kg	

Table 13: Different anaesthesia protocols used for striped hyenas

Complications can occur during anaesthesia with these products (Hahn et al., 2007):

- Xylazine can induce emesis, bradycardia and loss of temperature control. Bradycardia can be compensated by atropine and other side effects can be prevented by yohimbine.
- Ketamine can induce excessive salivation, rigidity, twitching and hyperthermia which can be reduced the atropine.

For long- and major surgeries, hyenas are catheterized, intubated and maintained on isoflurane anaesthesia (1%-2%). To reverse the effect of anaesthetic products, vets can use different antagonists:

- Atipamezole (0.1 to 0.2 mg/kg intramuscularly)
- Yohimbine (0.11 mg/kg intramuscularly)
- Tolazoline (0.5 to 1.0 mg/kg intramuscularly)

Analgesia (Hahn and al., 2007):

Analgesia is always provided following major surgeries and dental procedures. Different analgesia products can be used:

- Buprenorphine (0.01 mg/kg subcutaneously or intramuscularly) is administered at the time of intubation and repeated following the end of surgery.
- Etodolac (10 mg/kg, Etogesic) can be given orally, once daily in food.

Transfer and pre-shipment suggested tests:

Every time that an EEP transfer is recommended, diagnostic testing for determining the health of these animals should be considered. A complete medical history should be sent to and reviewed by the receiving institution's vet, and vet advisor and EEP coordinator will always be available to discuss it.

A good pre-shipment examination should include:

- Complete physical examination
- Bloods: (CBC) and biochemistry profile
- Faecal examination: parasitology and bacteriology

If not vaccinated:

- Viral serology for: Canine distemper, parvovirus and rabies at least.
- Test for: *Dirofilaria immitis*, *Leptospira* spp., *Toxoplasma gondii*.

If possible:

- Radiographs: thoracic, abdominal radiographs.
- Ultrasound: examination of the reproductive tract is recommended for animals with breeding recommendations.
- Complete dental examination.

Diseases

Reproductive pathologies (Lécu, 2000):

In captivity, females can present metritis and pyometers: this may be due to the presence of sharp spicules on the penis. Hyper-sexuality in captivity could be a problem and can provoke lesions on the terminal part of the female's genital system and lead to infection.

Infectious pathology (Lécu, 2000):

- Bacterial infection: in hyenas, we can find bacterial infections known in wild carnivorous. There are two kinds of bacterial infection: *Salmonella* and *Leptospires*. A treatment with antibiotics is easily feasible and it doesn't lead to secondary effects.
- Viral disease: as all mammals, hyenas are sensitive to rabies. The vaccination is done with a killed vaccine, but we don't have any idea of its immunological effect. In 2021, a spotted hyena was tested positive for Sars-CoV2, thus presumptively even striped hyena could be susceptible. However, no illness was described in the positive spotted hyena.

Disorders

Parasites (Lécu, 2000):

Hyenas can present with different kinds of parasitisms:

- Protozoa: We can find two different kinds of Protozoa in hyenas:
 - Trypanosomiasis, in which exists in two genders:
 - Nannomonas (*Trypanosoma congolense*)
 - Trypanozoon (*Trypanosoma brucei*)
 - Hepatozoon, carried by ticks
- Helminthosis:
 - Toxascaris
 - Strongyloids
 - *Taenia*
 - *Spirocerca*

Signs of infection by one of these helminthosis are weight loss, diarrhoea and vomiting. To avoid contamination, different dewormers can be used: benzimidazols (flubendazol, fenbendazol), levamisol and niclosamid. Some other parasites had been found in striped hyenas such as *Babesia*-like spp, *Dipylidium caninum*, *Macracanthorhynchus catulina*, *Mesocestoides* spp, *Tchadorynchus quentini*, *Trichinella spiralis* (Fowler et al., 2003).

- External parasites: ticks, mallophaga and lice are usually found on the hyena's fur. To decrease the apparition of these parasites, the creation of a muddy place is a good solution and facilitates the deworming of hyenas by themselves. Another solution is to use a veterinary insecticide. Like many carnivores, striped hyena can be affected by heartworm diseases. In an area where heartworm is endemic, an antiphilariasis treatment is recommended by using oral ivermectin pills.

Common injuries and treatments (Lécu, 2000)

Trauma:

The majority of traumas are caused by conflicts between two or more individuals. This is usually caused by hierarchical disputes. In the past, it was one of the most important causes of death.

Wound and bite:

The parts of the body which are the most concerned by these injuries are the neck, the head, the anterior legs and the external genital organs (Figure 66). These injuries can be very severe, but infections are very rare. A treatment by antibiotics can be used by oral administration.



Figure 71: Injuries provoked by a conflict between a male and two of its sons © La Barben Zoo

Pad ulcer:

This problem is provoked by the substrate of the enclosure, for example concrete. This may be encouraged by exaggerated walking, like stereotyping and pacing. Pad ulcers can lead to lameness. To treat this problem, it is recommended to use copper naphthenate. But to prevent the problem, the enclosure should be rearranged, in particular changing the concrete substrate to natural substrate. Enrichment should be provided to hyenas to decrease stereotyping.

Dental complaint:

Striped hyenas can have different dental problems, like apical abscess, dental fractures and periodontitis. Hyenas can also have tartar on the teeth, above all when they don't eat enough carcasses. Medical training for mouth examination is a good way to partially examine the mouth and diagnose teeth fractures, tartar excess or abscesses.

Foreign bodies:

In captivity, hyenas bite a lot of objects present in their environment and sometimes they ingest them. This can cause trauma in the oral cavity, occlusion of the oesophagus, coprosthesis and paralytic ileus. When there are not a lot of injuries, apomorphine or xylazine can be used for their emetic effect. The second solution is to carry out an endoscopy or gastrostomy. It seems to be a common problem in striped hyena (Vet Survey 2022). It is recommended to make a strong evaluation of items used for environmental enrichment but also an important evaluation of the enclosures (indoor and outdoor).

Gastritis:

The symptoms of gastritis are vomiting, polydipsia, abdominal pain and sometimes diarrhoea. The treatment is relatively easy because hyenas swallow medicine by oral route without problem.

Tumours:

Mandibular osteosarcoma, lymphosarcoma and mammary adenocarcinoma with lung metastasis have been reported in hyenas in captivity. Most of the time, these tumours are malignant and metastasis can grow quickly. Unfortunately, these tumours evolve without impairment of the general state of the animal and when the first symptoms appear, it is often too late to save the animal.

2.8 Bibliography

- Abi Said, M.R. 2004. Breeding potential of the Striped Hyaena (*Hyaena hyaena syriaca*) in captivity. *Zoology in the Middle East* 33, 79-86.
- Ashford, K. 2009. Hand-rearing protocol of 1.2 striped hyenas at Tallinn zoo-Estonia.
- Berger, D.M.P., Frank, L.G. and S.E. Glickman 1992. Unraveling Ancient Mysteries: Biology, Behavior, and Captive Management of the Spotted Hyaena, *Crocuta crocuta*. 1992 Proceedings, joint meeting AAZV/AAWZ : 139-147.
- Blanc, B. 2007. Elevage manuel de deux hyènes rayées (*Hyaena hyaena*) au CERZA.
- Blin, M & Houssaye, F. 2013. Management of striped hyena in captivity, investigation report. CERZA Zoo.
- Clum, N. J., Fitzpatrick, M. P., Dierenfeld, E. S. 1996. Effects of Diet on Nutritional Content of Whole Vertebrate Prey. *Journal of Zoo Biology*, 15, 525-537.
- Divers, B. J. 1986. Hyaenidae. In: Fowler M. E.: *Zoo and wildlife animal medicine*. Saunders Company, 829-831.
- Gajera, N., Dave, S.M. & Dharaiya, N. 2009. Feeding patterns and den ecology of striped hyena (*Hyaena hyaena*) in North Gujarat, India. *Tigerpaper*, Volume 36 n°1 p13-17.
- Grant, K. 2004. Wildlife Safari Cheetah hand-rearing protocol. Oregon State University Department of Fish and Wildlife.
- Hahn, N., Parker, J.M., Timmel, G., Weldele, M. and West, G. 2007. Hyenas. In: *Zoo animal and wildlife immobilization and anesthesia* wrote by West, G., Heard, D and Caulkett, N. Blackwell publishing.
- IATA, 2007. Annual report 2006.
- Joslin, J., Amand, W., Cook, R., Hinshaw, K., McBain, J. and Oosterhuis, J. 1998. Guidelines for zoo and aquarium veterinary medical programs and veterinary hospitals.
- Lécu, A. 2000. La famille des Hyénidés: données biologiques générales et vie en captivité. Thèse pour le doctorat vétérinaire. Ecole Nationale d'Alfort.
- Pilgrim, M. & Biddle, R. 2013. Best Practice Guidelines Black Rhinoceros (*Diceros bicornis*)
- Rieger, I. 1979b. Beobachtungen zur Aufzucht von Streifenhyänen, *Hyaena hyaena*. *Vierteljahresschr. Naturf. Ges. Zürich*, 124:169-183.
- Rieger, I. 1979c. Breeding the Striped hyena. *International Zoo Yearbook* vol.19.
- Rieger, I. 1981. *Hyaena hyaena*. *Mammalian Species* No.150 pp.1-5, 3figs.
- Schelvis, T. & Spijkman, E. 2008. Brown, spotted and striped hyena husbandry guidelines (DRAFT).
- Shoemaker, A., Dulaney, M. & Noble, G. 2006. Standardized Animal Care Guidelines for Hyaenas and Aardwolves. In: *AZA-guidelines for Captive Care of Hyaenas*.
- Wildlife Society of India, 2009. Status Ecology and Conservation of Striped hyena (*Hyaena hyaena*) in Gir National Park & Sanctuary Gujarat India. Annual Progress Report 2008-2009.

Appendix 1: Composition of Nebraska Feline Diet

Ingredients:

- Beef
- Meat by-products
- Fish meal
- Soy bean meal
- Dried beet pulp,
- Calcium carbonate,
- Dicalcium phosphate
- Dried egg,
- Brewers dried yeast
- Salt
- Taurine

Vitamin Premix

(Choline chloride, vitamin E supplement, niacin, vitamin B-12 riboflavin, folic acid, vitamin A acetate, thiamine mononitrate, d-calcium pantothenate, mineral oil, biotin, pyridoxine hydrochloride, vitamin D-3 supplement).

Trace Mineral Premix,

(zinc oxide, manganous oxide, copper oxide, mineral oil, sodium selenite, calcium iodate).

GUARANTEED ANALYSIS: As Fed

- Crude Protein (min.)..... 18.00%
- Crude Fat (min.)..... 10.00%
- Crude Fiber (max.) 1.00%
- Moisture (max.) 62.00%
- Calcium (min.) 0.60%
- Phosphorus (min.) 0.50%

Nutrient	Units	Nebraska Feline Diet	
		As is basis	Dry matter basis
Moisture	%	61.00	
Protein	%	18.29	46.91
Ash	%	2.07	5.31
Crude Fat (maximum)	%	18.00	46.15
Crude Fat (minimum)	%	12.00	30.70
Crude Fiber	%	0.99	2.54
Metabolizable Energy Carnivore	Kcal/kg	1326	3385
Lysine	%	1.27	3.27
Methionine	%	0.50	1.29
Methionine + Cystine	%	0.69	1.77
Threonine	%	0.65	1.67
Arginine	%	1.17	3.01
Histidine	%	0.47	1.21
Isoleucine	%	0.61	1.56
Phenylalanine	%	0.66	1.68
Tryptophan	%	0.12	0.32
Valine	%	0.92	2.38
Taurine	%	0.08	0.21
Vitamin A	IU/kg	4025	10320
Vitamin E	IU/kg	156	399
Vitamin D	IU/kg	389	998
Vitamin K	ppm	0.78	2.01
Thiamin	ppm	4.6	11.72
Vitamin B12	ppm	0.03	0.069
Choline Chloride	ppm	967	2480
Calcium	%	0.62	1.6
Total Phosphorus	%	0.53	1.36
Magnesium	%	0.04	0.11
Sodium	%	0.22	0.56
Chloride	%	0.18	0.45
Potassium	%	0.35	0.9
Iron	ppm	77	198
Zinc	ppm	49.3	126
Copper	ppm	3.49	8.94
Manganese	ppm	8.27	21.20
Selenium	ppm	0.21	0.53

Appendix 2: Composition of Carnizoo®

Analytical components

- Crude proteins 2.4 %
- Crude fat 1.4%
- Crude cellulose 0.4%
- Crude ash 56.7%
- Calcium 15%
- Phosphorus 0.4%
- Magnesium 1.5%
- Sodium 0.8%
- Potassium 5%
- Linoleic Acid 0.3%
- EPA + DHA 0,25%
- Taurine 2%

Additives/kg

- Vitamin A 400000 UI
- Vitamin D3 40000 UI
- Vitamin E 2000 UI
- Vitamin K3 75 mg
- Vitamin B1 225 mg
- Vitamin B2 275 mg
- Vitamin B6 275 mg
- Niacine 2200 mg
- Calcium D panthenate 1000 mg
- Vitamin B12 1000 µg
- Folic Acid 55 mg
- Choline chloride 10000 mg
- Biotin 17500 µg
- Vitamin C 1500 mg
- Carnitin 1150 mg
- Copper 300 mg
- Iron 500 mg
- Manganese 500 mg
- Zinc 550 mg
- Iodine 100 mg
- Selenium 10 mg

Appendix 3: Composition of Carmix®

Analytical components

- Crude proteins 10.9 %
- Crude fat 2.5%
- Crude cellulose 0.5%
- Crude ash 53%
- Calcium 15%
- Phosphorus 0.19%
- Magnesium 0.5%
- Sodium 0.12%
- Potassium 5%
- Linoleic Acid 0.4%
- EPA + DHA 0,5%
- Taurine 2%

Additives/kg

- Taurine 20g
- Vitamin A 200000 UI
- Vitamin D3 15000 UI
- Vitamin E 2500 UI
- Vitamin K3 75 mg
- Phosphorus 0.19%
- Vitamin B1 300 mg
- Vitamin B2 220 mg
- Vitamin B6 150 mg
- Niacine 220 mg
- Calcium D panthenate 345 mg
- Vitamin B12 1200 µg
- Folic Acid 40 mg
- Choline 10000 mg
- Biotin 40000 µg
- Vitamin C 2500 mg
- Copper 250 mg
- Iron 3000 mg
- Manganese 250 mg
- Zinc 4000 mg
- Iodine 75 mg
- Selenium 1,50 mg

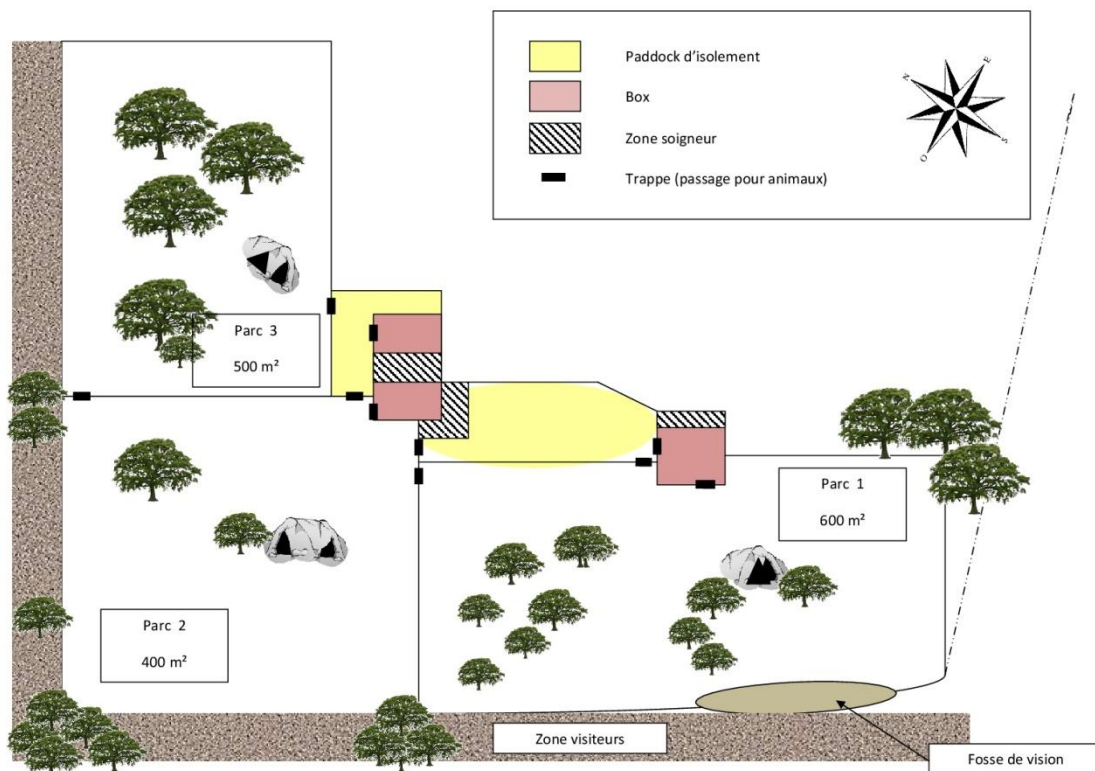
Appendix 4: Composition of Mazuri Carnivore Supplement

- Calcium carbonate
- Chicken preserved with BHA
- Propyl gallate and citric acid
- Taurine
- Zinc sulfate
- L-ascorbyl-2-polyphosphate (stabilized vitamin C)
- dl-alpha tocopheryl acetate (form of vitamin E)
- Menadione sodium bisulfite complex (source of vitamin K)
- Nicotinic acid,
- Copper sulfate
- Thiamine mononitrate
- Vitamin A acetate
- Pyridoxine hydrochloride
- Riboflavin supplement
- Calcium pantothenate
- Cholecalciferol (form of vitamin D3)
- Calcium iodate
- Folic acid
- Biotin
- Manganese sulfate
- Vitamin B12 supplement

Appendix 5: Management of the family group of striped hyenas between August 2017 and January 2018 at La Barben Zoo

Name	Sex	Date of birth	Date of death	Details
Shinaï	Female	05/11/2010		Breeding female
Olly	Male	14/03/2004		Breeding male
« L'Isolée »	Female	07/07/2016		Young of 2016
« La Brune »	Female	07/07/2016		Young of 2016, transfer to Attilly the 22 November 2017
« Pustule »	Male	07/07/2016		Young of 2016
« Beau Gosse »	Male	07/07/2016		Young of 2016
	Unk	12/08/2017	17/08/2017	Cub of 2017
	Unk	12/08/2017	17/08/2017	Cub of 2017
	Unk	02/01/2018	02/01/2018	Cub of 2018
	Unk	02/01/2018	02/01/2018	Cub of 2018

Composition of the group of La Barben Zoo during the monitoring



Plan of the enclosure of striped hyenas during the monitoring © La Barben zoo

Month	Date	Observations
AUGUST 2017	Monday, 07	Shinaï has the stomach swollen and she digs the cave (=den, G1) in the enclosure 1 (E1).
	Thursday, 10	The breeding female changes its behaviour. She is in late at the 2 feedings and takes its chicken to G1. She still has the stomach swollen.
	Saturday, 12	When the keeper arrives, he doesn't see Shinaï. At 9 AM , the keeper calls the biologist, who finds the female in another cave (G3) in the E3. Other hyenas are in paddock, lying down or standing up in front of the opened trap of paddock 3. Shinaï moves: she wakes up and goes back to lie down in the cave. Keeper hears squeaks: there are one or more babies in the cave. She is feeding alone, in the E3 and the access to this enclosure is not closed
		At 12 , the female didn't change of place. 2 to 3 young born in 2016 often come in the E3 and E2. They come close to the cave where the mother is, but she has not any reaction.
	Sunday, 13	In the afternoon, someone observes that Shinaï carries one or two cubs in the mouth between the enclosure 3 and 1.
	Monday, 14	As Sunday, 13, the female seems nervous and she continues to carry its babies between different enclosures.
	Wednesday, 16	Shinaï is observed during 5 minutes in the cave 3. When she sees the keeper, she erects its mane and stays close to the cave. Observations are stopped to not disturb the female.
	Thursday, 17	Around 9 AM , Shinaï, Olly and the 4 young of 2016 are in the E1. They seem to wait feeding. One of the young follows its mother, it is submissive. Hyenas are very interested by the observant. Shinaï doesn't pay attention on G3, even if the observant tries to look in G3. She changes its behaviour: she is quiet and goes back to sleep in the paddock.
The female goes to the E1. The 4 young of 2016 come with her, only 2 stay with her. One of the 2 screams a lot and is submissive to Shinaï. <ul style="list-style-type: none"> • 9h03: Shinaï goes in E2. • 9h04: Shinaï is in E3 and after in paddock, Olly does the same thing. • 9h12: The family is in E1, Shinaï sleeps with one young of 2016. • 9h25: 2 young of 2016 are in E3, the others are in paddock. • 9h35: 4 young of 2016 and the father are in the paddock, one of the young goes out. • 9h40: 1 young + Shinaï in the little enclosure. The mother shows its dominance. • 9h45: All the family is in the E1. • 10h10: A keepers come to fed hyenas. He doesn't find any signs of presence of cubs. They are officially declared dead. 		
SEPTEMBER 2017	Tuesday, 12	First serious conflict occurs between the 2 young females of 2016: "L'Isolée" and "La Brune". Both have serious injuries on the ears, neck and the head. « L'Isolée » is put alone in E3 and paddock.
	Wednesday, 13	Vet operates the 2 females to treat their injuries.
	Friday, 15	New conflict between 2 young of 2016: one female "La Brune" and one male "Pustule"

	Monday, 18	<ul style="list-style-type: none"> • “L’Isolée” tries to have contact with Olly and “Beau Gosse” through the fence. • Olly licks “L’Isolée” through the fence. • The mother arrives, growls and pushed away Olly and goes away. • “La Brune” arrives and growls to “L’Isolée”, who is a little submissive. « Beau Gosse » tries to push away « La Brune » which bites “Beau Gosse”. • Shinai comes; “La Brune” lies down: Shinai smells her and bites her hairs of the spinal column. • During this time, “Pustule” is alone in E1: he looks at E2 where all the family except “L’Isolée” is. When its brother or its father comes, he has not any reaction but when “La Brune” comes, he growls. • 16h: Big conflict between “La Brune” and “Pustule”. • “La Brune” is isolated in E2. The 2 young males and the breeding couple are in E1. • Shift of enclosure: “La Brune” in E3 and “L’Isolée” in E2.
	Thursday, 21	<ul style="list-style-type: none"> • Open access between E1 and E2. “L’Isolée” can have contact with its parents and brothers. There is no conflict but a lot of scent marking. Tensions between Shinai and “L’Isolée”. • At the end of the morning, there are aggressive contacts between the family and “La Brune” through the fence. All the family is moved in E1. During the afternoon, no tensions.
	Saturday, 30	Mating between Shinai and Olly.
OCTOBER 2017	Sunday, 01	Mating between Shinai and Olly.
	Friday, 06	“La Brune” breaks the fence and goes in the enclosure 2.
	Saturday, 07	The fence is repaired and “La Brune” is treated with Prozac.
	Thursday, 19	Minor tensions in the group. « Beau gosse » is chased by te others during feedings.
	Thursday, 26	The fence between the paddock 1 and the airlock is broken and has to be repaired.
NOVEMBER 2017	Friday, 17	<p>“La Brune” is still isolated. New conflict in the group, between “L’Isolée” and its brother “Beau Gosse”: biting of the ears, of the neck and the tail. “Pustule” joins the fighting against “Beau Gosse” intermittently. « L’Isolée » is separated from the group.</p> <ul style="list-style-type: none"> • E1: “L’Isolée” • E2: Breeding pair and their two sons • E3: “La Brune”, which will be transferred to another zoo.
	Sunday, 19	A hole has been dug between E1 and E2. “Pustule” goes in and out. « L’Isolée » is injured on the neck.
	Monday, 20	“Beau gosse” is isolated in E2. « L’Isolée » and « Pustule » are with the breeding pair in E1.
	Wednesday, 22	« La Brune » is transferred in the other zoo, « Beau gosse in E3.
DEC 2017	Friday, 01	New conflicts between “Pustule” and “L’Isolée”, “Beau gosse” is still isolated. Young have important injuries. The breeding pair and their sons are in E2 and E3. “L’Isolée” is alone in E1.

	Friday, 15	All the individuals are in the same enclosure like Friday, 01. Often, « Pustule » threatens its father. “L’Isolée” tries to enter in contact with its parents through the fence. Shinaï is fat, so a pregnancy is suspected.
JANUARY 2018	Monday, 01	Shinaï is not interested by food and does pacing. The breeding pair is with their 2 sons.
	Tuesday, 02	Shinaï doesn’t come to eat the morning. The team thinks that she gave birth to cubs so she is isolated from the rest of the group. She is in the cave 2 in the E2. Later in the morning, she leaves the cave and doesn’t come back in. At 12h30, keepers discover 2 dead cubs. Female comes back with the 3 males during the day.
	Thursday, 18	Conflict between the 3 males. Olly, the father, need to be check by the vet because he has major injuries contrary to the 2 young males. <ul style="list-style-type: none"> • Olly is isolated in paddock and little box • Shinaï is alone in the E1 • The 2 young males are in the E2 • The young female is alone in the E3. Maybe the origin of the conflict is the oestrus of Shinaï.
	Tuesday, 23	<ul style="list-style-type: none"> • The young female is in the E2 • The 2 young males are in the E3 • Shinaï and Olly are in E1

Appendix 6: Composition of Milkodog

Composition

- Milk and derivatives
- Oil and fats
- Cereals
- Extracts of vegetables proteins
- Minerals

Additives/kg

- Vitamins and provitamins:

- | | |
|---------------------|----------------------|
| • Vitamin A 25000UI | • Vitamin B6 16 mg |
| • Vitamin D 1000UI | • Vitamin B12 0.3 mg |
| • Vitamin E 160mg | • Vitamin K 0.8mg |
| • Vitamin B1 22mg | • Vitamin C 10mg |
| • Vitamin B2 34 mg | • Taurin 2000mg |

- Trace elements:

- | | |
|-------------------|------------------|
| • Zinc 180mg | • Copper 10 mg |
| • Iron 100mg | • Iodine 3 mg |
| • Manganese 60 mg | • Selenium 0.3mg |

- Antioxidants:

- BHT 62ppm
- BHA 10ppm

- Binders
- Antiagglomerating
- Flavourings
- Emulsifying

Analytical components

- Raw fat 32%
- Raw proteins 28%
- Raw ashes 7.6%
- Calcium 1.1%
- Phosphorus 0.8%
- Sodium 0.48%
- Raw cellulose 0.2%

Appendix 7: Composition of Biodiet®

First Packet (14,7g):

- Glycine: 3,018g
- Sodium Chloride: 4,602g
- Sodium Citrate: 0,662g
- Sodium Citrate (sesquihydrated acid): 1,804g
- Potassium citrate: 3,247g
- Potassium dihydrogen phosphate: 1,363g
- Erythrosine (E127) : 0,005g

Second Packet (62,7g):

- Glucose: 57,001g (monohydrate form)

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