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Saiga antelopes (*Saiga tatarica*) at Cologne Zoo: husbandry experiences and observations

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English version of the article "**Saiga-Antilopen (*Saiga tatarica*) im Kölner Zoo: tiergärtnerische Erfahrungen und Beobachtungen**" published in 2016 in **Zeitschrift des Kölner Zoos Vol. 59 (3): 135-149**

Fig. 1: Saiga female with suckling offspring at Cologne Zoo. (picture: K.-H. Vogel)

Introduction

The saiga antelope (*Saiga tatarica*) is a very special animal species whose husbandry and breeding was realized at Cologne Zoo over a long period. The saiga antelopes were living in the centre of the zoo, between the exhibits of the zebras, baboons and elephants in the enclosure, where nowadays goitered gazelles (*Gazella subgutturosa*) are kept. The animals arrived in Cologne 40 years ago, on 11th November 1976 and took up residence in their enclosure in December of the same year. They were kept for almost 33 years. In May 2006 a red fox (*Vulpes vulpes*) entering the enclosure resulted in the death of the last breeding females and their offspring. This was the end of the saiga breeding in Cologne Zoo. The last male, *Imo*, died in October 2009.

The challenging husbandry was continued for a long time after an initial article was published by Dr. Waltraut Zimmermann that dealt with the beginning of the saiga keeping at Cologne Zoo (ZIMMERMANN, 1980). Other articles were published from 1960 to the early 1990s dealing with the husbandry and breeding of saiga in various American and European zoos and report from Winnipeg Zoo (VOSS, 1969), Dallas Zoo (FONTAINE, 1965), Oklahoma City Zoo (RAMSAY et al., 1992), Tierpark Berlin (POHLE, 1987) or recount about the dam-reared lambs in San Diego Wild Animal Park (RUBIN & MICHELSON, 1994). It is a fact that in the past several zoos kept saiga antelopes (ZOOTIERLISTE, 2016), but nowadays the zoo population is nearly extinct. Only four animals, two males and two females, are currently living in Almaty Zoo, Kazakhstan (ZIMS, request from 18th October 2016). Further, there is a breeding centre in Kazakhstan (G. Glázer, pers. comm.) keeping saigas. Additionally an unknown number of saigas are living semi-wild at Askania Nova, Ukraine (ASKANIA NOVA, 2016).

In May 2016 Gergely Glászer visited Cologne Zoo. He wanted to find out more about the husbandry of this antelope species. For us, this was the incentive to collect and publish the data about the husbandry and breeding of saigas at Cologne Zoo. This article is looking in retrospect at the husbandry and breeding of saigas and via this constitutes an "update" of the earlier article. Even if Cologne Zoo does not keep saigas today, we want to share knowledge about this endangered species and its husbandry. Questions that we dealt with during our work are: How were the saigas kept? What were the requirements of the saigas? What happened during almost 33 years of saiga husbandry at Cologne Zoo? A lot did happen: most notably, during these years we were able to collect data and to make observations that can only be collected in zoos.

The sources of information were interviews with the zoo keepers of the saiga antelopes, Karl-Heinz Vogel and Heinz Ladener. Further, the keeper's journals were viewed. Data about the Cologne animals were taken from ZIMS (Zoological Information Management System) and supplemented with data from the compilation by Marvin L. Jones (JONES, 1996).

Fig. 2: The senescent male *Imo* at the age of 7 years in June 2009. The characteristic nose and the transparent horns are visible. (picture: A. Sliwa)

The saiga – a brief presentation

The Russian or western saiga is an Eurasian antelope. Together with the closely related Mongolian saiga antelope (*Saiga mongolica*) it belongs to the genus *Saiga* within the family of Bovidae, the hollow horned ruminants. They have a shoulder height of 57 – 79 cm. Males are taller than females and only the males carry horns that are 28 – 38 cm long, almost straight, wax-coloured and semi-transparent. The thinner summer coat is yellowish-red and the winter coat is thicker, longer and paler. The nose is very characteristic: the nasal bone is reduced, but the nasal cavity is extremely enlarged and inflatable (CASTELLÓ, 2016; GROVES, 2011).

In the past, saiga antelopes inhabited the steppes and semi-deserts in southeast Europe and central Asia (MALLON, 2008). Nowadays there are three populations in Kazakhstan: along the Ural River, on the Ustjurt-Plateau and in the Betpak-Dala steppe. An European population occurs on the right bank of the Volga River in the Kalmyk Steppe (GROVES, 2011). During the last ice age, saigas occurred in a wide strip from England and France to the Northwest-Territories in Canada and to the New Siberian Islands (CAMPOS et al., 2010). They occurred also in Germany as shown by the skull found in Bottrop in 1970 (KAHLE, 1975). Still in the years 1600 to 1800 saigas occurred up to the Carpathian Mountains and up to the River Bug and River Prut. They inhabited the entire European zone of steppes and a many areas of the forest steppes (SOKOLOV, 1974).

A reduction of the population and of its distribution began after 1800. Between 1920 and 1930 a total of 1,000 animals occurred in the Kalmyk Steppe and in Kazakhstan. The populations recovered and from the 1930s and 1940s the saiga reoccupied its range (SOKOLOV, 1974). In the 1970s the population stood at 1.25 Mio animals within the entire range (MALLON, 2008). From the 1990s their number declined and stood at 50,000 animals in 2002 (MILNER-GULLAND et al. 2003).

In the wild saigas cover distances of 12 km per day, which can increase up to 80 to 120 km per day during migration (SOKOLOV, 1974). Neither seasonal migrations occur in all populations, nor do they take place every year (HEPTNER et al. 1988). They are gregarious animals. They form groups of 30 to 40 animals and gatherings of up to 1,000 animals, where 5 to 50 animals form subgroups (SOKOLOV, 1974).

The natural enemy of this antelope is the grey wolf (*Canis lupus*). Further natural threats are blizzards and droughts that can lead to mass die-offs. Nowadays, humans are the main threat. The males' horns are highly coveted in the traditional Chinese Medicine and the antelope is hunted for its meat. Additional threats are habitat destruction and impairments of their migration routes (MALLON, 2008). The skewed selection for males had an influence on the sex ratio in such a way that a reproductive collapse was suggested for the Kalmykian population that again had negative impacts on the total population (MILNER-GULLAND et al., 2003). Meanwhile, the populations in Kazakhstan had recovered during the 2010s and the census in the Betpak-Dala region in 2015 resulted in 242,000 animals. A mass die-off in the same year, caused by haemorrhagic septicaemia, lead to the death of 200,000 animals which was 90 % of this population or 60 % of the total population, respectively (FZS-1, 2016; FZS-2, 2016).

Thus, saiga antelopes suffer from different threats. The IUCN classifies the saiga as critically endangered (A2acr ver 3.1) (MALLON, 2008). With that said, the question arises more than ever whether and how saigas might be kept and bred successfully in zoological gardens.

Fig. 3: Saiga male *Imre* in 2007 at the age of 5 years. (picture: A. Sliwa)

Fig. 4: Male saiga *Imre* at the age of 4 years in summer coat in September 2006 while marking a twig in the exhibit with the secretion from the gland under his eyes. (picture: A. Sliwa)

Fig. 5: Male saiga *Imo* at the age of almost 7 years in winter coat in January 2009. (picture: A. Sliwa)

Fig. 6: Female saiga in winter coat in December 2005 at Cologne Zoo. (picture: V. Rduch)

Fig. 7: Head of a female saiga. As the mouth is slightly open one can see the teeth. (picture: K.-H. Vogel)

Fig. 8: A typical group of saiga in the endless steppe of Kazakhstan. These are part of the Bepak-Dala population, not far from the village Topar, in June 2008. (picture: A. Sliwa)

Fig. 9: In the wild, like here in Kazakhstan, Saiga groups are moving permanently. (picture: A. Sliwa)

Saigas in Cologne

Already in the 19th century (1873 to 1876) saiga antelopes were part of the animal collection at Cologne Zoo: in October 1973 a male and two females were kept (PAGENSTRECHER, 1874). Director Nicolas Funck reports about the loss of two animals and the acquisition of three animals in 1874 (FUNCK, 1875). A report published in 1876 mentions this antelope for the last time during period (BÖLSCHE, 1876). There is no evidence of saigas being kept in Cologne Zoo afterwards (Ralf Becker, pers. comm. 21./22.10.2016). Thus, on 11th November 1976 the next saiga antelopes arrived again at Cologne Zoo.

Within aperiod lasting almost 33 years a total of 99 saigas lived in Cologne. Of those 51 were males and 48 females. The number of individuals living at any moment at the zoo was fluctuating depending on births, deaths, arrivals and departures. On 31th December of each year, between 1 and 10 saigas were held. Thus, most of the time the group size corresponded to the natural size of a saiga group or subgroup in the wild (SOKOLOV, 1974). Hierarchic structures within the group were not observed. No males were living in Cologne within the periods from 29th January to 24th March 1977, from 4th September to 3rd October 1981, from 9th April to 2nd October 1990 and from 22th February 1995 to 20th May 1997. Between 1976 and 2005 on 31th December of each year, an average of 6.27 (± 0.30) animals were held. Recorded by sex this resulted in an average of 2.11 (±0.22) males and 4.30 (±0.24) females. Based on the size of the enclosure of 640 m² there was an average area of 102 m² per saiga available. While there were twelve saigas on 1,115 m² in San Diego, USA (RUBIN & MICHELSON, 1994), which results in 93 m² per animal, there was a maximum of seven animals within the enclosure of 1,180 m² in Oklahoma City Zoo (RAMSAY et al., 1992) which amounts to 268 m² per animal.

Over the years, on several occasions, saigas were transferred to Cologne or left the zoo. For the transport we used crates that were slightly larger than the antelopes themselves. In order to habituate the animals to their new environment the boundaries of the exhibit were highlighted with foliage or brushwood. Additionally the new arrivals had to stay in the stable for at least three days. In ten transports events nine males and eleven females were brought to Cologne. They were born in the former USSR, Tierpark Berlin, Zoo Nürnberg, Askania Nova (Ukraine) or in Cologne and arrived (again) in Cologne by various routes. In six cases, saigas left Cologne, males only. They went to Neumünster Zoo as a loan or to Chomutov Zoo (Czech Republic). With just one exception they left Cologne in their first or second winter. The male *Aljoscha* (No. 1817) is noted here: he was

transported to Neumünster Zoo in 1994 in his first autumn. From there he was brought to the quarantine in Newburgh NY in 1996 and finally to San Diego, USA (JONES, 1996). There, however, he did not contribute to the breeding but died four months after his arrival in January 1997 (ZIMS request from 18th October 2016).

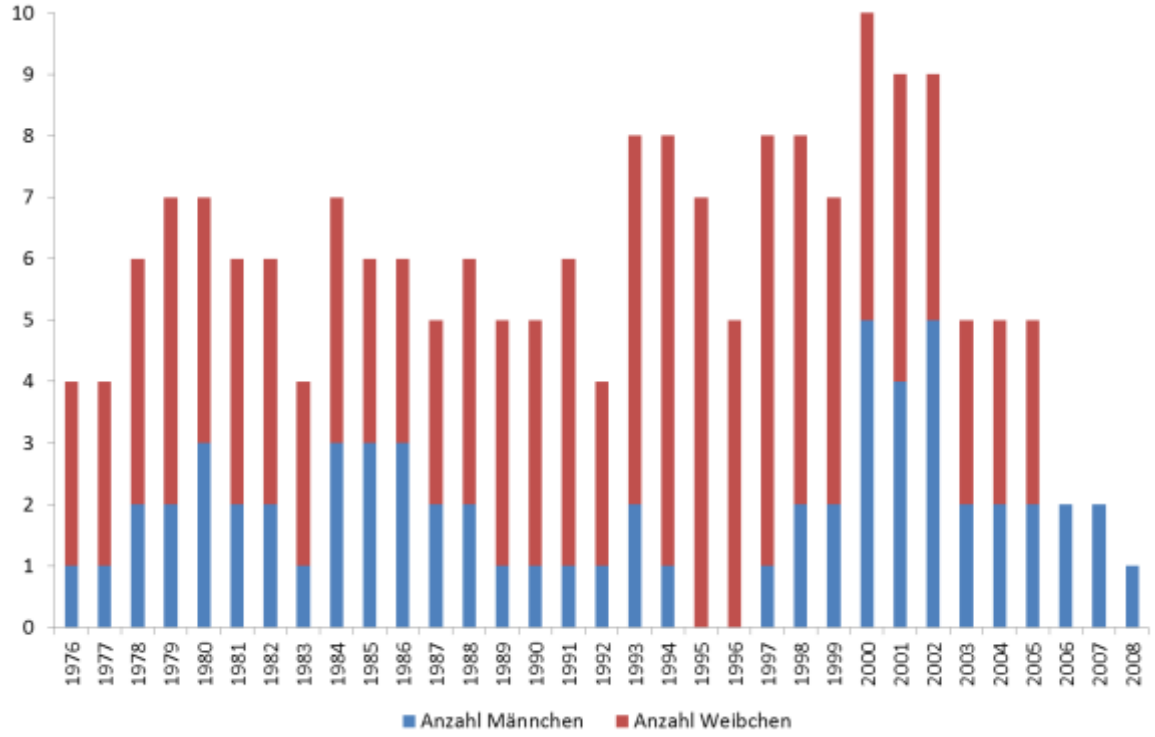

Fig. 10: Overview of the number of saigas kept at Cologne Zoo on 31th December of each year divided by sexes (males: blue, females: red).

Fig. 11: A group of saiga females at Cologne Zoo. Like in the wild there was no leading animal within the group. (picture: K.-H. Vogel)

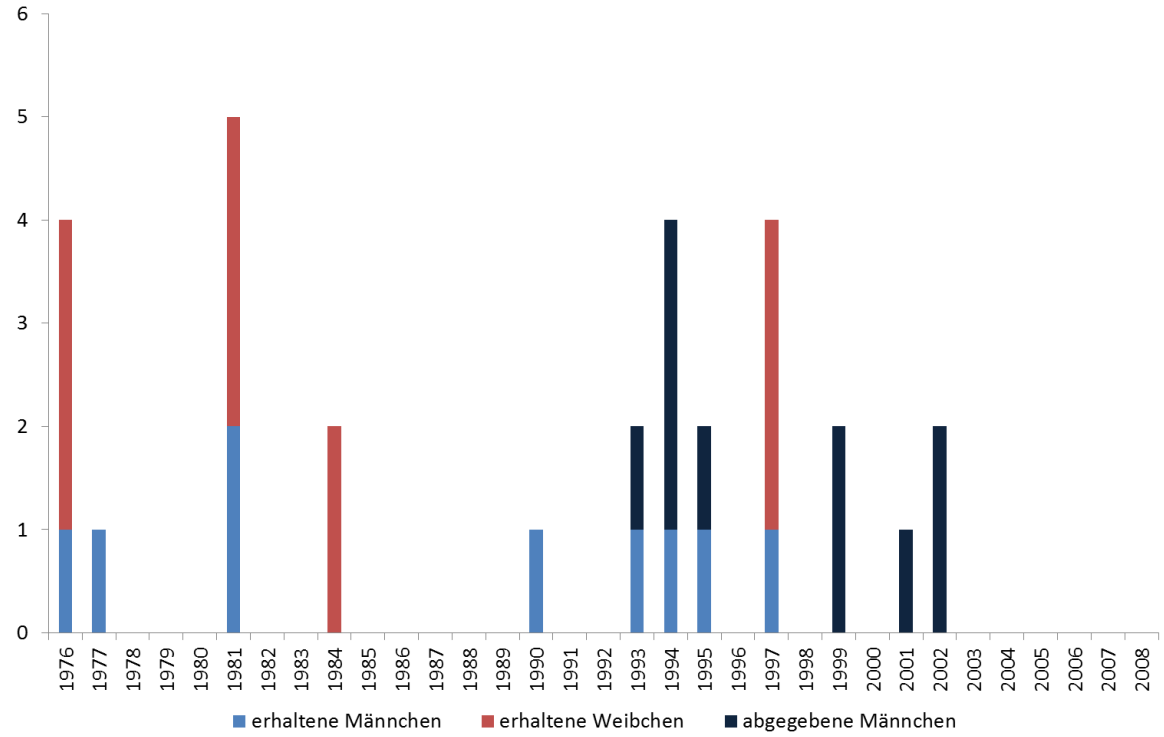

Fig. 12: Overview of the number of saigas by sex that arrived at or left Cologne Zoo (males received: light blue, females received: red, males that left Cologne: dark blue).

Fig. 13: Young male saiga. The horns are not yet fully developed and likewise not as transparent as in fully adult males. (picture: K.-H. Vogel)

The daily routine with the saigas

The enclosure in Cologne Zoo covered an area of 20 m x 32 m which amounts to 640 m² (ZIMMERMANN, 1980). It was surrounded by a game fence of 1.60 m in height. Plantings just behind the fence served as an optical barrier to the saigas to prevent them from running into it when

panicked. Additionally, the fence had special features: it hung loosely and the fenceposts were placed outside the enclosure. This should prevent injuries in the case that an animal was still running into the fence. The surface of the enclosure, very meticulously cleaned daily, was composed of dolomite and a sand bed for resting. The sand bed was replaced on average every two years. Originally there was no vegetation within the enclosure except for three weeping willows (*Salix babylonica*); later, grass covered the soil. The male was not with the females for all the time. Therefore, a portion of the enclosure was separated by a game fence. Likewise there were two stables, a larger one for the female group and a smaller one for the breeding male. These have been renovated since. Their ground plan was circular, providing no corners in order to prevent injuries, which has served the keeping of saigas well.

The handle to operate the saiga's sliding door to the stable was positioned in an unfavourable way, about 3 m from the door itself. At night, the saigas were meant to be shut inside their stable. The immediate proximity of the keeper, in combination with no possibility of separating the animals within the stable and the general dislike of the saigas against the stable turned out challenging for locking all the saigas inside. Since the ground of the stable was covered with hay, the nests that the saigas trampled before lying down were well visible.

The saiga's character of being permanently ready to flee is essential for its survival in the steppes. Their temper made this species difficult charge in the zoo. They were unpredictable and panicked quickly. To get the saigas used to a daily routine or keepers can be considered a challenge.

The males differed in temper. While some of them could stay with the females for longer periods of times, from the breeding season up the births of the young, others had to be separated very quickly. Meanwhile, the males carried rubber balls or tubes on their horntips to prevent injuries resulting from impaling. Similar to Oklahoma City Zoo (RAMSAY et al., 1992), we noted aggressive behaviours of some males against the keepers.

Saigas are diurnal and in the wild they spend a lot of time foraging. During the hot summer they feed mainly in the morning and early evening and rest at midday (SOKOLOV, 1974). Also in Cologne, the saigas liked to rest around midday. During the day in the enclosure and at night in the stable, hay was available ad libitum,however, they fed on it reluctantly.

The saiga's diet in the steppes of Asia consists of about 100 species of plants (SOKOLOV, 1974; HEPTNER et al., 1988). Depending on the source of information the diet was based mainly on grasses (HEPTNER et al., 1988; BEKENOV et al., 1998) or herbs (GRZIMEK & ZIMMERMANN, 1988). The proportions of the different plants differ according to seasons and regions (BEKENOV et al. 1998; GRZIMEK & ZIMMERMANN, 1988). Apart from hay the saigas received feed pellets twice a day. During the course of the years the diet plan was adopted according to the individual requirements. Gestating or lactating females for example were receiving bigger rations. In the morning, each animal received one portion (one cup) of "Zoopress" (feed pellets) or oats. In the evening each animal received one bowl of chopped fruits and vegetables, "Zoopress" and oats, together about one litre. Concerning fruits and vegetables we used apples, carrots, beetroots, celeriac, kohlrabi, cucumbers or leek. Zoopress, Höveler Zootierfutter ©, is a supplementing pellet food mainly composed of barley, soy grist, maize and wheat. The saigas liked to feed on leaves of poplar (*Populus* sp.) and willows (*Salix* sp.), if available, or fresh grass from the enclosure or provided additionally. There is no

information on the mineral requirements under natural conditions (BEKENOV et al., 1998). In Cologne Zoo the saigas were provided with salt and minerals licking stones that were rarely used.

The hooves of six saigas had to be trimmed. For two animals this was required only once, while the female *Ludmilla* (No. 1335) had to get her hooves corrected seven times, at an average interval of 256 days. However, as reported from Oklahoma City Zoo (RAMSAY et al., 1992) trimming saiga hooves can be considered as only an occasional treatment.

Fig. 14: Still in 2016 the fenceposts are placed outside the enclosure and testify the requirement of the saigas towards the enclosure's characteristics. Nowadays the Persian goitered gazelles (*Gazella subgutturosa*) are kept here. (picture: V. Rduch)

Fig. 15: View from the back of the enclosure to the sand patch and the weeping willows (*Salix babylonica*) in July 2016. The hill and the shrubs in the background were not present at the time when the saigas were kept. (picture: V. Rduch)

Fig. 16: The stables of the saigas in September 2006: on the left the smaller stable for the male, on the right the larger stable for the female group. (picture: A. Sliwa)

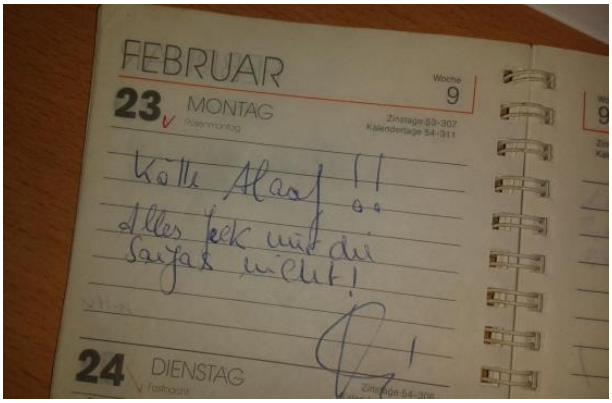

Fig. 17: The entry in the keeper's journal on Carnival Monday 1998. Translation: „Cologne Alaaf! Everything is crazy except the saigas!" (picture: V. Rduch)

Fig. 18: Head of a male saiga with rubber tubes on the horns, which aimed to reduce the risk of injuries. (picture: K.-H. Vogel)

Fig. 19: A male saiga in bright winter coat, with inflated nose and rubber balls on the horn-tips to prevent injuries to females. (picture: K.-H. Vogel)

Fig. 20: An afternoon meal for one saiga. (picture: A. Sliwa)

Fig. 21: The saiga male *Imo* eating leaves in September 2006, when he was more than four years old. (picture: A. Sliwa)

Aspects of veterinary medicine

Reports from different zoos highlight intestinal parasites being a frequent health problem in saigas (VOSS, 1969; RAMSAY et al., 1992). Generally the level of endoparasite infection is very high and influence the mortality rates (BEKENOV et al., 1998). Also in Cologne the enclosure was meticulously cleaned and close attention was paid to changes in the texture of feces. The antelopes were dewormed and treated agains coccidia routinely and when there was an indication. During the course of the years different drugs were used for deworming (we provide German trade names.) The antelopes best liked Panacur©-paste (active substance: Fenbendazol). Other drugs used for deworming were Ivomec P© (active substance: Ivermectin), Rintal© (active substance Febantel), Telmin© (active substance: Mebendazol), TMPS-Oral© (active substances: Sulfamethoxazole and Trimethoprim) and Furexel© (active substance: Ivermectin). Among others we used Baycox© (active substance: Toltrazuril) against coccidia.

From 1991 on, the keeper's journals list the deaths of 48 saigas. 19 animals were euthanized, there were three stillborn, in 17 cases a juvenile saiga died and in 28 cases an adult saiga. For 24 animals the cause of dead can be concluded. Despite all precautions with regard to the enclosure or the husbandry, leg problems, broken legs or injuries (29 %) as well as direct or indirect consequences of intestinal problems (21 %) made up half of the death causes. One male and one female, respectively, died following injuries that resulted from a male's attack.

Age

In this section we only included animals that were at least 30 days old. Several animals that were not born in Cologne are lacking exact birth dates were thus excluded.

The oldest female was *Inka* (No. 1609). She was born on 28th May 1993 in Cologne and she was euthanised on 17th June 2003 reaching the age of 3,670 days (10 years and 20 days). The oldest Cologne male with a known age of 2,703 days – which translates to 7 years, 4 months and 26 days – was *Imo* (No. 2939). He was born on 9th May 2002 and was euthanized on 5th October 2009. Probably, the male *Alexej* (No. 2242) was the oldest male and the oldest saiga that lived in Cologne. His exact birth date is unknown, declared as between May 1993 and May 1995. He was euthanized on 19th March 2003 when he was about 3,200 to 3,950 days old (8 years, 9 months and 26 days or 10 years, 9 months and 26 days, respectively).

There was a significant difference between the longevity of males and females: the females on average reached 1,584 days (N=35), 4.3 years, which is almost twice the age of males that reached an average of 934 days (N=40), 2.6 years (N = sample size).

The oldest female in Tierpark Berlin reached the age of 7 years and 9 months (POHLE, 1987), and thus did not attain the age of the oldest Cologne female. Longevity from the wild is difficult to assess. HEPTNER et al. (1988) report not less than 5 to 6 years for males and twice that age for females. BEKENOV et al. (1998) mention an age record of 9.5 years for a female and report that because of the high natural mortality of males during the rut period and because of the selective hunting by humans, males die earlier than females.

Body weights

The data was recorded in the keeper's journals and are all body weights of dead animals. Three stillborn weighed 3.5 to 4.5 kg. The body weights of eight newborns and newborns that died between 0 and 3 days of age were 2.00 to 4.05 kg and an average value of 3.05 kg. By this they are within the range presented for Oklahoma City Zoo (RAMSAY et al., 1992) or from the wild (HEPTNER et al., 1988). There were significant differences between adult males and females: reaching 33 kg of body weight the males were 9 kg heavier on average than females that reached 23 kg. The range of the body weight spanned from 25 to 42 kg for males (N=6) and from 16,9 to 31 kg for the females (N=15). Data of body weight of adult saigas from the wild report heavier animals: Males in Kazakhstan in December reach on average 45.7 kg and females 36 kg (HEPTNER et al., 1988). The causes of dead of the Cologne animals might have influenced the body weights as well as the seasons and body or nutritional condition. The question remains unanswered, whether body weights were in general lower than in the wild.

Breeding season, oestrus and gestation

Breeding is seasonal in Saigas. A sudden cold spell during wintertime induced the receptiveness of the females in Cologne. When in oestrus, and only then, the females showed a specific wagging of their tails. Depending on the male, at least from that moment, he was introduced with the females. During rut the nose of the males inflates and the pre-orbital glands produce a dark brown, strong smelling secretion (GRZIMEK & ZIMMERMANN, 1988). The receptiveness as well as some of the short copulations could be observed by the keepers during the course of the day. If the male was with the

females, he drove them without interruption – often he was turning in a small area in the middle of the enclosure while the females had to walk larger circles. In order to give some rest to both males and females, they were separated at least during the night. Astonishingly, the appetite of the male was normal during this period, which contrasts the behaviour of males in the wild. They concentrate thoroughly on the defence of their harem, neglect feeding activities and often die from exhaustion. It is the only time of the year when groups of saigas are led by males (SOKOLOV, 1974). The focus of the breeding activities in Cologne was generally in the months of December and January, but during the keeping of saigas in Cologne such behaviours could be observed from the end of November to the beginning of March.

As a rule, the females were in oestrus for one to two days, but some periods of oestrus lasted up to four days. If the females did not mate successfully, they came in oestrus again after a period of 19.85 (±0.55; N=20) days. A total of 20 gestations could be related to the last day of a female's oestrus. There were significant differences in the gestation period for singletons or twins. If a singleton was born the gestation period was 139-151 days (average 143 [±1.00] days, N=11), if twins were born the gestation period was 133-143 days (average 138 [±1.48] days, N=7) which is five days longer for singletons. Dallas Zoo, USA, reports gestation periods of 153 days (FONTAINE, 1965), from the wild gestation periods are reported to last 145 (SOKOLOV, 1974) or 150 days (HEPTNER et al., 1988) which is longer than in Cologne. BEKENOV et al. (1998) report gestation periods averaging 138 days. All these information lack the differentiation between the length of the gestation for singletons and twins. Thus, the data from Cologne are particularly interesting.

Fig. 22: Saigas had their breeding season during wintertime. At that time the males were introduced to the females for varying periods. (picture: K.-H. Vogel)

Fig. 23: A male saiga urinating within the enclosure in order to impress the females. (picture: K.-H. Vogel)

Births and young animals

Generally the births were without complications and happened at day and night. The afterbirths were not consumed by the females. After 30 to 60 minutes the fawns stood up and also began to suckle. The duration of the each suckling event was short, also reported from San Diego (RUBIN & MICHELSON, 1994). Within the first days of life the young lay down and showed no attempts to flee. Within this time period it was easy to approach them laterally. Shortly after births, the saigas were vaccinated and individually marked with a microchip and coloured earmarks. From their 5th or 6th day the young saiga took solid food.

A total of 79 saigas were born in Cologne, 43 males and 36 females which resulted in a slightly skewed sex ratio of 1.12:1 (males:females). From the wild an equal sex ratio of male and female

young is reported (HEPTNER et al. 1988). The number of births and young saiga changed in the course of the years. In some years there were no young, in 1998 there were a record of eight lambs, four males and four females. Three of the five years without births could be explained by the absence of a breeding male at Cologne zoo: 1977, 1990 and 1995 to 1997. For the time periods from 1982 to 1983 and 2003 to 2004 the question arose if the later breeding males *Sascha* (born in 1981) and *Imo* (born 2002) were not yet able to reproduce at the age of two or if other reasons might explain the absence of births. However, other breeding males, *Igor*, *Niki* and the nameless No. 1334 reproduced successfully at the age of almost two years.

The births spread unevenly over the months of April (30%), May (65%) and June (5%). In the Kalymk steppes lambing also begins in late April, in Kasachstan it starts in May (SOKOLOV, 1974; BEKENOV et al. 1998). Survival during the first year differed. 28 young, 35%, did not survive the first 30 days. A proportion of 44%, which is 35 animals completed the first year of life. In the wild under good conditions it is suggested that 39% of the young saiga complete the first year of life (BANNIKOV, 1963). These values are comparable to those at Cologne Zoo although the conditions differ very much. Also at Tierpark Berlin the number of 63 from 116 (54%) young saiga died within their first year of life (POHLE, 1987), which means that 46% completed their first year, a value comparable to Cologne. Staff of the institute of Askania Nova collects the lambs and hand-raises them in order to guarantee their survival, preventing predation by wolves or foxes. As soon as they are used to solid food they are released.

43 singletons and 18 twins were born in Cologne distributed erratically over the years. Twin births amount to 30 % of all births. Litters of three or more young saiga did not occur in Cologne. Looking at the number of individuals, 36 animals were from twin births which is 45 %. The average number of saigas per births was 1.30. From Tierpark Berlin 90 births with 116 young are reported (POHLE, 1987), thus a very similar ratio of births of singletons and twins. 28.9 % of births are twins, like in Cologne. These are intriguing results when comparing them with wild populations, where twinning is reported as 70 – 90 % (HEPTNER et al. 1988) or 63 % (KÜHL et al., 2009).

This analysis really even more exciting if taking into account information on the exact age and origin of the females. A female at Cologne was on average 1,211 days (3.3 years) when giving birth, taking into account all its reproductive history (N = 18 females). The youngest female was 364 days old when giving birth (*Ilu*, No. 2602, on 30th April 2001), the oldest female was 2,886 days old and thus almost 8 years (*Ilka*, No. 92, on 23rd April 1991). Among the saiga females born in Cologne, twin births occurred in 43% of the births; 73% of their offspring were twins. Among the females that were brought to Cologne from another place, twin births occur in only 12% of the births, only 21% of the offspring are twins. It remains speculative if it is the transport or the necessary habituation to the new environment that influences the condition of females or if they did not get used to the new, small-area environment. The following analyses are based only on the data of females born in Cologne. There was a low correlation between the litter size and the age of the females. Similarly, there was a low correlation between the litter size and the number of births of the female. Both relations (see Table 1 and 2) allow the conclusion that older females tend to bear twins, which is also known from the wild (BEKENOV et al., 1988, KÜHL et al., 2009). However, twin birth are not the rule among the older Cologne females – in contrast to the wild: Among the primiparous females in the wild over 80 % bear singletons and 10 % bear twins, while older females bear twin births in 80 % or more cases (BEKENOV et a., 1988, KÜHL et al., 2009).

On average the females born in Cologne had 2.78 offspring during their lifetime. This statistic encompasses only those females being at least one year old, and thus being able to produce offspring. The female with the highest number of offspring was *Irina*, No. 2347, that lived from 1998 to 2006: she had 4 twins births and thus 8 young.

The combination of early sexual maturity in females and the high percentage of twin births enables wild populations to recover quickly (HEPTNER et al., 1988). Thus, after the mass die-off in 2015 the saiga population in the Betpak-Dala region in Kazakhstan showed signs of recovery already in 2016 (FZS-1, 2016). Compared to other ungulates, saigas have a short life span, but a high reproduction rate (KÜHL et al., 2009). These statements, above all with regard to the twinning rates, can only be partially supported by the data from Cologne Zoo.

Fig. 24: A new-born saiga lies on the ground within the enclosure. (picture: K.-H. Vogel)

Fig. 25: A female saiga and two young. The numbered and coloured earmarks are visible which helped to distinguish the individual during daily routine. (picture: K.-H. Vogel)

Fig. 26: Saiga young *Inga*, only a few days old, while nibbling branches in the Cologne exhibit in the year 2005. (picture: W. Zimmermann)

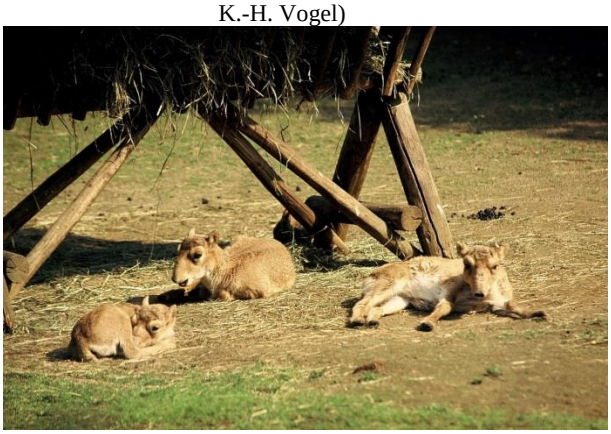

Fig. 27: Only a few days old saiga young at Cologne Zoo. (picture: K.-H. Vogel)

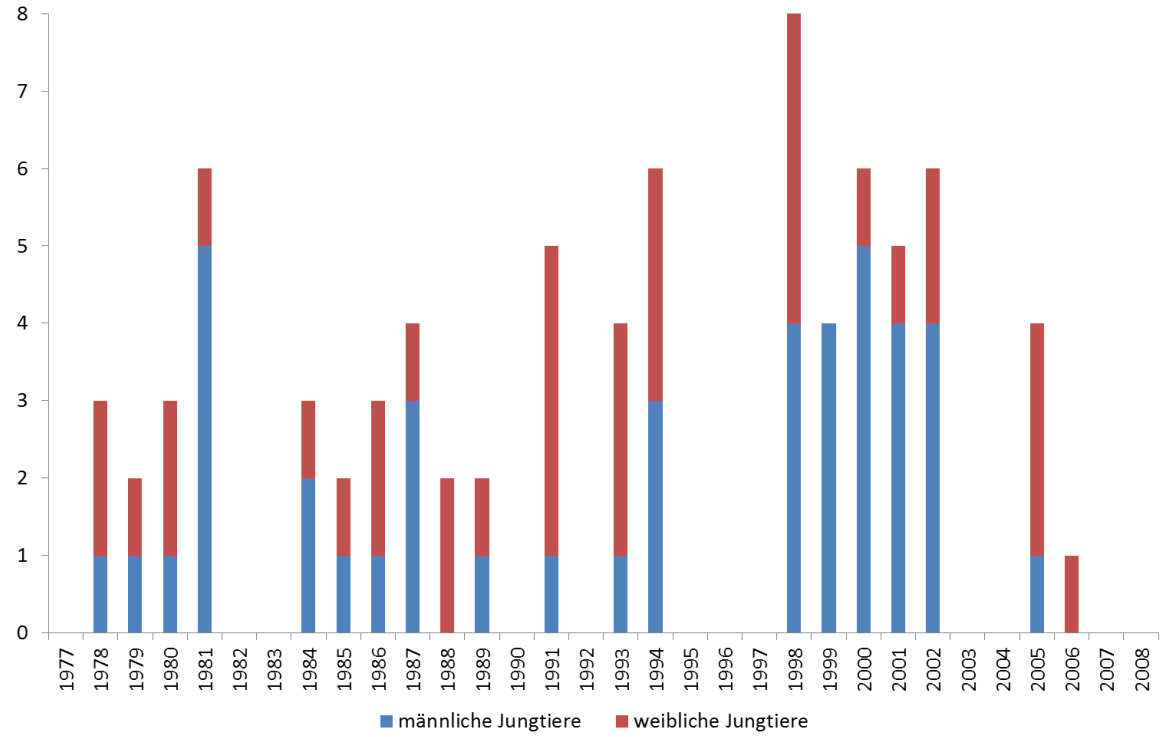

Fig. 28: Temporal overview of the number and sex of saigas born at Cologne Zoo. Males are in blue,females in red.

Table 1: Litter sizes of the females born at Cologne Zoo in relation to the age of the female. Only females with offspring are considered.

litter size		**age of the female**							**total**
		1	**2**	**3**	**4**	**5**	**6**	**7**	
N	1	4	6	5	1	2	2	0	20
	2	1	2	3	3	3	1	2	15
%	1	80.0	75.0	62.5	25.0	40.0	66.7	0	57.1
	2	20.0	25.0	37.5	75.0	60.0	33.3	100	42.9
mean litter size		1.2	1.25	1.38	1.75	1.60	1.33	2.00	1.43

Table 2: Litter sizes of the females born at Cologne Zoo in relation to the number of births of the female. Only females with offspring are considered.

litter size		**number of births**				**total**
		1	**2**	**3**	**4**	
N	1	11	7	2	0	20
	2	5	4	4	2	15
%	1	68.8	63.6	33.3	0	57.1
	2	31.1	36.4	66.7	100	42.9
mean litter size		1.33	1.30	1.80	2.00	1.43

Fig. 29: During summertime female and young saiga frolicked in the enclosure. (picture: K.-H. Vogel)

Fig. 30: Saiga juveniles hand-raised at the breeding station of Askania Nova, Ukraine. (picture: Nataliya Yasynetskaya)

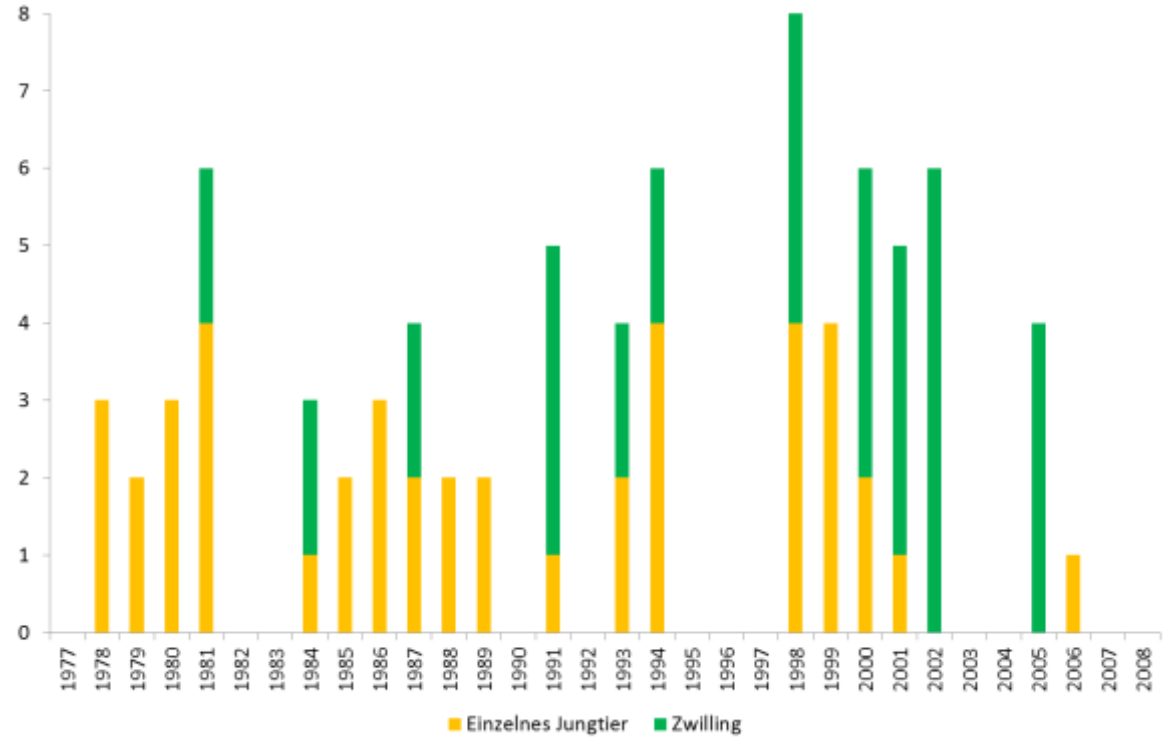

Fig. 31: Temporal overview of the number of saiga individuals born at Cologne Zoo. They are distinguished as singletons (yellow) and twins (green).

The Cologne Saigas at the museum

In the mammal collection of the Zoological Research Museum Alexander Koenig in Bonn, Germany, there is material form 14 saigas, all from Cologne Zoo. There are skulls and skeletons of the adult saigas and sometimes their skin. Further, among the specimen preserved in alcohol, there is a saiga embryo that did not appear in the ZIMS data or in the data of Marvin Jones. This embryo was discovered when opening the dead females Anouschka (No. 2345, euthanized after the fox entered the saiga enclosure on 17th May 2006). It weighted 387.4 gram. Only the female Oka was taxidermied.

Fig. 32: The saiga female *Oka* amongst the other preserved specimen within the mammal collection at the Zoological Research Museum Alexander Koenig in Bonn, Germany. (picture: V. Rduch)

Conclusions

The saiga is one of the most difficult to maintain ungulate species in zoos. Unfortunately, this statement of DOLAN (1977) still holds true today. Until now successful, long-term captive breeding has not been possible outside its natural range under zoo conditions.

The failure of the zoos, to establish a stable population in captivity, is echoed by the threat situation in the Asian steppes where poaching and mass die-offs threaten the remaining populations (DOLAN, 1977; MALLON, 2008; FZS-1, 2016; FZS-1, 2016). This unfavourable combination is a challenge for species conservation. And the question arises more than ever if and how the survival of the saiga might be guaranteed also with the assistance of zoos. Is it necessary to establish a stable population in zoos? And if yes, how would saiga husbandry in the 21st century look like?

We did a first step in describing the keeping of saigas in Cologne Zoo and the data about their lives and their breeding in retrospect. Many data only could be gained because a team of keepers took the time to observe and to write down these observations meticulously in the keeper's journals. The normal visitor often did not pay much attention to the saigas, and if so because of the unusual looks . However, as shown by the fascinating analysis of the Cologne data, saigas are highly interesting animals. Saigas are rare zoo animals, their husbandry is not standard animal keeping, but a challenge. A challenge met by Cologne zoo for more than 30 years.

Summary

The saiga (*Saiga tatarica*), a critically endangered antelope of the steppes and semi-deserts of Asia, is currently not kept by any zoo outside of Kazakhstan. This article is dealing with the former husbandry and breeding of this extraordinary antelope at Cologne Zoo from 1976 to 2009. Retrospectively, we describe the rather difficult character of this animal species for zoo keeping and its husbandry requirements. The data dealing with the life and breeding of the saiga in Cologne revealed remarkable information. In this context we highlight the differences in duration of the gestation period, births of single or twin calves and especially the lower twinning rates in Cologne compared to data from the wild. In addition we analysed the data on maximal age and age at reproduction by saigas using exactly

known ages. This kind of data collection by close observation is only possible in zoos and complement data from the wild. It underlines once more the unique possibility and importance of research in zoos.

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