1999-2001 Veterinary report on African Wild Dog (Lycaon pictus)
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Foreword

Our last report was three years ago, the 1998 report. Since 1999 and 2000 were relatively quiet years with not much news to report, it was decided to prepare a single report for the years 1999 through 2001.

However, a serious canine distemper virus (CDV) outbreak struck our African Wild Dog Program by the end of 2000. 49 out of 52 dogs died.
In fact, this outbreak symbolized the end of the first five years of our breeding program, which started with the arrival of 25 pups from the Masai Steppe in September of 1995. This period ended abruptly when the last of the 25 original dogs, present in Mkomazi, died on the fourth of August 2001, although two of the original dogs are still living at the Ol Jogi Ranch, Kenya. At about the same time, a new era began on the seventh of July 2001, symbolized by the birth of the first litter of pups to the dogs which had survived the canine distemper outbreak. This report covers the years 1999, 2000, and 2001, i.e. concludes the era of the original 25 dogs and includes details of the fresh start.

The report is dedicated to the memory of the original dogs and their offspring that died during the canine distemper outbreak. The dogs did not like all aspects of the program, but accepted it as being important for the welfare and the future of their species. We, as humans who carried out the program, are very grateful to have known them and their individual traits. They enriched our lives.

Aart Visee
March 2002

Introduction

The George Adamson Wildlife Preservation Trusts, (joined in 2000 by the African Wild Dog Foundation), through their Field Director Tony Fitzjohn, were invited in July of 1988 by the Tanzanian Government, to establish a rehabilitation program for the African wild dog (Lycaon pictus) involving capture, captive breeding and re-introduction.

The African wild dog is an extremely endangered species. Diseases, large predators (lions), and man, threaten their existence. In areas where game is scarce, wild dogs tend to get close to human settlements. As a consequence they are poisoned, and may come into close contact with domesticated dogs. As the African wild dog is susceptible to diseases also found in domestic dogs (distemper, rabies and parvo virus), cross infection may occur--leading, in some cases, to high mortality.

It took many years and much searching before dens were finally located from which pups could be collected. It was most important that the pups came from a non-conservation area (in this case the Masai Steppe), to prevent the unnecessary decline of numbers in conservation areas. And, it was thought likely that pastoralists would have poisoned them sooner or later anyway. Finally, the right moment arrived in early August of 1995. Twenty-five pups were lifted from three different dens in the Masai Steppe. At the time of lifting, they were not totally dependent on their mothers--they could eat solid food. They ranged in age, approximately, from three to five weeks.

According to the location where they were found, they were called the Lendanai Group (sex 1m, 3f), the Llondirrigiss Group (sex 7m, 1f), and the Najo Group (sex 7m, 6f). The pups were flown to the Mkomazi Game Reserve (Kisima Camp) on September 3, 1995. For them, and the people involved, it represented a new start for the rescue of the genetically unique East African population of the African wild dog (Lycaon pictus)--considered by some researchers to be a distinct subspecies. With the arrival of the dogs, it was decided to collect as much data as possible without stressing the dogs too much, and with a minimum of interference in their lives. For these reasons, blood samples were not taken on all occasions from each of the dogs. Alpha females and alpha males were sedated as little as possible, to prevent any possible adverse effects on their social status. Pregnant females were not sedated for obvious reasons.

For 5 years the program developed well and prospered. By the end of 2000, there were a total of 52 dogs, and plans for re-introduction into the wild were seriously underway. However, just before Christmas 2000, fate struck. The breeding program was hit very hard with a canine distemper virus infection (CDV), despite the fact that the dogs had been vaccinated according to an intensive schedule. In the section 'Veterinary Work' this epidemic is fully reported and discussed, and includes the measures to be taken in the future.

This report is divided into two sections:

Husbandry and Veterinary Work

For continuity reasons, and to help clarify this report, sections of the 1997 and 1998 Reports have been included.

Husbandry – pack development

On arrival at Kisima Camp the pups were kept separately, in their original litter formations. In December 1995, a transponder was inserted in the left side of the neck of each dog, so that it was possible to identify them at all times. On December 21, 1995, it was judged the right time to put the three litters together. They settled themselves into a new social order without much quarrelling, and lived happily together for the first nine months of 1996. Breeding packs were then composed, and the dogs were separated into three breeding compounds. In October of 1998, a fourth breeding pack was established.

In August of 1996, a request was received from the Kenya Wildlife Service (KWS) for four male dogs. KWS had recently captured a pack of four adult females with hunting experience, who had been stock raiding (sheep). Their intention was to add males to the pack, and reintroduce the whole pack in the Serengeti-Mara ecosystem. With the permission of the Tanzanian Wildlife Department and the Serengeti Wildlife Research Institute, four males were sent to Kenya: Llondirrigiss #299, Najo #273, #288 and #303. Eventually the dogs were released in Tsavo West. The project proved to be a partial success. Richard Kock, at that time head of the veterinary department of KWS, wrote a report about the release (available on request).

To get a good overview of the development of the packs, it is advisable to read the 1997 and 1998 Reports first

Development of the different breeding packs will be given per pack.

Lendanai Pack

On the 6th of January, 1999, alpha female #262 gave birth. Najo #274 was still alpha male, and father of the newborn pups. It was the second litter of the pack. In the beginning, everything went normally, but after three weeks (on January 26th) a lot of noise was heard coming from the den. It was only possible to investigate the den the next day, while the mother was confined to the feeding area. Only one sick pup was left in the den, but the next day, it also died.

For the rest of 1999, the alpha pair showed no signs of sexual activity. The pack began and finished the year with 10 dogs, with #262 and #274 being the alphas. Early in January 2000, the alpha female was pregnant and gave birth to seven pups on the 4th of April. The litter appeared to consist of a healthy set of pups; all pups survived, until the canine distemper virus outbreak--of which they were the first victims.

The Lendanai pack was very balanced in their social interactions. The only aggression was displayed when the alpha female was eating (always with the alpha male), at which time she was fairly aggressive toward her sisters--but there was no fighting.
Only one dog survived the canine distemper epidemic--a male, #325.

Sangito Pack

By the end of 1998, finally the alpha-ship was firmly settled, with the alpha female being Najo #306, and alpha male Llondirrigiss #289. As a result, #306 gave birth to 10 pups on the 28th of February. Unfortunately, between the 12th and 25th of April, the pups died. On the 12th of September, #306 gave birth to another set of pups (her third), consisting of 11 pups. Once again, the pups started out well, but between October 22nd and December 12th, eight pups died. This time, an infestation of worms was suspected, and the pups were treated accordingly. As a result, three pups survived. By the end of 1999, the pack consisted of 14 dogs, with #306 and #289 being the alphas.

The year 2000 was generally peaceful. The only exception involved two brothers, #289 (alpha) and #291, while the alpha female was 'in season'. It appeared that to retain his position, #289 had to fight his brothers. Also, when the alpha female (#306) was pregnant, she chased her sisters away from the food, and was generally aggressive toward them. On the 12th of June, the alpha female gave birth to 11 pups. Over the next four months the pups died sporadically. By the end of 2000, only 4 pups survived. Midway through February 2001, following the canine distemper epidemic, there was only one survivor: the alpha female #306.

Kisima Pack

The year 1999 started well. Alpha female Najo #284 gave birth to four pups on the 8th of January and the father was Llondirrigiss #298. The pups, 3m.1f, grew well, with the exception of the female pup. She lagged behind in growth. Being smaller than her brothers gave her a disadvantage at the food. As a result, her growth was retarded, and she died on the 5th of April. Her three brothers grew up well and without complications.

On June 22nd just over 12 months since her last litter was born and died, the beta female Najo #285 gave birth to six pups (4m.2f). The father was #296. The alpha female #284, who in 1998 had given birth about a month before her subordinate sister, but had subsequently lost her entire litter, began to harass her

sister with the new pups. This harassment intensified in the following weeks, and the alpha female would chase #285 out of her den. By the end of July the alpha was pregnant again, which might have influenced her behaviour toward her subordinate sister. As a result of the harassment, #285's pups suffered from malnutrition and died between July 27th and August 3rd. On the 16th of September, 15 months after her last litter, the alpha female #284 gave birth to four pups.

The decision was taken to remove Najo #285 from the pack and introduce her into the Ayubu pack, which took place October 28th. At the end of 1999, the Kisima pack consisted of 14 dogs, with #284 and #298 being the alphas. For underlying reasons, see Report 1998.

The year 2000 was characterized with fights between the brothers #293, #296 and #298. Occasionally the younger two brothers in the pack, (#333 and #335) from the first Kisima litter, who were unrelated to either of the alpha pair, would join in. The alpha male, #298, was the main aggressor. It appeared that his alpha status was not well established in the pack. This may, in part, have been due to the behaviour of the alpha female, #284, who appeared ambivalent in her choice of partner. The male aggression may also have been due to the attempt by the young males to displace the alpha, who they were not related to, with one of the younger males taking over as alpha. This behaviour would be expected in a free-living pack, had the same situation arisen.

In early February 2000, #284 mated with #298, and #276 mated with #296. However, both females miscarried during the next two months. During the fights between the males, alpha female #284 temporarily rejected #298, and consorted with #296. However, she finally returned to #298 and had her fourth set of pups, four in all, on the 22nd of September. The father was #298. For no obvious reasons, the pups deteriorated and died one-by-one by the end of November. This pack also had only one survivor, male #372, after the canine distemper epidemic.

Ayubu Pack

In October 1998 the Ayubu pack was formed. In 1999 there were no indications that one of the females had become alpha. Peace reigned. To bring more activity in the group, it was decided to introduce Najo #285 to the group. On the 28th of October, she was sedated and put into the feeding compound of the Ayubu boma. After a complete recovery, the only male in the pack, Lendanai #263, was introduced to her the next day in the feeding area. The dogs showed no hostilities at all toward each other. Three days later, November 2nd, the three younger females were introduced, and once again no hostilities were shown--#285 was accepted. The only sign of stress #285 showed, was her calling every morning and night, for many weeks. This call is typically given by an individual dog, who has temporarily lost touch with its pack.

The dogs in the Kisima pack responded to her calls. At the time, the alpha female (#284) in the Kisima boma had young pups, and there was a lot of activity there. This could be heard by #285 in the Ayubu boma. She was likely responding to these activities in her former pack. It was remarkable that the introduction of #285 went so well, maybe due to the fact that #285 was not a strange dog, as they had all been members of the same pack until October

1998, when the Ayubu pack was established. The Ayubu pack consisted of five dogs by the end of 1999. The only male was #263, and there was no obvious alpha female.

What we had hoped for, happened early on in 2000. The arrival of #285 in the pack stirred things up and it soon appeared that #337, one of the three Kisima sisters, had become the alpha female. On the 25th of May, she gave birth to three pups. The pups, the first dogs born to a captive Mkomazi-bred dog, grew well until the 19th of August. After having eaten well the night before, all that remained of two of the pups were their heads--their bodies were never found. The third pup grew up well, until her untimely death, when the whole pack perished due to canine distemper virus.

Dominance Problems

To give more insight into the dominance problems experienced in the Sangito and Kisima packs, a slightly re-edited paragraph based on the 1998 Report follows:

It is possible that some of the dominance problems might be related back to the mixing of the three original litters, when the pups were approximately five months old. Until then, they lived in separate compounds, and each had separate male and female dominance hierarchies. The combined litter then lived together until February of 1997, when the individuals were approximately 19 months old. During this time, a new male and female dominance hierarchy was established--with Llondirrigiss #297, and Najo #300 in firm alpha positions.

Following the split in the three breeding packs, the newly formed packs, apart from the Kisima, which still contained #297 and #300, had to establish a new alpha pair. It took some time for the males in the Sangito compound to sort out a new dominance hierarchy in 1998. As the occurrences in the year 2000 show, the male alpha position was not as firmly established as we had assumed in 1999. After the death of Llondirrigiss #297 in 1997 in the Kisima compound, Najo #300 could no longer maintain his male alpha status. Thus, he became a subordinate male, who raised his own pups without assistance, once his mate had died. Najo #300 did not bother to fight for his alpha status at all. Subsequently, the remaining males and females had to establish a new dominance hierarchy, which caused the fighting between the females #284 and #285. The fighting stopped with the removal of #285 in 1999. Due to the ongoing hostilities in 1999, and peaking in 2000, it was apparent that the male alpha status was never very firmly established.

Restart/Kimondo Pack

After the devastating canine distemper period from December 2000 – February 2001, it was a real thrill for all the people and dogs involved to see the three survivors united on March 13th 2001. During the preceding weeks, they had been calling to each other every night. For the occasion the two males, #325 and #372 were sedated and transferred to the feeding area of the Sangito boma. The female #306 was locked out of the feeding area. The moment she noticed the other dogs, still sedated, she started to whine softly. After waking up, the two males (seeing each other for the first time), showed no signs of hostility toward each other, although #325 took more time for a complete recovery. In the meantime, #306 tried to make contact through the wire, and started to roll over onto her back. After 2½ hours, #325 was completely recovered, and since no signs of hostilities were shown though the wire (in fact #306 and #372 were very interested in each other), the dogs were put together. Immediately #306 and #372 joined, and #306 was putting her nose under #372's belly. #325 kept a little distance. The next day, the three of them were eating and sleeping together. Apparently at the introduction, it was already decided who was going to be alpha-male.

In the second half of April, #306 and #372 mated, and on the 7th of July, #306 gave birth to eight pups (m5, f3). The pups flourished. Unfortunately, on the 4th of August, fate struck again. All of a sudden #306 showed signs of serious distress, and died within six hours (see Veterinary Work). That day, the pups were exactly four weeks of age, and old enough to live on solid food. Having a lot of experience in raising the original pups, it was decided to separate the pups from the males, to keep a close watch on them. The pups were transferred to the Kisima boma. Nevertheless, one female pup died on the 3rd of October (see Pathology). The remaining seven pups grew up well.

At the end of June, two female wild dogs showed up in the vicinity of our bomas. It was most likely that they were two sisters looking for an all-brother party to start a new pack. The females were very interested in the pups as well; they kept coming and going for the next couple of months.

After the death of #306 they stayed even more closely to our bomas. Apparently, they had no intention of leaving, and the decision was made to try and introduce them to our males. At the end of August the door of one boma was kept open and the two females went in. Before the door could be properly shut one female escaped. However, she stayed close to the boma where her sister was kept. Toward the end of September she was still hanging around, and it was apparent that she had no intention of leaving. At that time the wildlife veterinarians from TAWIRI (Drs. Robert Fyumagwa and Harald Wiik) were in Mkomazi on other duties, and they decided to provide us with their professional assistance in order to transfer her safely into the boma--finally re-uniting her with her sister.

Few hostilities took place when the four dogs were introduced to each other, and we expect that they will establish a new breeding pack soon (Kimondo pack). In December 2001, it looked like #372 was the alpha male, and #040 the alpha female.

Success From Tragedy

Over the past three years Roger Burrows has visited our breeding program on several occasions. His visits were highly valued, as he offered his knowledge and expertise without reservations. It seemed only logical to compare the behaviour of the captive Mkomazi wild dogs with the behaviour found in free-living East African packs. We are fortunate and grateful that Roger wrote the next chapter in close collaboration with us.

Behaviour

Despite the tragedy, the first six years of our African Wild Dog Breeding Program has produced some very positive results.
The behaviour (i.e. feeding and sexual hierarchy) of the original (wild-born) and captive-born dogs is comparable with the behaviour found in East African free-living packs, studied in the Serengeti ecosystem between 1965-91 (FRAME et al 1979, BURROWS 1995).

1. Feeding Hierarchy

In Mkomazi the dogs are fed once a day. To ensure that each dog has access to the food at some time, the keeper developed, out of necessity, a highly artificial system. The system is subject to change, depending on the social interactions of the dogs at a particular time. Access to the food in the feeding enclosure is controlled by a couple of gates which makes it possible to rotate the dogs in the feeding area, ensuring that all dogs have the opportunity to feed. Different groups were given access for a few minutes at a time before they were removed and another group fed, with no group of individuals being given unlimited access to the food.

To see if one of the captive packs would behave as if they were a free-living pack on a kill, a simple experiment was performed. During one evening feed in 2000, all of the individuals in a pack were allowed access to the food at the same time. For a better understanding of the experiment, the behaviour of a pack in the wild at a kill is described first.

In the wild, when the pups are old enough to join the adults at a kill, the pups have feeding priority. The adult dogs, apart from the alpha female, immediately stand back and drive away would-be scavengers while the pups and the alpha female feed. The pups use behavioural postures and vocalizations to prevent the adults from coming back to the kill. Once the pups are satiated, they lose interest in the food and move away, allowing the yearlings (12-24 months old) to feed. Once the latter are satiated, the alpha male and older subordinate dogs of both sexes are the last to return to what remains of the kill. Some of these dogs may have made the kill before the rest of the pack arrived on the scene. Most of the pack now leaves the kill site with the pups, and move away to find shade or water. Consequently, a very small group of adults, or often a lone dog (particularly one of a subordinate pair), remain on the kill, and may get little time to feed before the remains are scavenged by spotted hyenas, vultures, eagles, jackals, and occasionally lions.

Experiment: In Mkomazi during an evening feed in 2000, all individuals of a pack were allowed access to the food at the same time. After a few seconds of chaos and much noise around the food, the pattern described above for the wild packs suddenly emerged, with

the young pups left eating, and the adults standing around awaiting their turn.
This admittedly very limited experimental evidence suggests that the feeding behaviour in African wild dogs is not learned by example. Since none of the original 25 pups were old enough at the time of capture to have joined their parents in a hunt, the feeding behaviour appears to be genetically determined. Released captive groups of wild dogs from Mkomazi into the wild, would in all probability, once a pack is formed, immediately show the same feeding hierarchy as that observed in free-living packs.

2. Sexual Hierarchy

    a. Female dominance hierarchy
    In free-living groups of sisters, either within a pack or dispersing, one sister will be alpha. She will have assumed that position usually without overt aggression. The lower ranks in the female hierarchy can, and do, change; sometimes after serious fighting.
    In one Mkomazi pack, the Kisima, considerable female aggression was observed. In the Lendanai pack, the alpha female harassed, but did not fight, her lower ranking sisters.

In the wild, subordinate females are likewise harassed. If they produce pups, these pups may die either from starvation or be killed due to the aggressive interactions between the alpha and subordinate females. In the Kisima compound two litters born to a subordinate female died. It is interesting that, as in the wild, the beta litter of 1998 was born after the alpha had given birth. Any subordinate's pups are therefore younger than the alpha's; in the wild, sometimes by as much as two months.

In the wild however, sometimes a subordinate's pups do survive, but only after being taken over by the alpha. If the alpha loses her litter, she still may have the pups of the beta female to act as helpers in the following denning season. This way, the continuity of the pack is ensured until the alpha female is successful in raising her next litter.

In the Serengeti, the function of the sisters in a newly formed pack is to provide help in raising the first litter of the alpha. In the subsequent year(s), the subordinate sisters of the alpha leave the pack. This leaves the alpha female as the only adult female in the pack. The dispersing sisters can form new packs with groups of any unrelated males that they meet.

The losses of subordinate litters in Mkomazi, suggest that to prevent pack disruption and unnecessary mortality of pups, due to aggression between the adult females, only one adult breeding female should be kept in a captive pack.

    b. Male dominance hierarchy

Following the demise of most of the Mkomazi captive population in 2001, the two surviving males from different natal packs, both captive-born, were given access to the lone surviving mature wild-born female. A new pair bond was immediately established with the younger male as alpha. This behaviour parallels the behaviour found in free-living Serengeti packs.

Recently, observations of male hierarchies in South Africa found the same behaviour as that observed in the Serengeti wild packs and the Mkomazi captive packs. When two hand-raised younger males and two free-born older males were introduced to a free-born female, the alpha male turned out to be one of the younger captive-raised males (HOFMEYR 2000).

The same thing happened in free-living Serengeti wild dog packs. When a dispersing group of related males of different ages left their natal pack, one of the younger males took over the alpha position. Similarly, when the last adult female in a pack died, a male from her last litter became the alpha in the now all male group. Such all male groups remain on the former packs' home range.

In October 1997, the alpha female (#297) in the Kisima pack died. One year later some dogs were removed from this pack to start the Ayubu pack. What remained of the Kisima pack contained two young males, sons of the deceased alpha female, their father (#300, former alpha male) and three males of the same age. The latter males were not related to the former alpha male. A new alpha pair was formed, but neither was related to the sons of the former alpha. However, these young males were seen to join in disputes between the new alpha male and his two brothers, and in disputes between the adult females.

It is likely that the younger males from the original alpha pair were, as the youngest males present, attempting to take over the alpha role, and would not accept an unrelated older male as the alpha in the compound.

Experiment: This time unplanned. At the end of June 2001, two wild females arrived at our bomas in Mkomazi. These females came and went. After the death of the captive alpha female on August 4th they stayed even closer to the boma, and eventually joined the program.
This is the scenario that we hope will happen with future re-introductions: A group of captive-bred males await within a boma for the arrival of immigrant females. The captive-born males would then be allowed to join the females to form an instantaneous new pack.

Conclusions

The Mkomazi African Wild Dog Breeding Program has produced some extremely useful findings:

1. The social and feeding hierarchies of the captive Mkomazi packs parallel that of free-living African wild dogs in the Serengeti ecosystem.

In both the Mkomazi and the Madikwe captive packs, as in the free-living Serengeti population, in all-male groups of mixed age, a younger dog takes over the alpha position despite the presence of older, heavier, and more experienced males--including, if present, his father. This counter intuitive finding has considerable practical implications for any re-introduction or supplementation programs in East Africa, and in at least some southern Africa populations.

Based on data from free-living Serengeti packs from 1965-91, and the captive packs in Mkomazi, a general protocol emerges: When in a pack, if either parent (one of the alpha pair) dies, a male from the youngest cohort in the pack becomes the alpha (see also FRAME et al., 1979, BURROWS 1995). Likewise, in an artificially constructed pack consisting of unrelated males, the alpha will be from the youngest cohort present-- irrespective of his relationship, relative strength, or hunting experience.

2. The behavioural similarities of captive and free-living packs suggest that captivity, in the short term at least, does not change basic behaviour, although other studies show that hunting skills are acquired after release. For this reason, it is important that a combination of a wild-bred group and a captive-bred group of the opposite sex be released together
3. It is unwise for pack stability to mix pups from different natal packs.
4. A 'nuclear pack' consisting of one breeding adult female and one unrelated male is all that is necessary to start a captive pack.
5. There is no reason to leave yearlings from a captive mating pair in the same enclosure with their parents once a new litter of pups is produced and raised. Such yearlings would be ideal subjects for translocation.
6. There is no evidence in captivity of aggression leading to severe physical injury resulting from hierarchy disputes in male African wild dogs. Conversely, in free-living packs, aggression between females for social rank can lead to severe injuries.
7. The arrival of the two females (June 2001) suggests that even in areas in which the African wild dog is described as 'absent' or 'vagrant', dispersing groups pass through, as they are known to do in the former Serengeti study areas. This also suggests that the technique proposed in the "Plan for the Re-introduction of the African Wild Dog" (VISEE et al., 2001) is realistic, and has a considerable chance of success.

Husbandry – zootechnique

1. Composition of Packs

The original litters in 1995 had the following composition:

Lendanai	Llondirrigiss	Najo
261F	289M	265F
262F	291M	273M
263M	293M	274M
264F	294M	275F
	296M	276F
	297F	284F
	298M	285F
	299M	288M
		300M
		303M
		305M
		208F
		310M
1:3	7:1	7:6

F= Female M= Male Najo 273, 288, 303 and Llondirrigiss 299 were sent to Kenya. Llondirrigiss 297 died in October of 1997

Below is an overview of each pack's composition at the time of the canine distemper virus (CDV) outbreak. Included are the dates of birth and death, and the origin of the dogs

Boma I: Kisima pack

Identification	Sex	Date of birth	Date of death	Origin
293	M	August 1995	05-02-2001	Llondirrigiss
296	M	August 1995	01-02-2001	Llondirrigiss
298 alpha	M	August 1995	13-02-2001	Llondirrigiss
276	F	August 1995	01-02-2001	Najo
284 alpha	F	August 1995	31-01-2001	Najo
300	M	August 1995	26-01-2001	Najo
				Mother x Father
333 Kisima I	M	04-03-1997	18-01-2001	Llondirrigiss x Najo
335 Kisima I	M	04-03-1997	06-02-2001	Llondirrigiss x Najo

366 Kisima II	M	08-01-1999	01-02-2001	Najo x Llondirrigiss
369 Kisima II	M	08-01-1999	31-01-2001	Najo x Llondirrigiss
372 Kisima II	M	08-01-1999	Alive	Najo x Llondirrigiss
312 Kisima III	M	16-09-1999	30-01-2001	Najo x Llondirrigiss
344 Kisima III	F	16-09-1999	30-01-2001	Najo x Llondirrigiss
349 Kisima III	F	16-09-1999	03-02-2001	Najo x Llondirrigiss

Number of dogs: 14, Sexes: 10,4 at the time of the CDV outbreak

Boma II: Lendanai pack

Identification	Sex	Date of birth	Date of death	Origin
261	F	August 1995	07-01-2001 c	Lendanai
262 alpha	F	August 1995	09-01-2001 c	Lendanai
264	F	August 1995	07-01-2001 c	Lendanai
274 alpha	M	August 1995	06-01-2001 c	Najo
310	M	August 1995	07-01-2001 c	Najo
				Mother x Father
322 Lenjo I	M	01-02-1998	11-01-2001 c	Lendanai x Najo
323 Lenjo I	F	01-02-1998	02-01-2001	Lendanai x Najo
325 Lenjo I	M	01-02-1998	Alive	Lendanai x Najo
327 Lenjo I	F	01-02-1998	10-01-2001 c	Lendanai x Najo
329 Lenjo I	M	01-02-1998	29-12-2000 c	Lendanai x Najo
780 Lenjo II	F	03-04-2000	31-12-2000	Lendanai x Najo
812 Lenjo II	F	03-04-2000	23-12-2000	Lendanai x Najo
817 Lenjo II	M	03-04-2000	05-01-2001 c	Lendanai x Najo
850 Lenjo II	M	03-04-2000	05-01-2001 c	Lendanai x Najo

893 Lenjo II	M	03-04-2000	07-01-2001 c	Lendanai x Najo
912 Lenjo II	F	03-04-2000	21-12-2000	Lendanai x Najo
924 Lenjo II	F	03-04-2000	29-12-2000	Lendanai x Najo

c = day of death confirmed. The dates of death without a “c” means that the transponder was not checked at the time of death. The date given may not be exact. Number of dogs: 17, Sexes: 8,9 at the time of the CDV outbreak

Boma III: Sangito pack

Identification	Sex	Date of birth	Date of death	Origin
289 alpha	M	August 1995	24-01-2001	Llondirrigiss
291	M	August 1995	29-01-2001	Llondirrigiss
294	M	August 1995	05-02-2001	Llondirrigiss
265	F	August 1995	31-01-2001	Najo
306 alpha	F	August 1995	04-08-2001	Najo
305	F	August 1995	29-01-2001	Najo
308	F	August 1995	05-02-2001	Najo
				Mother x Father
352 Sangito I	M	01-05-1998	14-07-2000*	Najo x Llondirrigiss
355 Sangito I	M	01-05-1998	29-01-2001	Najo x Llondirrigiss
358 Sangito I	M	01-05-1998	14-07-2000*	Najo x Llondirrigiss
359 Sangito I	M	01-05-1998	24-11-2000*	Najo x Llondirrigiss
319 Sangito II	F	12-09-1999	27-01-2001	Najo x Llondirrigiss
360 Sangito II	M	12-09-1999	25-01-2001	Najo x Llondirrigiss
361 Sangito II	M	12-09-1999	05-02-2001	Najo x Llondirrigiss
Pup Sangito III	F	12-06-2000	18-01-2001	Najo x Llondirrigiss
Pup Sangito III	M	12-06-2000	18-01-2001	Najo x Llondirrigiss

Pup Sangito III	M	12-06-2000	29-01-2001	Najo x Llondirrigiss
Pup Sangito III	M	12-06-2000	31-01-2001	Najo x Llondirrigiss

Number of dogs: 15, Sexes 9,6 at the time of the CDV outbreak. * Died before the CDV outbreak.

Boma IV: Ayubu pack

Identification	Sex	Date of birth	Date of death	Origin
263 alpha	M	August 1995	03-02-2001	Lendenai
				Mother x Father
336 Kisima I	F	04-03-1997	04-02-2001	Llondiirigiss x Najo
337 Kisima I alpha	F	04-03-1997	29-01-2001	Llondirrigiss x Najo
348 Kisima I	F	04-03-1997	11-02-2001	Llondirrigiss x Najo
285	F	August 1995	06-02-2001	Najo
Pup Ayubu I	F	25-05-2000	25-01-2001	Llondirrigiss x Najo X Lendenai

Number of dogs: 6, Sexes 1,5 at the time of the CDV outbreak

2. Identification

Every time an animal was sedated, the transponder was checked. They were all working in good order.

The Kisima pups, born 08-01-1999, received their transponder in November 1999, numbers ending with 366, 369 and 372. The Kisima pups, born 16-09-1999, received their transponder in November 2000, as did the Sangito pups, born 12-09-1999, and the Lendanai, born 03-04-2000 (for numbers see overview above). All transponders started with the letters and numbers NLD 093500110 followed by the three numbers to identify each animal.
As an extra way of identification, photographs were taken from both sides of the dogs in lateral recumbency.

3. Housing

In 1999 and 2000 the four bomas of the dogs were not altered. (For details see Report 1997).
As an extra precaution to keep small animals and people at a distance, a six foot high fence made of chicken wire was placed at a distance of approximately two meters from the outside of the perimeter fence of the Sangito and Kisima bomas in 2001.

4. Nutrition

There was no reason to alter the feeding of the dogs from 1999 to 2001. (For details see Report 1997).

5. Bodyweight (See Appendix I)

It was only possible to measure the bodyweight of the dogs when they were sedated. They were weighed during each sedation.

The original dogs show the next, average, bodyweights in the course of time:

Bodyweight in Kilogrammes (kg)

Date	Age (approx.)	Male	Female
19/12/1995	5 months	10.1	9.5
29/02/1996	7 months	12.8	11.3
09/03/1997	1 year 7 months	22.9	18.5
15/10/1997	2 years 3 months	25.7	19.2
15/02/1998	2 years 7 months	24.7	18.4

04/10/1998	3 years 3 months	25.7	18.8
30/03/1999	3 years 9 months	22.4	19.8
02/11/1999	4 years 4 months	23	19.1

Although the number of dogs is not the same at every date of weighing, one might conclude that the average bodyweight for dogs above two years of age is 22-25 kg for males, and 18-19 kg for females.

The pups of the different litters showed the following development of bodyweight

Kisima I (04-03-1997)

Date	Age (approx)	Male	Female
15-10-97	6 months	17.4	15.4
15-02-98	1 year	22.3	20.1
04-10-98	1 year 7 months	23.0	21.0
02-11-99	2 years 8 months	23.8	20.3

It is interesting to note that these dogs have about the same average bodyweight as the original dogs from the age of 1½ years onward, although the female Kisima dogs are slightly heavier (1 kg)

Lenjo I (01-02-1998)

Date	Age (approx)	Male	Female
04-10-98	9 months	16.6	16.8
30-03-99	1 year 2 months	18.8	20.2
02-11-99	1 year 9 months	19.7	19.8
30-03-00	2 years, 2 months	21.4	20.2

Sangito I (05-03-1998)

Date	Age (approx)	Male	Female
05-10-98	5 months	12.3	
30-03-00	2 years, 1 month	21.7	

Kisima II (08-01-1999)

Date	Age (approx)	Male	Female
02-11-99	10 months	18.4	
08-11-00	1 year 10 months	20.3	

Sangito II (12-09-1999)

Date	Age (approx)	Male	Female
08-11-00	1 year 2 months	17.8	15.6

Kisima III (16-09-1999)

Date	Age (approx)	Male	Female
08-11-00	1 year 2 months	19.9	15.4

Lenjo II (03-04-2000)

Date	Age (approx)	Male	Female
08-11-00	7 months	11.4	11.2

Veterinary work – preventative medicine

Preventative medicine is the most important part of the work and takes the most time. It is far better to prevent diseases than to cure diseased animals, particularly in the given situation whereby many animals are kept in relatively close confinement and contagious diseases will spread easily.

The most dangerous diseases to the dogs are canine distemper, rabies and parvovirus infections. A program has been developed in which the dogs are vaccinated against these diseases. In addition, their blood is taken on a regular basis to study the effect of the vaccinations, which makes it possible to alter the vaccination schedules according to the results. Vaccination policy and results will be discussed in the chapter on Vaccines.

Another important part of preventative medicine is the prevention of parasites, which will be reported and discussed in the chapter on Parasites.

Vaccines

The African wild dog appears to be extremely susceptible to diseases like canine distemper virus, parvoviral disease and rabies. Little is known about the effectiveness of vaccinating wild dogs against these diseases. The purpose of vaccinating our captive wild dogs is first, to attempt to protect them from the above-mentioned diseases, and secondly, to study the effectiveness of the vaccinations. As a common rule, only inactivated (i.e. killed) vaccines were used for two reasons: first, to prevent the introduction and spread of viruses in the environment, and secondly, to prevent any ill side effects on the dogs.

At the 40th International Symposium of Zoo-and Wildlife Diseases, Rotterdam, the Netherlands, a paper was presented by Aart Visee: Distemper, Rabies and Parvovirus vaccinations in a captive breeding programme for the African wild dog (Lycaon pictus) in Northe0rn Tanzania. (Verh. Erkrg. Zootiere (2001) 40, 243-250). This paper covers the results of the first 5 years of the vaccination program. Parts of this paper are quoted, as they give an excellent overview of the work accomplished. The paper is available on request.

Canine Distemper Virus (CDV) - see Appendix II

Vaccinations

No inactivated distemper vaccine is commercially available, however, the Institute of Virology, Erasmus University, Rotterdam, developed and kindly donated such a vaccine: CDV-ISCOM Vaccine. This vaccine must be kept frozen until used, i.e. in a cold chain.

Individuals were vaccinated three times in the first year; with a 14-day interval between the first and second vaccination, and a 30-day interval between the second and third vaccination. The 3 vaccinations were followed by a single annual booster vaccination.

The Regime Adopted for the Original Dogs

1. All (N=25) pups were first vaccinated and blood-sampled following sedation on 19/12/1995 when approximately 5 months old. A second vaccination and a third vaccination were carried out on 03/01/1996 and 14/02/1996 by blowpipe without sedation and no blood-samples were taken. Blood sampling took place following sedation on 29/02/1996.

2. A fourth vaccination as the first annual booster was given by hand, following sedation on 09/03/1997. Blood-samples were taken also.

3. Blood-samples were taken but no vaccinations were given on 15/10/1997.

4. Blood-samples were taken on 15/02/1998 and a further vaccination by hand was carried out using a new batch of vaccines.

5. In 1998, the annual February booster vaccination was replaced by a similar vaccination in October (04/10/1998). This meant that the dogs were vaccinated twice in 1998, again using the new vaccine batch.

6. In March 1999, 5 dogs were tested.

7. In November 1999, the annual booster vaccination was given and blood-samples taken.

8. As there was no vaccine available (a new batch of vaccines was still in the safety-testing phase at the Erasmus University), the dogs were not vaccinated in November 2000. The dogs were supposed to receive their annual booster vaccination at that time

The Regime Adopted for the Pups Born in the Breeding Program

1. The pups were vaccinated according the schedule described above. After finishing the initial course of three vaccinations in the first year of their lives, blood-samples were taken. Then the pups participated in the annual vaccination program.

2. Most pups were due to receive their annual booster vaccination November 2000. For reason described above, this did not happen.

Results

1. Pre-vaccination titers to CDV: Seventy-five percent (n=12) of the wild-born pups of 1995 were sero-positive for CDV when first vaccinated at approximately 5 months of age, on 19-12-95 (see Table 1). A group of (n=4) captive bred unvaccinated pups (Sangito Pack) were

sero-positive for CDV on 04/10/1998 when first vaccinated with titer levels of 80 (1x3) and 20 (x1).

2. Post-vaccination titers from 29-2-96 to 30-03-2000(see Table 1). All dogs had completed the course of three vaccinations at the time of testing.
   One year after the annual booster vaccination of 1998, 87% of the tested dogs had antibody titers >20. In March 2000, 5 months after the booster vaccination of November 1999, 67% of the tested dogs had antibody-levels >20.

3. In November 2000, only one of the nine tested, vaccinated dogs had sufficient antibodies. These were all dogs that went through a complete course of vaccinations. The other 7 dogs (780-924) tested, had less than 20 neutralizing antibodies, but they were non-vaccinated pups at that time.

Table 1: Virus neutralizing antibody titers in African Wild Dogs during a vaccination trial with a CDV-ISCOM vaccine.

Date	Number of dogs NT-titer $\geq$20	%	Number of dogs NT-titer <20	%	Total number of Dogs
19-12-1995*	9	75	3	25	12
29-02-1996	22	88	3	12	25
09-03-1997	5	26	14	74	19
15-10-1997**	0	0	22	100	22
15-02-1998***	14	78	4	22	18
04-10-1998****	24	100	0	0	24
30-03-1999	5	100	0	0	5
02-11-1999	13	87	2	13	15
30-03-2000	6	67	3	33	9
08-11-2000	1	11	8	89	9

NT-titer >20 are considered protective.
* pre-vaccination titer
** not vaccinated on this occasion
*** a new vaccine batch was used in February 1998
****in 1998 the annual booster vaccination was replaced from February to October, as a consequence the dogs were vaccinated twice that year

Discussion

This is the first report of sero-positivity in unvaccinated African wild dog pups, both wild-caught and in captivity. As pups of 4-5 weeks of age are confined to the area of the den and exposure to CDV was confirmed in 75% of the pups from the three litters obtained from three different dens, it is likely that they carried maternal antibodies. This suggests that the adults in the three packs, from which the wild-captured pups were obtained, had been exposed to canine distemper virus (CDV) in the Masai Steppe. Strictly speaking CDV or morbillivirus. As CDV is a morbillivirus, it is theoretically possible that another morbillivirus instead of the CDV was involved. However, here it concerns land carnivores, and CDV is most likely.

The presence of CDV titers in the African wild dog population of the Masai Steppe is similar to the situation in the Selous (approximately 400 km south of the area from which the pups were obtained), where 59% of adults immobilized for radio-collaring were sero-positive. Here the evidence presented suggested they were not the result of surviving an epidemic (CREEL et al, 1997). Because of the absence of domestic dogs in both the Selous and Mkomazi, wildlife serving as a reservoir of CDV seems to be likely.

The presence of antibodies in the captive-born pups, as with the wild-born pups, suggests maternal antibodies. In the case of the wild-born pups, a mild infection cannot be ruled out, as the titers of 1995 and early 1996 show a great variety (from <20 up to 540), and the maternal antibodies are believed to have disappeared after 2 months.

Although initially the titers achieved after three vaccinations appeared to be satisfactory, a year later (1997) the titers had declined below the protective level in the majority of the individuals. Failure of the CDV vaccinations was possibly due to the batch used. The way the vaccines are stored may also have had a negative influence; ideally, the vaccines should be stored in a freezer at minus 70 °C, but ‘in the bush’, it is impossible to reach that temperature in a freezer dependant mainly on solar energy. After a new batch was used, results improved dramatically.

The bad results of November 2000, might be partially explained by the fact that the dogs received vaccines, stored over a longer period in the Mkomazi freezer, which might have reduced the activity of the vaccine; i.e. a breakdown in the coldchain. All individuals (except #366, #369 and #372), were vaccinated with a freshly arrived batch of vaccine in November 1999.

Conclusion

Vaccinating the dogs three times in the first year (14 days between the first and the second vaccination, and 30 days between the second and third vaccination), followed by a single annual booster vaccination appeared to be successful in providing a protective titer (>20). One year after the third vaccination, all dogs tested appeared to have (i.e. in 1998) antibody-titers, that are considered to be protective (OSTERHAUS pers.com.).
However, much to our surprise and horror, in December 2000, a serious outbreak of canine distemper occurred. (See Clinical Work--Diseases).

Rabies - see Appendix III

Vaccinations
In December 1995, at the age of approximately 5 months, the dogs received their first, single, rabies vaccination. However, due to lack of sero-conversion (see Results) in 1997, the vaccination schedule was changed and the dogs were vaccinated three times; a second and third vaccination was given after 1 and 5 months respectively. Antibody testing was carried out at approximately 1 month, 5 months, and 12 months after the third vaccination.

One month after the third vaccination (October 1997), antibodies were again measured in 22 dogs (see Table 3). Due to a shortage of vaccines, 9 dogs had received only 2 vaccinations; and 13 dogs received the full course of 3 vaccinations. In 1995 & 1997, Dohyrab® (Solvay Duphar) was given, but was replaced in 1998 by Rabdomun® (Schering-Plough). Both Dohyrab® and Rabdomun® are inactivated vaccines. According to Solvay Duphar and Schering-Plough, these vaccines protect domestic dogs against rabies for up to 3 years, provided the dog is more than 12 weeks of age at the time of vaccination.

Results

1. Single vaccination: In February 1996, 2 ½ months after the single vaccination at the age of approximately 5 months, blood-samples from all dogs were collected. Not a single dog developed what are considered to be sufficient antibodies (>0.5 I.U./ml).

2. After 3 vaccinations sero-conversion occurred in 1997 (see Table 2).

Table 2: Rabies antibody titers in African Wild Dogs after vaccination with inactivated commercial rabies vaccines: Dohyrab® (Solvay Duphar) in 1995&1997 and Rabdomun® (Schering-Plough) from 1998 onward.

Months after third rabies vaccination	Number of dogs >0.5 I.U./ml*	%	Number of dogs <0.5 I.U./ml	%	Total number of dogs
1	12	92	1	8	13
5	13	100	0	0	13

12 **	17	85	3	15	20
24	6	60	4	40	10

* a Rabies Specific VNA titer of >= 0.5 International Units (I.U./ml) is considered to be the minimum titer likely to provide protection against challenge.
** received booster vaccination at the time of blood sampling.

85% of the tested dogs had sufficient antibodies (>0.5 I.U./ml) one year after the third vaccination (1998). One year after the annual booster vaccination (1999), the result dropped to 60% when only half the number of dogs were tested, as compared to previous years.
From the 9 dogs, which received 2 vaccinations, only one showed more than 0.5 I.U./ml (5 dogs and 4 dogs, respectively 6 months and 2 months after the second vaccination).

In November 2000, 6 pups were tested, which had received the full course of 3 vaccinations; 5 months after the third vaccination, 4 of the 6 dogs (66%) developed sufficient antibodies.
At the same time, 3 pups that had received only 2 vaccinations were tested. Five months after the second vaccination all 3 had a titer >0.5.

Conclusion
From the data presented, it may be concluded that 3 vaccinations with an inactivated vaccine, according to the above-mentioned schedule, result in sufficient antibodies production. But, a single vaccination of such a vaccine, as recommended for domestic dogs, or even two vaccinations (the second one month after the last vaccination), do not provide adequate titers.

Parvoviral Disease (CPV) - see Appendix IV

Vaccination
The inactivated vaccine Dohyvac I-LP® (Solvay Duphar) for use against parvovirus and leptospirosis was used. In the first year, the dogs were vaccinated twice, with a one-month interval. This was followed by an annual booster vaccination. These vaccinations were following the manufacturer's protocol for treating domesticated dogs older than 12 weeks: 2 vaccinations with a 4-week interval followed by an annual, single booster vaccination.

In March 1997, antibody testing for parvovirus infection on an annual basis ceased, but the annual, single booster vaccination was continued.
However, in 1999 it was impossible for us to acquire inactivated parvovirus vaccine. Instead, the dogs received the leptospirosis vaccination, Vanguard Lepto-CI® (Pfizer).
In the year 2000, the parvovirus vaccination was resumed, with a double vaccination of Dohyvac I-LP® (Solvay Duphar).

Results
Fourteen days after the second vaccination (February 1996), all 25 dogs were well-protected (Ig G >20). One year later (March 1997), the Ig G of all dogs tested (18) was still above 20. This excellent

result was reason enough to stop antibody testing for parvovirus infection on an annual basis, but the annual vaccination was continued.

Conclusion

During the first year, two vaccinations at a 30-day interval, followed by one single booster vaccination proved to be successful: 100% of the tested dogs had sufficient antibodies one year after the second vaccination.

<u>Parasites</u>

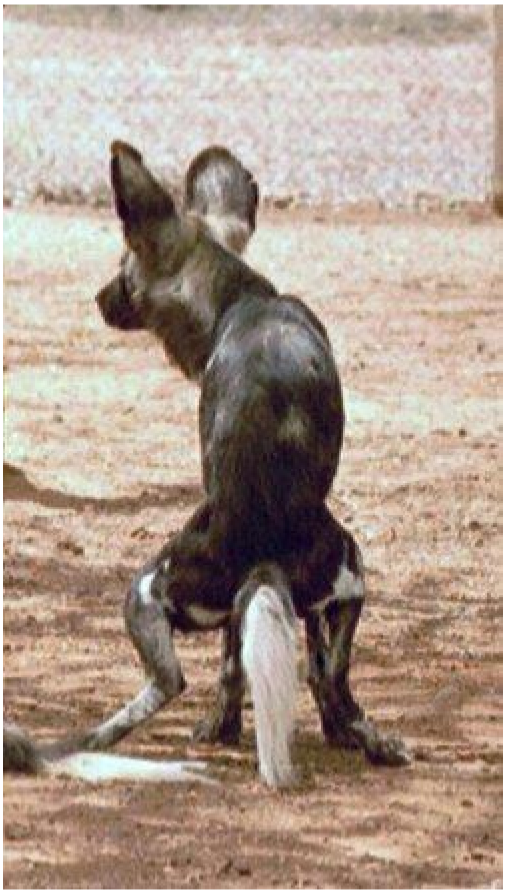
Endoparasites

In 1999, all dogs in each boma received Drontal® Dog* every three months, as an anthelmintic in their food. The dogs were not individually treated, but as a pack. The dosage was one tablet of Drontal® Dog* per 10 kg bodyweight. Pups were wormed every month until they reached the age of 7-8 months.

Twice a year, five faeces samples were taken from each pack, and were preserved with a 5% formalin solution. In March 1999, all samples were negative. However, in October 1999, the pups of the Sangito II litter started to deteriorate slowly and died one-by-one. Infection with worms was suspected, and Drontal® Dog* was administered three times to the pups at 10-day intervals. As a result, three pups survived. Faeces samples taken early in November, showed heavy infection of both round- and hookworms, in dogs in the Sangito and Kisima Packs.

The following measures were taken or continued:

1. The removal of the faeces from the bomas twice a day was continued in an even more scrutinized way.



2. Anthelmintic treatment of the Lendanai and Ayuba Packs was continued regularly--every three months. The dogs in the Sangito and Kisima boma received anthelmintic treatment every month for a period of six months. After six months, treatment was continued once every two months.

3. Females received anthelmintic treatment just after mating, and again 10 days later, to prevent the unborn pups from being infected in the uterus. As soon as they had given birth the females received the anthelmintic again, followed by a treatment 10 days later.

4. The pups received their first anthelmintic treatment as soon as they came to the surface of the dens and could take minced meat from a tray. This was followed by a second treatment 10 days

later. Treatments took place when the pups were about four weeks old.

The faeces samples collected in March and November 2000, proved to be negative again. However, the pups of the litter born 7-7-2001 were treated in a different way. The moment they started to eat solid food, the Drontal® Dog* was provided in the food of the adult pack members; i.e. the regurgitated food contained the anthelmintic. In this way, the anthelmintic was administered to the pups at an age of three weeks instead of four weeks. Unfortunately, these pups had to be separated from the adult dogs at the age of 4 weeks. However, this made it possible to treat them in an even more secure way--by putting the anthelmintic directly into their food every fortnight until they were six months old.

*Drontal® Dog (praziquantel, pyrantelembonaat, febantel), Bayer.

Blood Parasites
In March of 2000, EDTA blood samples were taken from 5 different dogs to be tested for pathogens at the Department of Parasitology and Tropical Veterinary Medicine, Faculty of Veterinary Medicine, Utrecht University, the Netherlands. GUBBELS et al. (1999), describe the technique used. The advantage of the technique is that the parasite species present can be identified, and their numbers counted if specific probes are available. At the time of testing, probes were available for Babesia, Theilleria and Ehrlichia species. Fortunately, all of the samples were negative.

Ectoparasites
On each occasion when sedation took place, the skins of the dogs were carefully checked for parasites. There were no signs of fungus infection or scabies. Fleas were detected only occasionally on the dogs. Since the flea outbreak of 1998, the dogs received Program®* in their food on the first day of each month. In combination with the application of Advantage®** at every sedation, this protocol appears to be satisfactory in keeping the fleas to an acceptable level. Obviously, we will continue this regime.

Unfortunately, the Program®* does not affect ticks, and after the devastating canine distemper episode, the Kisima boma in particular was heavily infested with young ticks. To reduce the tick numbers, the grass around the bomas was burned in the spring of 2001. As a result, the dogs in the Kisima boma had only a few ticks when sedated at the end of that year.

*Program® (lufenuron), Novartis.
**Advantage® (imidacloprid), Bayer

Veterinary work – clinical/diseases

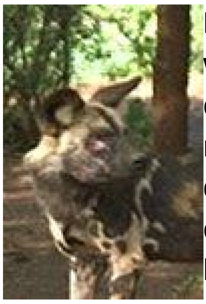
Our policy was, and remains, to interfere as little as possible in the breeding packs. Diseased dogs are only treated when it is possible to separate them, treat them and replace them immediately, or when pack treatment is required and possible. The canine distemper outbreak is described and discussed in detail.

Rectal Prolapse in Lendanai Dogs

Most unusual was the appearance and disappearance of rectal prolapse in the original Lendanai dogs. Over the past few years, three out of four Lendanai dogs occasionally showed a rectal prolapse. At the time of occurrence, they all held the alpha position, which makes it look like a stress-related condition. It may also be genetically related, as not a single dog from the Llondirrigiss or the Najo dogs showed this condition.

As described in the 1997 Report, in September of 1997, the rectal prolapse of #264 was surgically removed. At that time, #264 held the alpha female position. After her surgery, she lost that position to #262. In May of 2000, #262 also showed a rectal prolapse. The prolapse reverted in 10 days. After the male #263 was placed with the females of the first Kisima litter in a separate boma in October 1998, and in a way being forced to be alpha (being the only male), every now and then he showed a rectal prolapse. The prolapse showed for 3-5 days and then disappeared. Surgical intervention was never necessary. In both dogs, the prolapse was never larger than approximately 5 cm. As a means of precaution, both dogs were treated with Synulox®*.
Since the prolapses disappeared in less than 10 days, except for the prolapse in #264, it seems wise, provided the prolapse is not too large (less than 5 cm), to be reticent with surgery.

Wounds



Because of the occasional fighting, some dogs (mainly males), showed some wounds. Most of the time it was not necessary to treat these wounds, with a few exceptions. In December 2000, the alpha male (#289) in the Sangito Pack, had a nasty gash just under his right lower eyelid. Male #291 had a bad hind leg, with a couple of wounds. He rarely used the leg for support. The dogs had been fighting each other. An oral course of Synulox®* was administered to both of them and was beneficial.

Synulox® (amoxicllin, clavulanic acid), Pfizer.

Anesthesia

Over the years, the combination of medetomidine (Domitor®*) and ketamine HCL (100 mg/ml), with atipamezole (Antisedan®**) as an antidote for the Domitor®*, proved to be a safe way of sedating the dogs. From 1995 to 2001 slightly more than 200 sedations have been performed. Only one death (#297 in October 1997) is likely to be related to the sedation.

The drugs were administered by blowpipe, intramuscularly, in the hindquarters. For that purpose, the dogs were enclosed in a passageway. The passageway was divided into small compartments, with 2 or 3 dogs per compartment, to avoid confusion during the darting process.
Over the years, the adult dogs usually received 1.0 ml Domitor®* per 10 kg bodyweight, topped up with 0.1 ml ketamine HCL per dog--independent of their bodyweight.
Apparently, pups and adolescent dogs need a larger dosage: 1.5 ml Domitor®* per 10 kg bodyweight, topped up with the ketamine HCL. Using the dosage of the adult dogs in the young ones meant that most of them needed an extra administration of Domitor®*.
Induction time varied from 5 to 15 minutes. Some dogs were able to remove the syringe before it was completely emptied. Therefore, these, and other dogs who had received too little drug due to the mechanical failure of the syringe, received an extra 0.5 ml of Domitor®*.

This combination Domitor®* and ketamine HCL proved to be very satisfactory for purposes such as taking blood samples, applying transponders, measuring their bodyweight, etc.

The smaller dogs (<20 kg) received 1.5 ml Antisedan®**, and the larger dogs (>20kg) 2.0 ml Antisedan®**, immediately after the veterinary procedures involving them ended--on average 30 minutes after the administration of the Domitor®*.
Recovery time was 3 to 15 minutes, with little side effects from the ketamine HCL. The very slight side effects that were observed disappeared usually within 30 minutes.

*Domitor® (medetomidine hydrochloride 1 mg/ml), Pfizer.
**Antisedan® (atipamezole hydrochloride 5 mg/ml), Pfizer.

Diseases

Canine Distemper

Introduction

"Canine distemper is a disease that primarily affects the lungs, intestinal tract, and nervous system of dogs. Among the virus-induced diseases in dogs, the mortality rate of distemper is second only to that of rabies. The virus is highly contagious and is passed directly from dog to dog by close contact. The virus is easily killed by detergents and heat.

Most often young, unvaccinated dogs 3 to 6 months of age are infected with distemper. Nasal discharges containing virus are aerosolized by sneezing, thereby spreading the virus. The virus establishes itself in the nasal passages of a susceptible dog, multiplies, and spreads through the body. Dogs develop a fever a week after infection but this fever may not be noticed. Two weeks after infection, the virus produces severe damage to the cells of the nasal passages, eyes, lung, and intestinal tract. These damaged tissues commonly become secondarily infected with bacteria. This combined infection with virus and bacteria produces loss of appetite, fever, snotty nose, thick discharge from the eyes, pneumonia, and diarrhea. The virus also damages the immune system, thereby interfering with the body's ability to fight off the infection. Half of the dogs with distemper develop neurological disease."

From "Textbook of Veterinary Internal Medicine"; S.J.Ettinger, E.C.Feldman; page 1959.

Course of Infection

The first symptoms appeared in the Lendanai Pack on the 20th December, 2000. Two pups (#812 and #912), at 8 months old, showed no interest in food. One pup died overnight, the

other 2 days later. The disease ended in the Lendanai Pack with the death of #322 on the 11th of January, 2001. Between 20-12-2001 and 11-01-2001, 15 of the 16 dogs died, leaving male #325 as the sole survivor. The infection lasted for exactly 21 days.
Although it is very difficult to stop an infection like this, steps were taken to try to prevent spreading of the virus. These steps included a container with detergent posted at every boma entrance to disinfect footwear before entering and after leaving the boma, and a change of clothes and disinfecting utensils used in the boma. For the first five days, we had some hope that our efforts taken to stop the infection from spreading might succeed.

However, this was not to be, and the next boma to be infected was that of the Sangito Pack. On January 16th two Sangito pups refused food, and the alpha male (#289) started to cough. Between 16-01-2001 and 05-02-2001, 14 of the 15 dogs died, leaving the alpha female (#306) as sole survivor. The infection lasted 16 days.

At about the same time, the first symptoms of the disease appeared in the Kisima Pack, on January 18th and in the Ayubu Pack on January 24th. Between January 18th and February 13th, of 14 Kisima dogs--13 died, leaving the male (#372) as the only survivor. Between January 24th and February 11th all six dogs of the Ayubu Pack died. The duration of the infection in the Kisima Pack was 26 days, and in the Ayubu Pack it was 18 days.

On February 13th 2001, the last death occurred. The alpha male of the Kisima Pack, #298, died after one week of fighting for his life.
The epidemic lasted 56 days. By then, 49 of 52 animals had died of distemper.

Symptoms

The symptoms varied considerably and included: lack of appetite, listlessness, loss of condition, vomiting, diarrhea (greenish, watery, sometimes accompanied with blood), sneezing, coughing, and muco-purulent nasal and ocular discharge (nasal discharge more prominent than ocular discharge).

Some dogs showed few symptoms. They were just listless and without appetite one day, and dead the next day. Other dogs showed all of the symptoms; although one symptom was more obvious than the others were. For example, in one dog coughing and nasal discharge was more prominent, while in another dog diarrhea was more prominent. The disease lasted in the individual dogs from one day, to as much as ten days.
No neurological symptoms were observed.

Treatment

No antiviral drugs are available for the treatment of canine distemper. The presence of the virus presents a big opportunity for bacteria to invade the body. If a dog is lucky enough to survive the virus, it still runs the risk of dying from a secondary bacterial infection. Broad-spectrum antibiotics were used to control these infections. Since supportive therapy such as fluids and electrolytes are impossible to administer to African wild dogs without sedation, they were not used.

In all packs, antibiotics were put in the food and water. Only one dog (#289), was treated with injections of Synulox®* and Finadyne®*** (by blowpipe), for five consecutive days. He did not

recover, and his misery was possibly prolonged.
Antibiotics used were amoxicillin, Synulox®* and Baytril®**.

* Synulox® (amoxicillin, clavulanic acid), Pfizer
** Baytril® (enrofloxin), Bayer
***Fynadine® (flunixine meglumin), Schering-Plough

Discussion

The virus involved was Canine distemper virus (CDV)--(VAN DE BILDT et al., 2002). Most astonishing was that 49 out of the 52 dogs died. One might expect that some dogs die, but not in this horrifying quantity. The Mkomazi dogs lived in isolation, without direct contact with humans (and their domesticated dogs), and associated canid diseases. Consequently, the dogs had little opportunity, compared with their free-living relatives, of encountering naturally occurring canid viruses in the environment on a regular basis. Such exposure may have provided natural immunization, or at least boosted the dogs' immune system to combat such infectious diseases. Therefore, dogs kept in captive breeding programs such as the Mkomazi, appear to be more vulnerable to infectious diseases than free-living dogs, so their protection through vaccination is considered to be of paramount importance.

It is still unknown what the source of the canine distemper virus was. Direct contact with domesticated dogs can be ruled out. The nearest dogs are at a 28 km distance away, and have not been observed in the reserve for the last couple of years. Infected wild carnivores serving as reservoirs cannot be ruled out, although no diseased carnivores have been observed. Indirect contact is possible via humans or their equipment. In favor of the possibility of indirect transmission via humans, points to the fact that the outbreak started in the boma closest to the human lodgings.

As Appendix II shows, we had good reason to believe that the dogs were well protected by the vaccinations. Although the results fluctuated somewhat; the majority of the dogs tested always had a titer of 20 or more. Since the annual booster vaccinations were always given with a newly arrived batch of vaccine, any problems with the ‘cold chain’ can be dismissed. In November 2000, one month before the outbreak, the dogs were due to receive their annual booster. However, due to the fact that the safety procedures of the new batch of CDV-ISCOM vaccine had not been completed, no vaccine was available, and the dogs did not receive their annual booster vaccination. The annual booster was rescheduled for February 2001, but because this was (at the time of the outbreak) just one month overdue, it should not be the reason for the severity of the outbreak.

Also, the manner in which the vaccinations were applied should not have had an effect on the results. The dogs were either vaccinated by hand while sedated, or vaccinated by blowpipe and kept under strict observation (distance between blowpipe and target dog never more than one meter). The extremely high death rate might indicate a vaccination failure. It is possible that the vaccine used does not protect African wild dogs as well as it does the harbor seals (Phoca vitulina) and domesticated dogs. In addition, it is possible that the African wild dog differs in its antiviral immune response from that of the domesticated dog, as very little or nothing is known about this subject.

Based on our experience, canine distemper appears to be a big problem in the captive African wild dog. It may be also a problem in free-living packs. For instance, 15 of the 16 Lendanai dogs died within 21 days; 14 of the 15 dogs withdrew into the den to die. If such an occurrence took place in the wild, it is quite likely that no dog carcasses would be found. It would appear that the pack had 'just disappeared'. Only one case of CDV in free-living wild dogs has been confirmed (ALEXANDER et al, 1996).

We shall continue the Mkomazi wild dog captive breeding program, although alterations have already been made, and others are still under consideration.

Steps Taken/Considered

1. New vaccination policy and study of effect of vaccinations:

a. Change of vaccine. Instead of the CDV-ISCOM vaccine, Purevax™* (Merial) is going to be used. According to the manufacturer, Purevax™ is a lyophilized vaccine of a recombinant canarypox vector expressing the HA and F glycoproteins of canine distemper virus. More popular: a "canarypox-vectored canine distemper vaccine"; i.e. an inactivated distemper vaccine where genetic information of the distemper virus is built into the canarypox virus. The virus may multiply after injection and enhances the building up of immunity this way. After application in a mammal, the virus is unable to spread. The vaccine is developed for use in ferrets and tested in ferrets, domesticated dogs, and lesser pandas. Determination of the serum antibodies in response to the vaccination will be continued.

b. Cell mediated immunity will be studied to see how the African wild dog responds on a cellular level to the vaccine virus, which is more important than the humoral immune response in the case of canine distemper.

Both a and b are developed in close cooperation with the Institute of Virology, Erasmus University Rotterdam, the Netherlands. This Institute will carry out all of the laboratory work as well. To enlarge the number of dogs participating in this vaccination program, i.e. to come to results earlier, African wild dog pups born in Artis, Amsterdam, and Safari Beekse Bergen, Hilvarenbeek (both in the Netherlands), will participate in this program.

2. As an extra precaution to keep small animals and people at a distance, a fence of six-foot high chicken wire was placed at a distance of approximately 2 meters from the outside perimeter fence of the Sangito and Kisima bomas. The moment the other bomas are in use again, the same provision will be installed.

3. A strict policy is established in which only people with clear business are allowed in the bomas. Before entering the boma, they must disinfect their shoes with the disinfectant supplied at the door of the boma.

4. At the time of the distemper outbreak, the number of dogs was relatively high, despite the fact that the dogs were divided into four packs. Three of the four packs contained dogs/pups of different litters. As the dogs matured, they had no opportunity to move on in a natural way. Two measures should be considered:

a. As soon as pups have reached yearling age (18-24 months), and have assisted in raising the next litter, they should be removed from the pack. Accumulation of dogs is prevented that way.

b. Relocating half of the breeding program. If a new outbreak occurs, only half of the program is affected. The larger the distance that separates the two groups the less the chance that the other group is affected. The fact that two of our original dogs (#273 and #303) are still alive and well in Kenya (Ol Jogi), emphasizes this.

To prevent infection with the strain of canine distemper, circulating in East Africa, moving a pack abroad should be considered

Veterinary work – pathology

Due to the canine distemper epidemic many necropsies could have been performed, but only a limited number were carried out for reasons described in the section on pathology.

On two different occasions, not related to distemper, necropsy was also performed.

Due to the canine distemper outbreak, more necropsies than usual were performed. Only nine necropsies were performed out of the 49 dogs that died during the distemper outbreak.
This low number is explained as follows: with the exception of three, all necropsies were performed by laymen, i.e. the keepers of the dogs: Sangito and Ayubu. Over the years a bond was established between the dogs and them. It was extremely hard on the keepers to fight for the life of a dog one day, and perform a necropsy the next day. Despite their emotional bond with the dogs, they performed extremely well; preserving tissue samples of the deceased dogs in a correct way. This is even more impressive when one realizes that they were never trained in this field.
Fortunately, the diagnosis was made, and the virus isolated in an early stage of the epidemic, which made it less pressing to perform more necropsies.

VAN DE BILDT et al., (2002) describes the identification of the canine distemper virus (CDV) by means of an histological examination, virus isolation, reverse transcriptase-polymerase chain reaction analysis, and nucleotide sequencing. For results, the paper is attached to this report.

Unfortunately, we had to mourn the loss of another two dogs in 2001. In August 2001, the remaining female #306, mother of the pups, died; and in October 2001 one of her pups. On both occasions, the same procedure was followed for the necropsies of these two dogs. The histology of these two dogs is reported in detail.

Over the years pups died on different occasions. Most of the time only the head , or some other minor body-part or even nothing, of the deceased pup could be retrieved. Not enough to establish (for certain) the cause of death. Unsatisfactory, but there is nothing to do to prevent the adult dogs from scavenging the carcasses of the deceased pups.

As it is impossible to have pathological expertise at all times in Mkomazi, diagnoses have to be made on the basis of histology only, most of the time. Not finding answers for all questions is a logical consequence.

Pathology Report of #306
Date of Necropsy 04-08-2001

History
Gave birth to eight pups July 7th 2001. Pups developed well. Saturday August 4th sudden onset of symptoms: lateral recumbency, increasing dyspnoea, gasping for breath, and some blood in the saliva. Died approximately 6 hours after onset of symptoms. To the day of her death she ate well, and water intake was normal. The last two days before her death, it was noticed that her belly was enlarged.

Gross Examination of Organ Systems
No abnormalities noticed. Necropsy performed by the keeper of the dogs. Necropsy was primarily directed at collecting of tissue samples. No pus was observed in the abdominal cavity.

Histological Examination
Brain: Multifocally in white and grey matter are small areas of haemorrhage.
Heart: Multifocally in the epicardium, myocardium, and endocardium are small to medium-sized areas of hemorrhage.
Spleen: The capsule is corrugated (spleen atrophy). There is marked depletion of lymphocytes in the white pulp.
Liver: Except for a few small areas, the tissue is too autolysed for histology. There are abundant large bacilli (postmortem invaders) in the autolytic tissue.
Lung: The tissue is slightly autolytic, with extensive sloughing of epithelium and leakage of serous fluid into the alveoli. No intracytoplasmic inclusion bodies or multinucleated giant cells are seen.
Uterus: The lumen is distended and filled with pink amorphous material admixed with erythrocytes, inflammatory cells, and cell debris. Diffusely, the endometrium is infiltrated with moderate to many lymphocytes, plasma cells, and fewer macrophages, and neutrophils. Some macrophages are filled with amphophilic amorphous material. Multifocally the inflammatory infiltrate extends into the myometrium. There is multifocal hemorrhage in the uterine wall.
No abnormalities found in the following tissues: kidney.

Final Diagnoses
-Uterus: Endometrititis and myometritis, lympho-plasmacytic, diffuse, subacute, moderate.

-Brain: haemorrhage, multifocal, acute, mild.
-Heart: hemorrhage, multifocal, acute, moderate.
-Spleen: lymphocytic depletion, marked.

Final Comments
The primary lesion in this African wild dog was an inflammation of the uterus, (endo) metritis. In general, females are more likely to develop such an inflammation after parturition, as a result of bacterial infection. Based on the specimen submitted, it is not clear whether the endometritis would have been severe enough to cause death. It is possible that the lesion was more severe at other locations of the uterus. In principle, the hemorrhages observed in multiple organs fit with a toxemia due to endometritis.

Pathology Report of pup born 07-07-2001
Date of Necropsy 03-10-2001

History
Stayed behind in growth. Water intake increased. A week prior to death drinking in recumbent position.

Gross Examination of Organ System
Kidneys are markedly enlarged and pale. No other abnormalities noticed. Necropsy performed and tissue samples collected by keeper.

Histological Examination
Kidney: Diffusely, the glomeruli show loss of capillaries and are thickened by amorphous pink material (fibrous connective tissue; glomerulosclerosis). Some Bowman's capsules are filled with homogeneous light pink material (proteinaceous fluid). Diffusely, the epithelium of proximal tubuli, normally cuboidal, is squamous. Some tubuli are distended and filled with proteinaceous fluid. Multifocally in the interstitium of cortex are rare lymphocytes and plasma cells.
No abnormalities noted in the following tissues: intestine

Final Diagnosis
-Kidney: glomerulosclerosis, generalized, diffuse, marked, with tubular squamous degeneration, tubular cystic dilatation, and proteinaceous casts.

Final Comments
The primary lesion in this animal was a severe and diffuse fibrosis of the renal glomeruli, resulting in renal failure, and no doubt leading to the animal's death. The age in which this occurred and the virtual absence of inflammation or other lesions suggest that this is a genetic disease. For example, the histologic aspect resembles that of Samoyed hereditary glomerulopathy. Transmission electron microscopy of the glomerulus would be needed to further characterize the lesion.

Summary

In 1995, the George Adamson Wildlife Preservation Trusts, and The African Wild Dog Foundation, through the Ministry of Natural Resources and Tourism, and the Department of Wildlife, Tanzania, started a breeding program for the African Wild Dog in Mkomazi Game reserve, Tanzania.

In the first section, the development of the breeding packs is described, including the zoo technical aspects.

In order to protect the dogs from infectious diseases they were vaccinated against distemper, rabies and parvoviral disease. To establish the effectiveness of the vaccinations, testing for antibodies was performed.

Distemper vaccination (CDV-ISCOM) according to the schedule three vaccinations the first year (14 days between the first and second vaccination, and 30 days between the second and third vaccination), followed by an annual booster proved to be satisfactory until December 2000. Despite the vaccinations, a serious outbreak of canine distemper occurred. This outbreak is extensively reported on and discussed.

Three rabies vaccinations in the first year--one month between the first and second, and five months between the second and the third, followed by an annual booster, gave a satisfactory quantity of antibodies.

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Appendix 1 - body weight in kilograms

Identification		Sex	Date of birth	19/12/1995 kg	29/02/1996 kg	09/03/1997 kg	15/10/1997 kg	15/02/1998 kg	04/10/1998 kg	30/03/1999 kg	02/11/1999 kg	30/03/2000 kg	08/11/2000 kg	13/03/2001 kg
Lendanai	261	F		12	13.1	20.5			19.6	19.7				
Lendanai	262	F		11.1	12	19			19.6	18.8				
Lendanai	263	M		13.3	14.5	23.3	25.5	25	23.3		23.1			
Lendanai	264	F		12.4	14.1	21			21.2	20.7				
Llondirrigiss	289	M			13.7	22		24.8	24					
Llondirrigiss	291	M		9.2	11.9	20.2		26.5	22.7		20.3			
Llondirrigiss	293	M		10	12.7	22	22.5		23.8					
Llondirrigiss	294	M		10.5	14	25	28	27	25.6		23.6			
Llondirrigiss	296	M		10	10.8	23.5			26.5					
Llondirrigiss	297	F		9.1	13		22	died						
Llondirrigiss	298	M		11.1	15.5	25.5	27	25			24.9			
Llondirrigiss	299	M		10.5	14.3	Kenya								
Najo	265	F		8.1	9	17.2	19.5	18.1	17.1		18.1			
Najo	273	M		9.1	10.5	Kenya								
Najo	274	M		9.8	12.4	22.5			23.7	22.7				
Najo	276	F		8.7	10.5	17.5	15	17.7	18					
Najo	284	F		8.1	9.8	16.5	15.8	17.1	18					
Najo	285	F		8	9.5	17	15.9	17.5	17.9		17.4			
Najo	288	M		10.1	12	Kenya								
Najo	300	M		9.8	11.8		23	23.5	22					
Najo	303	M		9.7	11.9	Kenya								
Najo	305	F		9.5	11.2	19	22.3	20.8	19.2		20.4			
Najo	306	F		9.2	11.5	18.5	20.8	19.5	18.9					
Najo	308	F		9.3	10.7	19	22.5	20.5	19.3		20.6			
Najo	310	M		8.8	11.8	22			22.3	22				
Kisima I	333	M	04/03/1997				17.8	21.9	24		24.4			
Kisima I	335	M	04/03/1997				17	22.7	22.1		23.3			
Kisima I	336	F	04/03/1997				14.5	19	20.6		20.6			
Kisima I	337	F	04/03/1997				15.7	19	21.3		20			
Kisima I	348	F	04/03/1997				16.1	22.3	21		20.4			
Lenjo I	322	M	01/02/1998						14.7	17.8	19.7	19.4		
Lenjo I	323	F	01/02/1998						16.5	19.9	19.1	19.7		
Lenjo I	325	M	01/02/1998						17	19.9		21.4		19.9

Lenjo I	327	F	01/02/1998						17.2	20.6	20.6	20.8		
Lenjo I	329	M	01/02/1998						18			23.5		
Sangito I	352	M	05/03/1998						11.7			21.7		
Sangito I	355	M	05/03/1998						12.7			23.9		
Sangito I	358	M	05/03/1998						12.7			21.5		
Sangito I	359	M	05/03/1998						12.2			19.6		
Kisima II	366	M	08/01/1999								19.1		20.7	
Kisima II	369	M	08/01/1999								18.3		20.4	
Kisima II	372	M	08/01/1999								17.7		19.9	20.5
Sangito II	319	F	12/09/1999										18.2	
Sangito II	360	M	12/09/1999										15.6	
Sangito II	361	M	12/09/1999										17.5	
Kisima III	312	M	16/09/1999										19.9	
Kisima III	344	M	16/09/1999										14.9	
Kisima III	349	F	16/09/1999										15.9	
Lenjo II	780	F	03/04/2000										12.2	
Lenjo II	812	F	03/04/2000										10.4	
Lenjo II	817	M	03/04/2000										10.7	
Lenjo II	850	M	03/04/2000										12.1	
Lenjo II	893	M	03/04/2000										11.5	
Lenjo II	912	F	03/04/2000										9.8	
Lenjo II	924	F	03/04/2000										12.3	
Ayuba I		F	25/05/2000											
Sangito III		F/M	12/06/2000											
Sangito III		F/M	12/06/2000											
Sangito III		F/M	12/06/2000											
Sangito III		F/M	12/06/2000											
Sangito III		F/M												
Sangito III		F/M												
Sangito III		F/M												
Sangito III		F/M												

V = vaccination CDV-ISCOM
Neutralizing antibodies were tested
20 and up means well protected

Appendix II

Distemper antibodies levels (NVT) and vaccination dates

				19/12/1995		03/01/1996		14/02/1996		29/02/1996		09/03/1997		28/06/1997		02/08/1997		27/09/1997		15/10/1997		10/12/1997		15/02/1998
Identification		Sex		DO NT-Titer		DO NT-Titer		DO NT-Titer		DO NT-Titer		DO NT-Titer		DO NT-Titer		DO NT-Titer		DO NT-Titer		DO NT-Titer		DO NT-Titer		DO NT-Titer
Lendanai	261	F	V	540	V		V			20	V	20											V	
Lendanai	262	F	V	20	V		V			60	V	<20											V	
Lendanai	263	M	V	540	V		V			60	V	<20								<20			V	20
Lendanai	264	F	V	<20	V		V			60	V	20								<20			V	
Llondirrigiss	289	M	V	20	V		V			<20	V	<20								<20			V	20
Llondirrigiss	291	M	V		V		V			180	V	20								<20			V	20
Llondirrigiss	293	M	V	<20	V		V			60	V	<20								<20			V	
Llondirrigiss	294	M	V		V		V			20	V	<20								<20			V	20
Llondirrigiss	296	M	V		V		V			60	V	20								<20			V	
Llondirrigiss	297	F	V		V		V			<20	V									died <20				
Llondirrigiss	298	M	V		V		V			20	V	<20								<20			V	20
Llondirrigiss	299	M	V	180	V		V			60	Kenya													
Najo	265	F	V	20	V		V			20	V	20								<20			V	20
Najo	273	M	V		V		V			60	Kenya													
Najo	274	M	V		V		V			<20	V	<20											V	
Najo	276	F	V		V		V			180	V	<20								<20			V	20
Najo	284	F	V		V		V			60	V	<20								<20			V	20
Najo	285	F	V		V		V			180	V	<20								<20			V	<20
Najo	288	M	V		V		V			540	Kenya													
Najo	300	M	V	60	V		V			20	V									<20			V	20
Najo	303	M	V	<20	V		V			20	Kenya													
Najo	305	M	V	20	V		V			60	V	<20								<20			V	20
Najo	306	F	V	60	V		V			60	V	<20								<20			V	20
Najo	308	F	V		V		V			20	V	<20								<20			V	
Najo	310	M	V		V		V			60	V	<20											V	
Kisima I	333	M											V		V		V			<20	V		V	<20
Kisima I	335	M											V		V		V			<20	V		V	20
Kisima I	336	F											V		V		V			<20	V		V	<20
Kisima I	337	F											V		V		V			<20	V		V	20
Kisima I	348	F											V		V		V			<20	V		V	<20
Lenjo I	322	M																						
Lenjo I	323	F																						
Lenjo I	325	M																						
Lenjo I	327	F																						

Lenjo I	329	M																						
Sangito I	352	M																						
Sangito I	355	M																						
Sangito I	358	M																						
Sangito I	359	M																						
Kisima II	366	M																						
Kisima II	369	M																						
Kisima II	372	M																						
Sangito II	319	F																						
Sangito II	360	M																						
Sangito II	361	M																						
Kisima III	312	M																						
Kisima III	344	F																						
Kisima III	349	F																						
Lenjo II	780	F																						
Lenjo II	812	F																						
Lenjo II	817	M																						
Lenjo II	850	M																						
Lenjo II	893	M																						
Lenjo II	912	F																						
Lenjo II	924	F																						
Ayubu I		F																						
Sangito III		F/M																						
Sangito III		F/M																						
Sangito III		F/M																						
Sangito III		F/M																						

Distemper antibodies levels (NVT) and vaccination dates

Identification		Sex		27/06/1998 DO NT-Titer		12/08/1998 DO NT-Titer		10/09/1998 DO NT-Titer		04/10/1998 DO NT-Titer		04/11/1998 DO NT-Titer		10/02/1999 DO NT-Titer		30/03/1999 DO NT-Titer		02/11/1999 DO NT-Titer		22/01/2000 DO NT-Titer		06/02/2000 DO NT-Titer
Lendanai	261	F							V	40						80	V	60				
Lendanai	262	F							V	40						80	V					
Lendanai	263	M							V	20							V	20				
Lendanai	264	F							V	40						80	V					
Llondirrigiss	289	M							V								V					
Llondirrigiss	291	M							V	80							V	20				
Llondirrigiss	293	M							V	80							V					
Llondirrigiss	294	M							V	20							V	60				
Llondirrigiss	296	M							V	40							V					
Llondirrigiss	297	F																				
Llondirrigiss	298	M							V	40							V	20				
Llondirrigiss	299	M																				
Najo	265	F							V	80							V					
Najo	273	M																				
Najo	274	M							V	20						80	V					
Najo	276	F							V	80							V					
Najo	284	F							V	20							V					
Najo	285	F							V	20							V	<20				
Najo	288	M																				
Najo	300	M							V	80							V					
Najo	303	M																				
Najo	305	M							V	20							V	20				
Najo	306	F							V	80							V					
Najo	308	F							V	20							V	60				
Najo	310	M							V	40						80	V	20				
Kisima I	333	M							V	80							V	20				
Kisima I	335	M							V	40							V	20				
Kisima I	336	F							V	40							V	20				
Kisima I	337	F							V	40							V	20				
Kisima I	348	F							V	20							V	<20				
Lenjo I	322	M	V		V		V		V	40						80	V	20				
Lenjo I	323	F	V		V		V		V	20						80	V	<20				
Lenjo I	325	M	V		V		V		V	40						80	V					
Lenjo I	327	F	V		V		V		V	40						80	V	20				
Lenjo I	329	M	V		V		V		V	80						80	V					
Sangito I	352	M							V	80	V		V				V					

Sangito I	355	M							V	80	V		V				V					
Sangito I	358	M							V	80	V		V				V					
Sangito I	359	M							V	20	V		V				V					
Kisima II	366	M															V					
Kisima II	369	M															V					
Kisima II	372	M															V					
Sangito II	319	F																	V		V	
Sangito II	360	M																	V		V	
Sangito II	361	M																	V		V	
Kisima III	312	M																	V		V	
Kisima III	344	F																	V		V	
Kisima III	349	F																	V		V	
Lenjo II	780	F																				
Lenjo II	812	F																				
Lenjo II	817	M																				
Lenjo II	850	M																				
Lenjo II	893	M																				
Lenjo II	912	F																				
Lenjo II	924	F																				
Ayubu I		F																				
Sangito III		F/M																				
Sangito III		F/M																				
Sangito III		F/M																				
Sangito III		F/M																				

Distemper antibodies levels (NVT) and vaccinations dates

Identification		Sex		22/03/2000 DO NT-Titer		30/03/2000 DO NT-Titer		18/06/2000 DO NT-Titer		08/11/2000 DO NT-Titer		24/11/2000 DO NT-Titer		13/03/2001 DO NT-Titer
Lendanai	261	F												
Lendanai	262	F												
Lendanai	263	M												
Lendanai	264	F												
Llondirrigiss	289	M												
Llondirrigiss	291	M												
Llondirrigiss	293	M												
Llondirrigiss	294	M												
Llondirrigiss	296	M												
Llondirrigiss	297	F												
Llondirrigiss	298	M												
Llondirrigiss	299	M												
Najo	265	F												
Najo	273	M												
Najo	274	M												
Najo	276	F												
Najo	284	F												
Najo	285	F												
Najo	288	M												
Najo	300	M												
Najo	303	M												
Najo	305	M												
Najo	306	F												
Najo	308	F												
Najo	310	M												
Kisima I	333	M												
Kisima I	335	M												
Kisima I	336	F												
Kisima I	337	F												
Kisima I	348	F												
Lenjo I	322	M				20								
Lenjo I	323	F				20								
Lenjo I	325	M				<20							V	320
Lenjo I	327	F				60								
Lenjo I	329	M				20								
Sangito I	352	M				<20								

Sangito I	355	M				20								
Sangito I	358	M				20								
Sangito I	359	M				<20								
Kisima II	366	M			V		V			<20				
Kisima II	369	M			V		V			<20				
Kisima II	372	M			V		V			20			V	80
Sangito II	319	F	V							<20				
Sangito II	360	M	V							<20				
Sangito II	361	M	V							<20				
Kisima III	312	M	V							<20				
Kisima III	344	F	V							<20				
Kisima III	349	F	V							<20				
Lenjo II	780	F							V	<20	V			
Lenjo II	812	F							V	<20	V			
Lenjo II	817	M							V	<20	V			
Lenjo II	850	M							V	<20	V			
Lenjo II	893	M							V	<20	V			
Lenjo II	912	F							V	<20	V			
Lenjo II	924	F							V	<20	V			
Ayubu I		F												
Sangito III		F/M												
Sangito III		F/M												
Sangito III		F/M												
Sangito III		F/M												

V = vaccination CDV_ISCOM
Neutralizing antibodies were tested
20 and up means well protected

Appendix III

Rabies antibody levels and vaccination dates

		Sex		19/12/1995 IU		29/02/1996 IU		09/03/1997 IU		09/04/1997 IU		28/06/1997 IU		02/08/1997 IU		22/09/1997 IU		15/10/1997 IU		10/12/1997 IU		15/02/1998 IU		27/06/1998 IU
Lendanai	261	F	V			0	V	<0.5	V						V									
Lendanai	262	F	V			0	V	0.5	V						V									
Lendanai	263	M	V			0	V	>0.5	V						V			>0.5				>0.5		
Lendanai	264	F	V			0	V	>0.5	V						V			>0.5						
Llondirrigiss	289	M	V			0	V	<0.5	V								V	<0.5*				>0.5		
Llondirrigiss	291	M	V			0	V	<0.5	V								V	>0.5*				>0.5		
Llondirrigiss	293	M	V			0	V	>0.5	V						V			>0.5						
Llondirrigiss	294	M	V			0	V	<0.5	V								V	<0.5*				>0.5		
Llondirrigiss	296	M	V			0	V	<0.5	V						V			>0.5						
Llondirrigiss	297	F	V			0	V		V						V			<0.5				died		
Llondirrigiss	298	M	V			0	V	<0.5	V						V			>0.5				>0.5		
Llondirrigiss	299	M	V			0	Kenya																	
Najo	265	F	V			0	V	<0.5	V						V			>0.5				>0.5		
Najo	273	M	V			0	Kenya																	
Najo	274	M	V			0	V	<0.5	V						V									
Najo	276	F	V			0	V	<0.5	V						V			>0.5				>0,5		
Najo	284	F	V			0	V	<0.5	V						V			>0.5				>0.5		
Najo	285	F	V			0	V	>0.5	V						V			>0.5				>0.5		
Najo	288	M	V			0	Kenya																	
Najo	300	M	V			0	V		V						V			>0.5				>0.5		
Najo	303	M	V			0	Kenya																	
Najo	305	M	V			0	V	>0.5	V								V	>0.5*				>0.5		
Najo	306	F	V			0	V	<0.5	V						V			>0.5				>0.5		
Najo	308	F	V			0	V	<0.5	V						V			>0.5				>0.5		
Najo	310	M	V			0	V	>0.5	V						V									
Kisima I	333	M									V		V					<0.5*	V			<0.5		
Kisima I	335	M									V		V					<0.5*	V			>0.5		
Kisima I	336	F									V		V					<0.5*	V			>0.5		
Kisima I	337	F									V		V					<0.5*	V			>0.5		
Kisima I	348	F									V		V					<0.5*	V			>0.5		
Lenjo I	322	M																					V	
Lenjo I	323	F																					V	
Lenjo I	325	M																					V	

Lenjo I	327	F																					V	
Lenjo I	329	M																					V	
Sangito I	352	M																						
Sangito I	355	M																						
Sangito I	358	M																						
Sangito I	359	M																						
Kisima II	366	M																						
Kisima II	369	M																						
Kisima II	372	M																						
Sangito II	319	F																						
Sangito II	360	M																						
Sangito II	361	M																						
Kisima III	312	M																						
Kisima III	344	F																						
Kisima III	349	F																						
Lenjo II	780	F																						
Lenjo II	812	F																						
Lenjo II	817	M																						
Lenjo II	850	M																						
Lenjo II	893	M																						
Lenjo II	912	F																						
Lenjo II	924	F																						
Ayubu I		F																						
Sangito III		F/M																						
Sangito III		F/M																						
Sangito III		F/M																						
Sangito III		F/M																						

Rabies antibody levels and vaccination dates

				12/08/1998		04/10/1998		04/11/1998		30/03/1999		02/11/1999		22/01/2000		22/03/2000		30/03/2000		18/06/2000		08/11/2000		13/03/2001
Identification		Sex		IU		IU		IU		IU		IU		IU		IU		IU		IU		IU		IU
Lendanai	261	F			V	>0.5				>0.5	V	<0.5									V			
Lendanai	262	F			V	>0.5				>0.5	V										V			
Lendanai	263	M			V	>0.5					V	<0.5									V			
Lendanai	264	F			V	>0.5					V										V			
Llondirrigiss	289	M			V	>0.5					V										V			
Llondirrigiss	291	M			V	>0.5					V	>0.5									V			
Llondirrigiss	293	M			V	>0.5					V										V			
Llondirrigiss	294	M			V	<0.5					V	<0.5									V			
Llondirrigiss	296	M			V	>0.5					V										V			
Llondirrigiss	297	F									V										V			
Llondirrigiss	298	M			V	>0.5					V	<0.5									V			
Llondirrigiss	299	M																						
Najo	265	F			V	>0.5					V	>0.5									V			
Najo	273	M																						
Najo	274	M			V	>0.5				>0.5	V										V			
Najo	276	F			V	>0.5					V										V			
Najo	284	F			V	>0.5					V										V			
Najo	285	F			V	>0.5					V	>0.5									V			
Najo	288	M																						
Najo	300	M			V	<0.5					V										V			
Najo	303	M																						
Najo	305	M			V	>0.5					V	>0.5									V			
Najo	306	F			V	>0.5					V										V			
Najo	308	F			V	>0.5					V	>0.5									V			
Najo	310	M			V	>0.5					V	>0.5									V			
Kisima I	333	M			V	>0.5					V	>0.5									V			
Kisima I	335	M			V	>0.5					V	<0.5									V			
Kisima I	336	F			V	>0.5					V	<0.5									V			
Kisima I	337	F			V	>0.5					V	<0.5									V			
Kisima I	348	F			V	<0.5					V	<0.5									V			
Lenjo I	322	M	V		V	>0.5*				>0.5	V	<0.5						<0.5			V			
Lenjo I	323	F	V		V	>0.5*				>0.5	V	<0.5						<0.5			V			
Lenjo I	325	M	V		V	>0.5*				>0.5	V							>0.5			V		V	>0.5
Lenjo I	327	F	V		V	>0.5*				>0.5	V	<0.5						<0.5			V			
Lenjo I	329	M	V		V	>0.5*				>0.5	V							<0.5			V			

Sangito I	352	M			V	<0.5	V											<0.5			V			
Sangito I	355	M			V	<0.5	V											<0.5			V			
Sangito I	358	M			V	<0.5	V											<0.5			V			
Sangito I	359	M			V	<0.5	V											<0.5			V			
Kisima II	366	M															V		V		V	>0.5		
Kisima II	369	M															V		V		V	>0.5		
Kisima II	372	M															V		V		V	>0.5	V	>0.5
Sangito II	319	F											V		V				V		V	>0.5		
Sangito II	360	M											V		V				V		V	>0.5		
Sangito II	361	M											V		V				V		V	>0.5		
Kisima III	312	M											V		V				V		V	<0.5		
Kisima III	344	F											V		V				V		V	<0.5		
Kisima III	349	F											V		V				V		V	>0.5		
Lenjo II	780	F																			V			
Lenjo II	812	F																			V	<0.5		
Lenjo II	817	M																			V	<0.5		
Lenjo II	850	M																			V	<0.5		
Lenjo II	893	M																			V	<0.5		
Lenjo II	912	F																			V			
Lenjo II	924	F																			V	<0.5		
Ayubu I		F																						
Sangito III		F/M																						
Sangito III		F/M																						
Sangito III		F/M																						
Sangito III		F/M																						

V = vaccination
Resistance against rabies is measured in International Units (I.U.)
0.5 I.U. and up means well protected
* Two times vaccinated at the time of testing (15-10-97)

Appendix IV

Parvo antibody level and vaccination dates

				19/12/1995		15/12/1996		29/02/1996		09/03/1997		28/06/1997		02/08/1997		15/02/1998		27/06/1998		12/08/1998		04/10/1998
Identification		Sex		Ig G		Ig G		Ig G		Ig G		Ig G		Ig G		Ig G		Ig G		Ig G		Ig G
Lendanai	261	F	V		V			13,500	V	100					V						V	
Lendanai	262	F	V		V			1,500	V	90					V						V	
Lendanai	263	M	V		V			4,500	V	150					V						V	
Lendanai	264	F	V		V			1,500	V	270					V						V	
Llondirrigiss	289	M	V		V			1,000	V	270					V						V	
Llondirrigiss	291	M	V		V			13,500	V	270					V						V	
Llondirrigiss	293	M	V		V			1,500	V	100					V							
Llondirrigiss	294	M	V		V			1,500	V	90					V						V	
Llondirrigiss	296	M	V		V			500	V	90					V							
Llondirrigiss	297	F	V		V			4,500	died													
Llondirrigiss	298	M	V		V			1,500	V	100					V						V	
Llondirrigiss	299	M	V		V			1,500	Kenya													
Najo	265	F	V		V			1,500	V	100					V						V	
Najo	273	M	V		V			1,500	Kenya												V	
Najo	274	M	V		V			1,000	V	30					V						V	
Najo	276	F	V		V			500	V	90					V							
Najo	284	F	V		V			500	V	80					V							
Najo	285	F	V		V			1,500	V	90					V							
Najo	288	M	V		V			1,500	Kenya												V	
Najo	300	M	V		V			1,500	V						V							
Najo	303	M	V		V			13,500	Kenya												V	
Najo	305	M	V		V			1,500	V	90					V						V	
Najo	306	F	V		V			1,500	V	90					V						V	
Najo	308	F	V		V			4,500	V	90					V						V	
Najo	310	M	V		V			100	V						V						V	
Kisima I	333	M									V		V		V							
Kisima I	335	M									V		V		V							
Kisima I	336	F									V		V		V						V	
Kisima I	337	F									V		V		V						V	
Kisima I	348	F									V		V		V						V	

Lenjo I	322	M															V		V		V	
Lenjo I	323	F															V		V		V	
Lenjo I	325	M															V		V		V	
Lenjo I	327	F															V		V		V	
Lenjo I	329	M															V		V		V	
Sangito I	352	M																			V	
Sangito I	355	M																			V	
Sangito I	358	M																			V	
Sangito I	359	M																			V	
Kisima II	366	M																				
Kisima II	369	M																				
Kisima II	372	M																				
Sangito II	319	F																				
Sangito II	360	M																				
Sangito II	361	M																				
Kisima III	312	M																				
Kisima III	344	F																				
Kisima III	349	F																				
Lenjo II	780	F																				
Lenjo II	812	F																				
Lenjo II	817	M																				
Lenjo II	850	M																				
Lenjo II	893	M																				
Lenjo II	912	F																				
Lenjo II	924	F																				
Ayubu I		F																				
Sangito III		F/M																				
Sangito III		F/M																				
Sangito III		F/M																				
Sangito III		F/M																				

Identification		Sex		04/11/1998 Ig G		30/03/1999 Ig G		30/03/2000 Ig G		18/06/2000 Ig G		18/11/2000 Ig G		24/11/2000 Ig G		13/03/2001 Ig G
Lendanai	261	F					V				V					
Lendanai	262	F					V				V					
Lendanai	263	M					V				V					
Lendanai	264	F					V				V					
Llondirrigiss	289	M					V				V					
Llondirrigiss	291	M					V				V					
Llondirrigiss	293	M			V		V				V					
Llondirrigiss	294	M					V				V					
Llondirrigiss	296	M			V		V				V					
Llondirrigiss	297	F														
Llondirrigiss	298	M			V		V				V					
Llondirrigiss	299	M														
Najo	265	F					V				V					
Najo	273	M														
Najo	274	M					V				V					
Najo	276	F			V		V				V					
Najo	284	F			V		V				V					
Najo	285	F			V		V				V					
Najo	288	M														
Najo	300	M			V		V				V					
Najo	303	M														
Najo	305	M					V				V					
Najo	306	F					V				V				V	
Najo	308	F					V				V					
Najo	310	M					V				V					
Kisima I	333	M			V		V				V					
Kisima I	335	M			V		V				V					
Kisima I	336	F					V				V					
Kisima I	337	F					V				V					
Kisima I	348	F					V				V					
Lenjo I	322	M					V				V					
Lenjo I	323	F					V				V					
Lenjo I	325	M					V				V				V	
Lenjo I	327	F					V				V					

Lenjo I	329	M					V				V					
Sangito I	352	M	V				V				V					
Sangito I	355	M	V				V				V					
Sangito I	358	M	V				V				V					
Sangito I	359	M	V				V				V					
Kisima II	366	M					V		V							
Kisima II	369	M					V		V							
Kisima II	372	M					V		V						V	
Sangito II	319	F					V		V							
Sangito II	360	M					V		V							
Sangito II	361	M					V		V							
Kisima III	312	M					V		V							
Kisima III	344	F					V		V							
Kisima III	349	F					V		V							
Lenjo II	780	F									V		V			
Lenjo II	812	F									V		V			
Lenjo II	817	M									V		V			
Lenjo II	850	M									V		V			
Lenjo II	893	M									V		V			
Lenjo II	912	F									V		V			
Lenjo II	924	F									V		V			
Ayubu I		F														
Sangito III		F/M														
Sangito III		F/M														
Sangito III		F/M														
Sangito III		F/M														