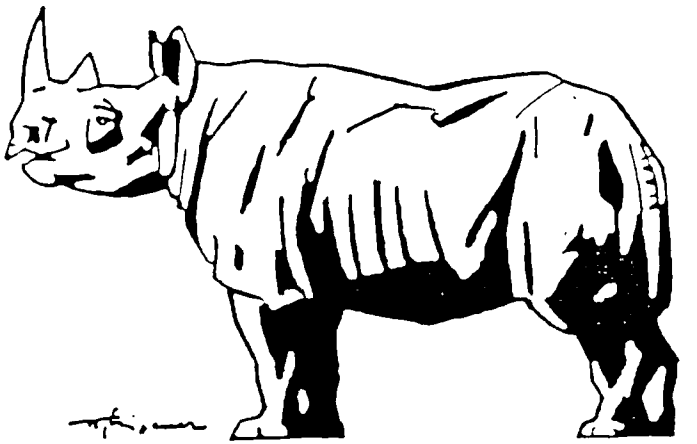
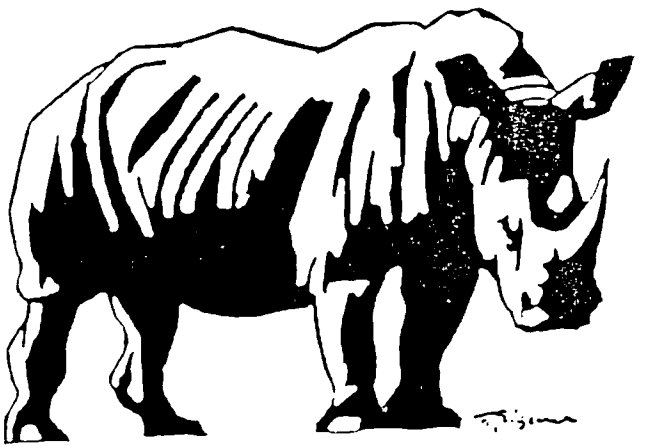
ZOOLOGISCHER GARTEN BERLIN

INTERNATIONALES ZUCHTBUCH FÜR AFRIKANISCHE NASHÖRNER
(Diceros bicornis/Ceratotherium simum)

INTERNATIONAL STUDBOOK FOR AFRICAN RHINOCEROSES
(Diceros bicornis/Ceratotherium simum)

Nr. 4





1.1.1991

INTRODUCTION to the 4th revised edition of the International Studbook of African Rhinoceroses

The drastic decline of black rhinoceroses in the wild to this date could not be brought to a halt.

In the 3rd edition (1987) of the INTERNATIONAL STUDBOOK OF AFRICAN RHINOCEROSES the international studbook keeper reports on the critical situation of this large mammal in the wild.
October 1986 an African Rhino Workshop was initiated and carried out by AAZPA - union of all North American zoospecialists. In 1986 estimated population of black rhino on the African continent totalled 4,000 animals. More effective protection of the species was demanded on a national and international basis. However, the better armed gamewardens became and the more flying personnel was mobilized the better armed and the more mobile poachers became.

The decline could, however, be slowed down in the past years. Till today the black rhino population was reduced to 3,000. Until 1970 the eastern black rhino subspecies *Diceros b. michaeli* predominated in number, today the southern subspecies *Diceros b. minor* is represented by about 2,000 individuals (BROOKS, 1989), totalling approximately one third of the entire population.

Due to actions taken by the authorities of the Republic of South Africa and Zimbabwe the situation of the southern white rhino subspecies remains stable. Its present status in the wild is about 3,500 animals. The black rhino population in that region also seems secured.

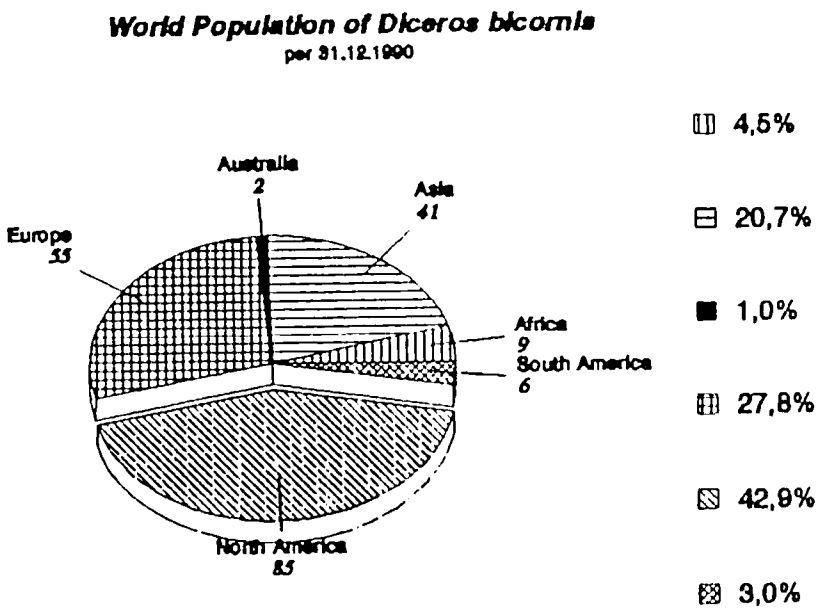
Dangerously small is the population of the northern white rhino subspecies *Ceratotherium s. cottoni*. REECE (1990) reports of 26 individuals - too small a basis for survival! However, encouraging are 4 births reported from Garamba National Park (Zaire) 1989 - last stronghold of *Ceratoterium s. cottoni*.
The situation for the captive *Ceratotherium s. cottoni* population is worse still: only 12 (5.7) animals live in zoos, 10 (3.7) of which in Dvur Kralove Zoo, CSFR.

1. GENERAL POPULATION TREND OF BLACK RHINOCEROSES IN CAPTIVITY

Captive live population of black rhino as of 31.12.1990 is 204 (91,113) animals in 72 locations.
Between 1987 and 1990 there were 24 (10.14) births of *Diceros b. michaeli* and 6 (2.4) births of *Diceros b. minor*. 10 (4.6) Diceros b. minor were acquired from Zimbabwe by zoos in the USA and 1.1 by Frankfurt/M Zoo, Germany. The importation to Northamerica was recommended and arranged for by the CBSG - CAPTIVE BREEDING SPECIALIST GROUP - a section of the International Union for Conservation of Nature (IUCN).
Goal of the transfer was to open two alternatives to international black rhino conservationists:
1. planned management of the population in situ
2. set up of population within the Species Suvival Program (SSP) of zoological gardens.

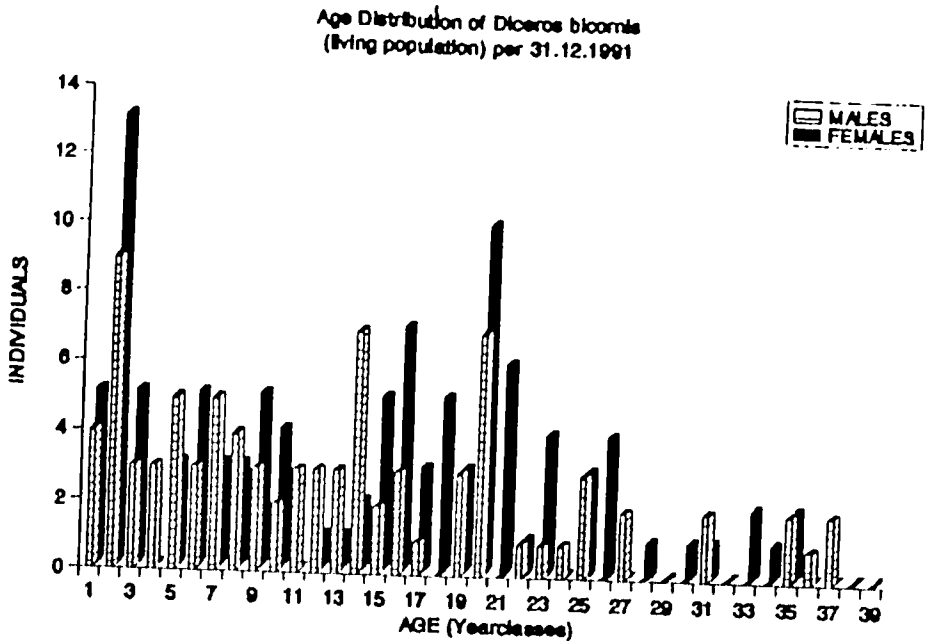
For the survival of the black rhino subspecies this initiative is of enormous importance since today only 24 (10.14) animals live in captivity.
Conservation efforts of European zoos - co-ordinated in the Continental European Survival Program (EEP) - were rewarded with rather good breeding results in Berlin, Zurich and Dvur Kraloè and may be attributed to planned management of population and planned transfer of breeding males. Between 1987 and 1990 there were 26 (14.12) black rhino deaths, average age being 18,5 years (maximum age 36 sofar). Seven animals died under the age of 1 year.

Figure 1



Above live black rhino world population (by continents) shows that North America takes predecence of all other continents with 85 animals.
Population increase in Asia may be attributed to the remarkable engagement of Japanese zoos. The European population became stabilized due to good breeding results.
Age-structure of the world live population average between 1 to 26. Only about 10 % of the population is older than that. One female is 40 years old. More than half the black rhino population is of breeding age (figure 2).

Figure 2



A large number of the North American live population is under 20 years of age. Noticeable is the large number of individuals under 5 (figure 3).

Individuals kept in Europe are older on an average. Less individuals in Europe are under 5, indicating a rise in ratio of old individuals to total population (figure 4).

Age-structure of Asian populations is quite balanced (figure 5).

Figure 3

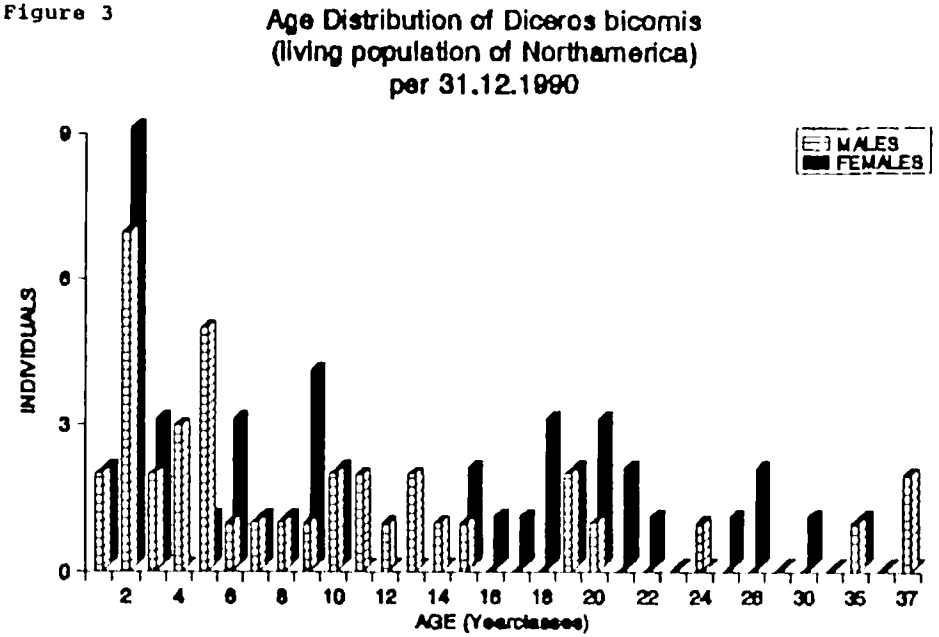


Figure 4

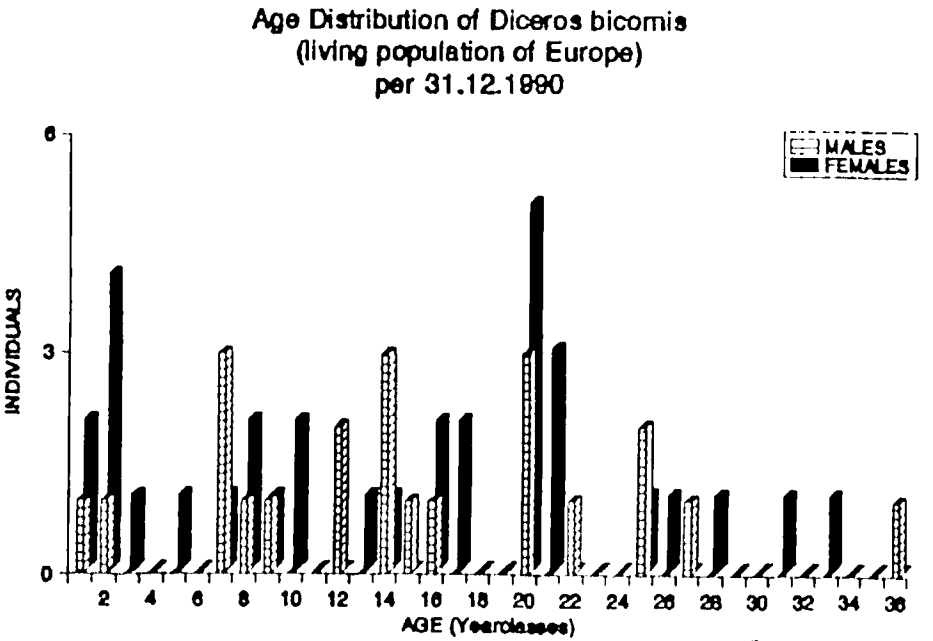


Figure 5

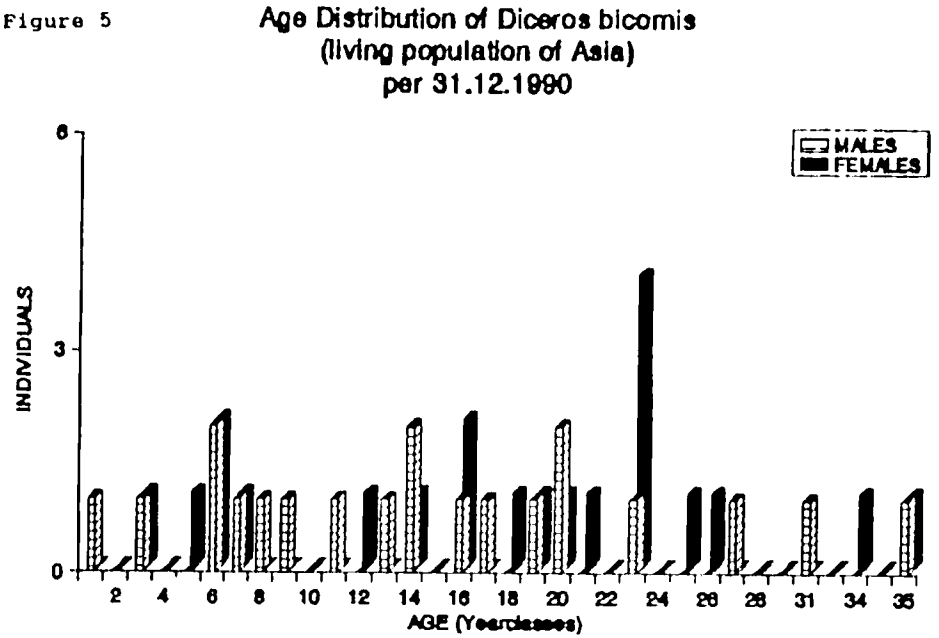
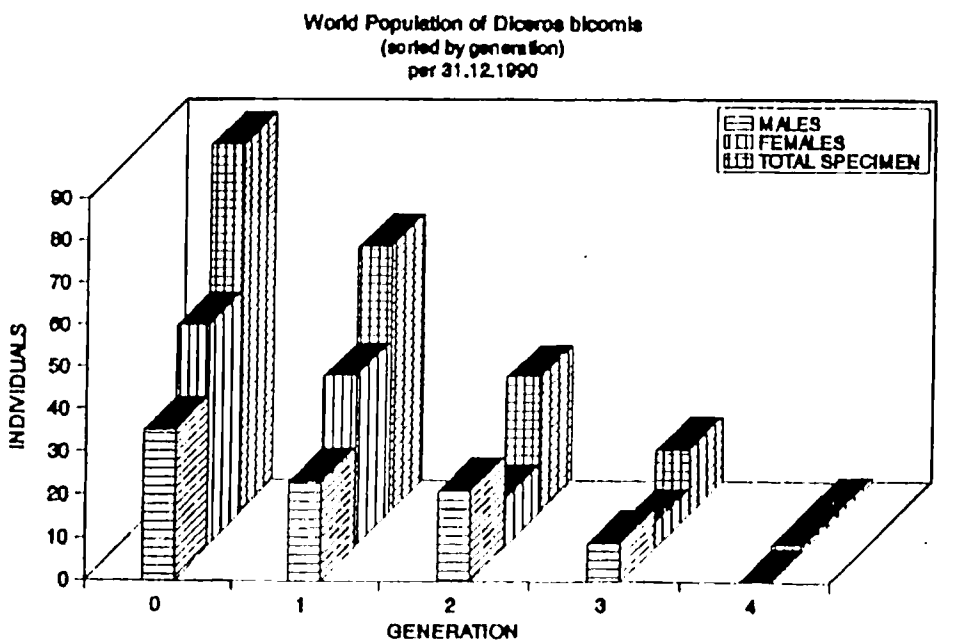


Figure 6



About 40 % of the captive live black rhino world population belong to the wild born founder generation; 30 % are 1st generation, and appr. 15 % 2nd generation. All other are 3rd generation animals.
One female cross breed (*Diceros b. michaeli* x *Diceros b. minor*) in Linn, North America, represents 4th generation (figure 6).
World-wide birth-rate by months shows an increase in the second half-year, which may be due to the fact that institutions mate their animals in spring and summer (figure 7).
Figure 8 (age-structure of dead population) clearly reveals an enormously high death-rate in black rhino under 4 years of age. Highest death-rate is found in animals under 2.

About 60 % of the total dead population died under 20 years of age. 30 % died between 20 and 30; all other lived to be older than 30 (figure 8).
In North America losses are even in young black rhino between 0 to 4 (figure 9).

In Europe less losses occur within the same age-group (figure 10).

Due to low reproduction age-structure of black rhino population in Asia is more less even. Here losses of young individuals represent no significance (figure 11).

Figure 7

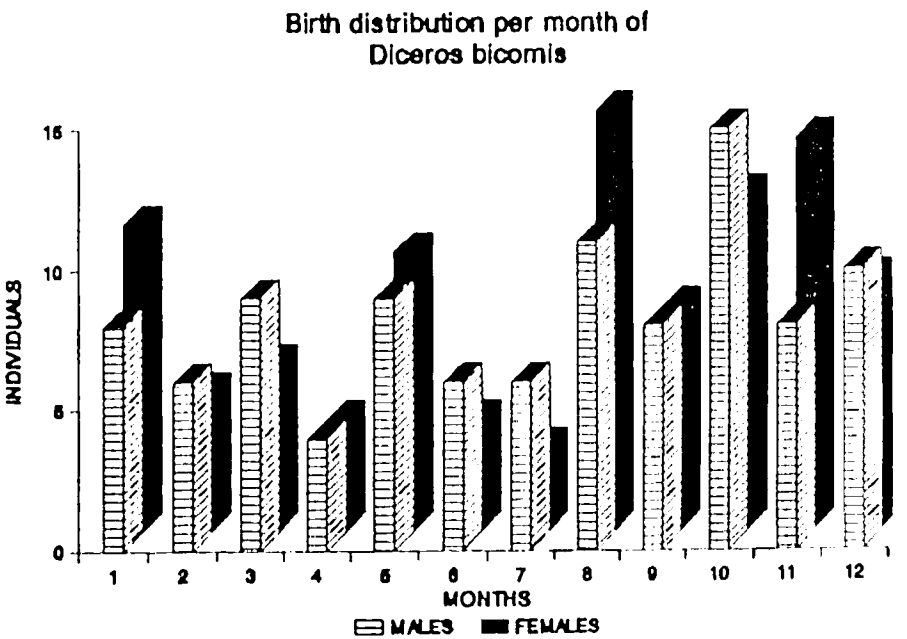


Figure 8

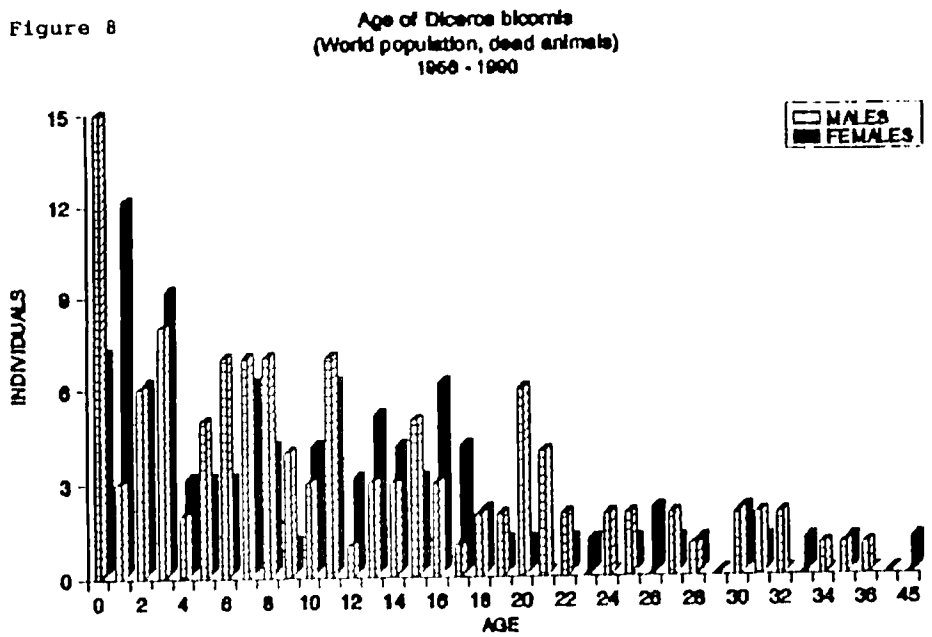


Figure 9

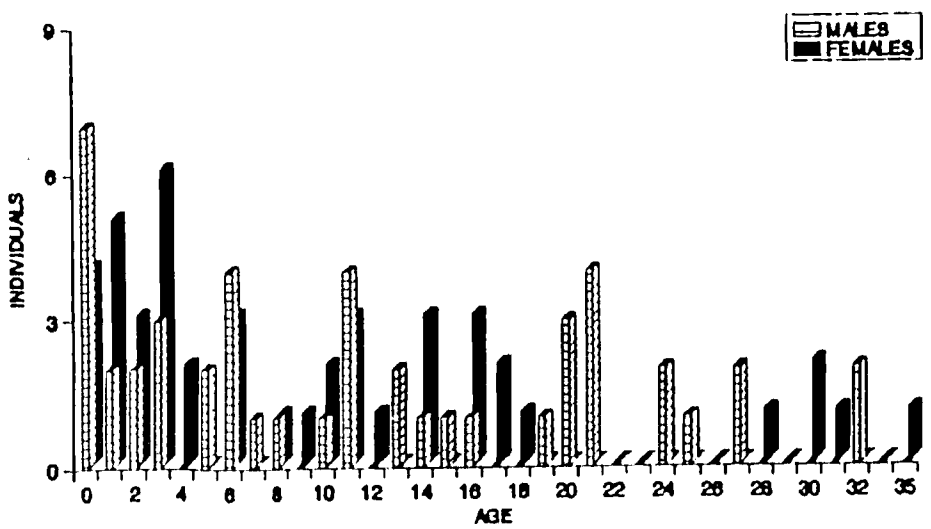


Figure 10

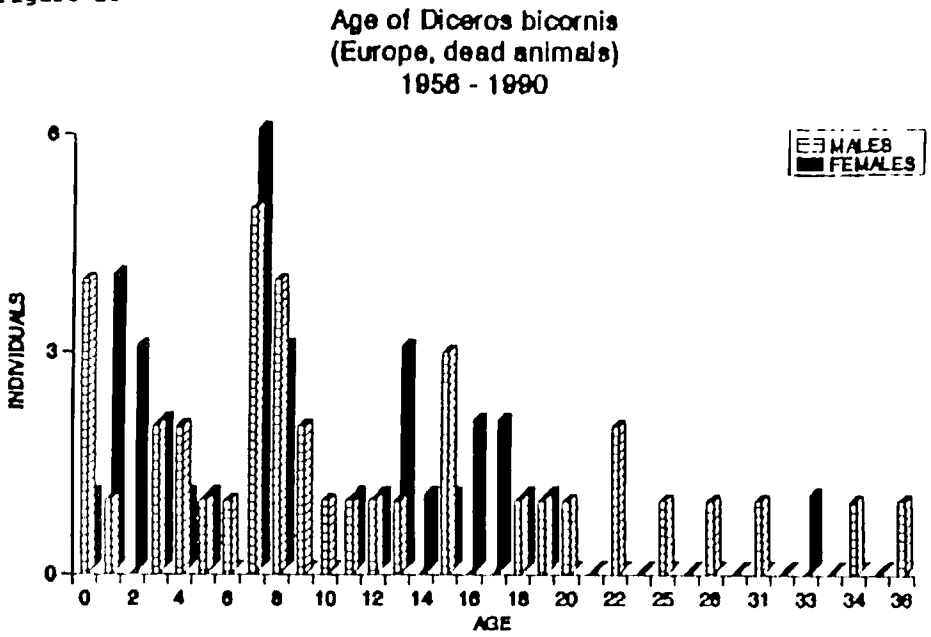
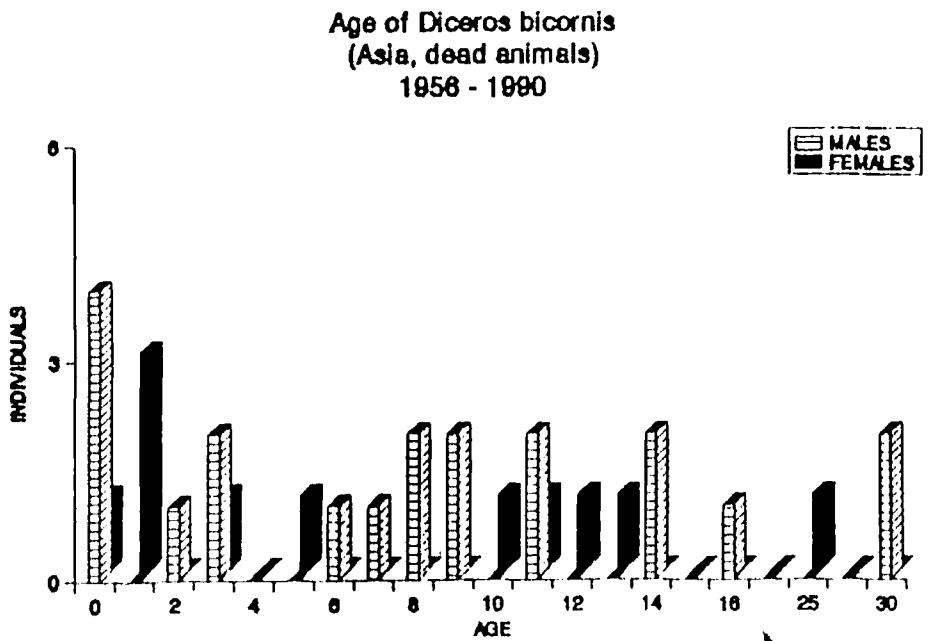


Figure 11



A slight but obvious rise of deaths can be noted world-wide between December and April (figure 12) which does concur with diet studies.

Since during the winter months fresh greenstuff is not available, fatal disorders may occur due to vitamin deficiencies mainly of the vitamin A, C, and E. To prevent such fatalities vitamin fortified feed supplements should be added to the diet. Research is being done in that field in US and European zoos.

In North America rhino deaths are more dependent on seasons than any other region (figure 13). Very few females die in summer, whereas from December through May the death-rate skyrockets. Male death-rate rises in December and January and in spring and summer.

Between June and September death-rate drops to a very low in both sexes in the European population and rises again, though in an even manner, throughout the rest of the year (figure 14).

In Asia the peak of deaths is reached in both sexes in January and February. Between March and June death-rate drops to an extreme low.

Figure 12

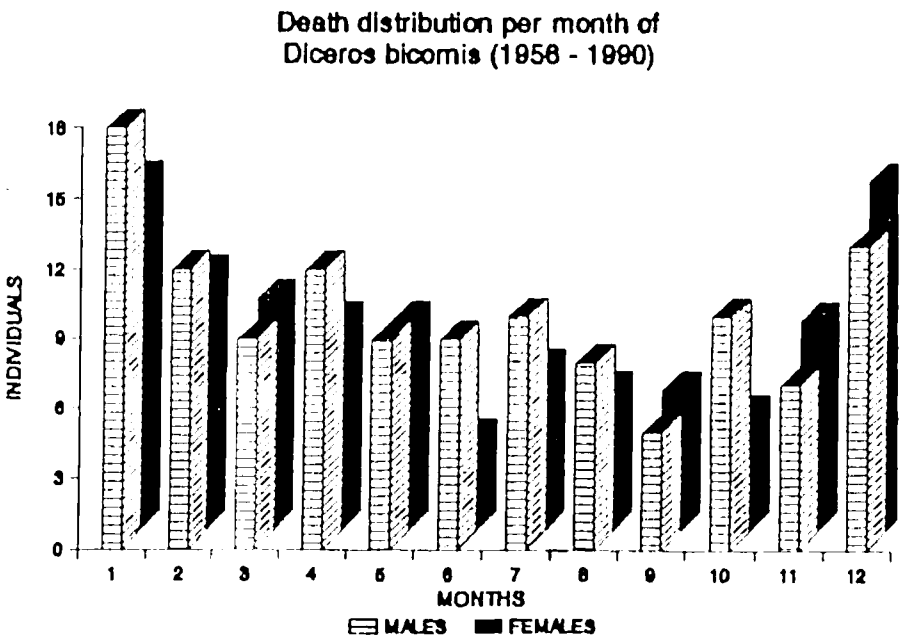


Figure 13

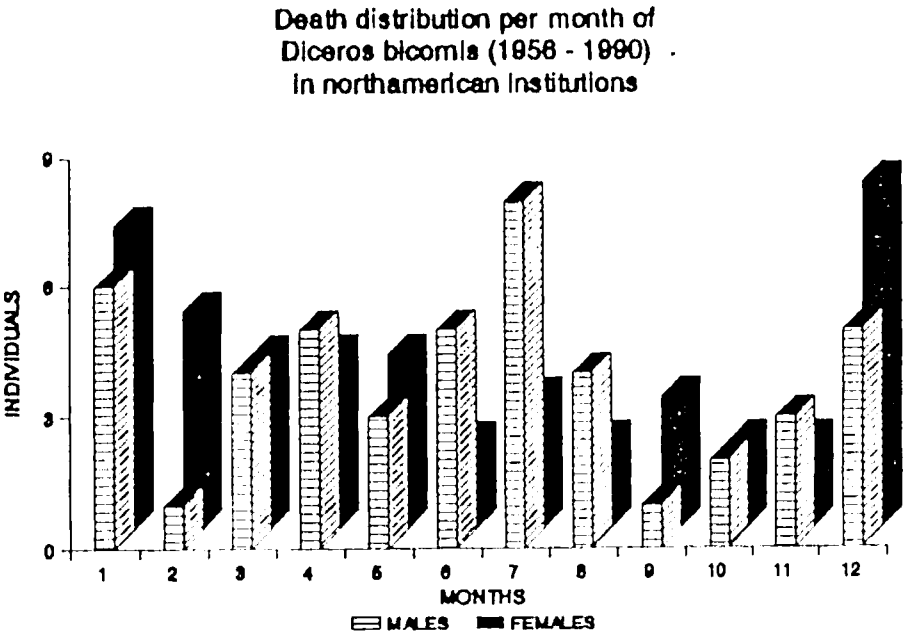
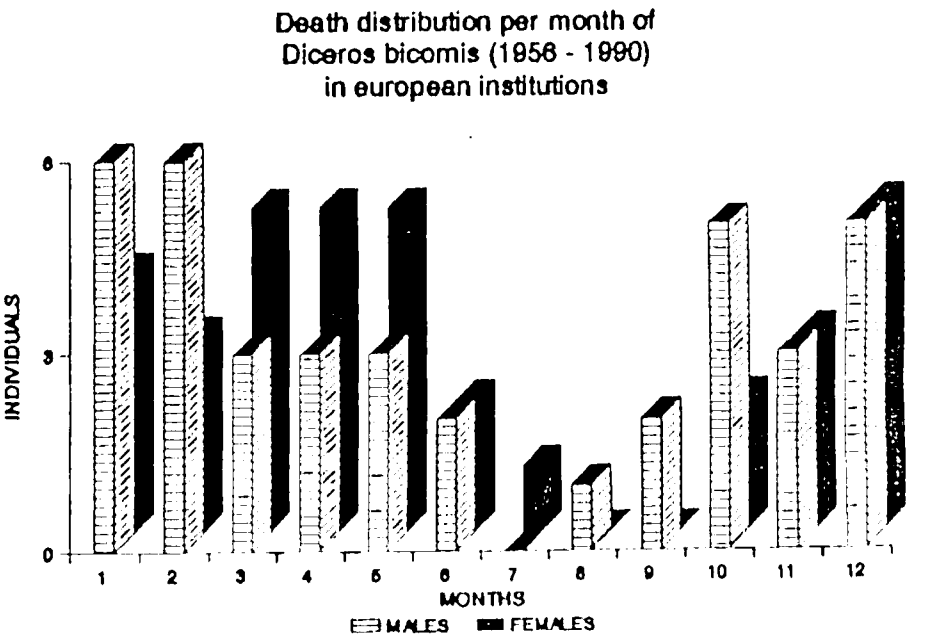


Figure 14



Population trend of captive black rhino is much more positive since 1987 than was expected (ref. 3rd edition of the International Studbook of African Rhinoceroses, 1987). 12 animals came from the wild, distorting this positive picture somewhat. The actual population increase by births is 17 animals since 1986.

The numerical increase of black rhino - although small - may give reason for hope, especially if one looks back at the steady decline of population respectively stagnation of births of recent years.

A rather positive situation can be noticed in North America where an especially high number of subadult individuals live. The positive population trend in Europe is due to good breeding results, which may be attributed to planned species management under the direction of the European Survival Program (EEP).
Since the installation of regional survival projects cooperation between the international studbook keeper and institutions keeping the species has improved considerably.

2. GENERAL POPULATION TREND OF WHITE RHINOCEROSES IN CAPTIVITY

Captive live population of white rhino as of 31.12.1990 is 709 (346.362.1) animals in 245 locations.
During the reporting period there were 45 (24.20.1) births, 0.1 of which belonging to the northern subspecies *Ceratotherium s. cottoni*.

There were 31 (11.20) white rhino deaths, 1.0 of which belonging to the northern subspecies (No 19/LON 01) (age at death ca. 40 years). Seven animals died under the age of 2.

One wild born female reached the age of 41 during the reporting period (No 58 in Pretoria, dead in March 1987). (In January 1991 died the male No 74 (cottoni) reaching the age of ca. 37)

White rhinos are kept in all continents, largest number (245 individuals) living in Europe, followed by 193 animals in North America and 131 in the Asian region (figure 15).

Largest number of the subspecies *Ceratotherium s. cottoni* is kept in Dvur Kralove (CSFR) - 10 (3.7) animals. Two males aged 18 and 34 are kept in San Diego Wild Animal Park.

General age-structure of the living population clearly reflects the wild born population, imported in the 70s (figure 2).

A decline of births has become quite evident in the past 2 years.
Here we feel bound to point out that by the year 2.000 about 250 animals will have died of old age! The loss of one third of the present total population within that period can hardly be met by the expected birth-rate.

Figure 15

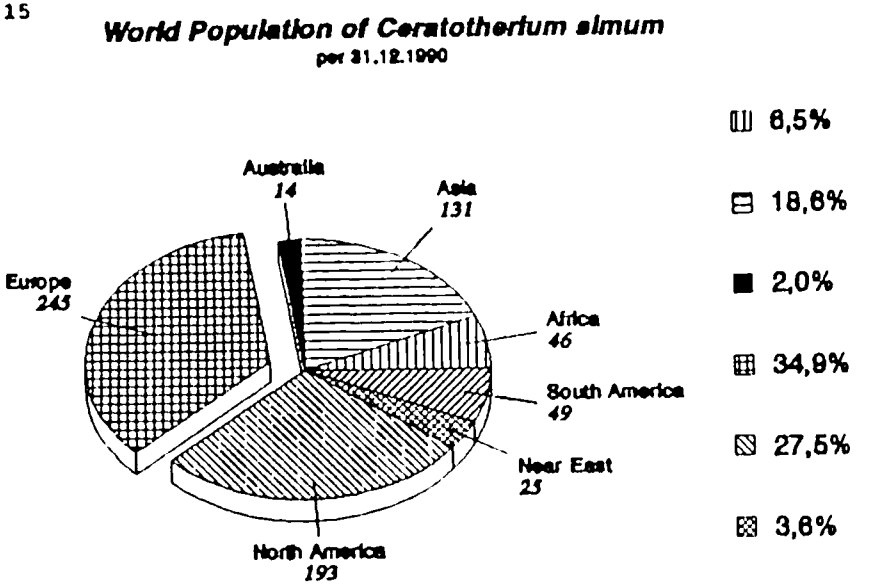
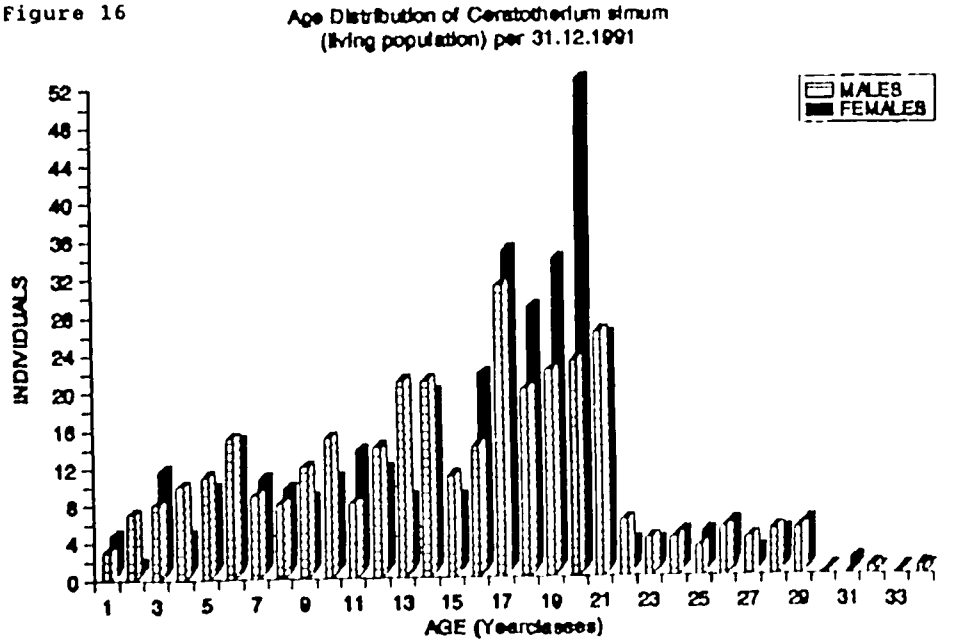


Figure 16



About half of the live population lineal descent from 1st generation; only 24 animals descent from 2nd generation (figure 17).

Figure 17

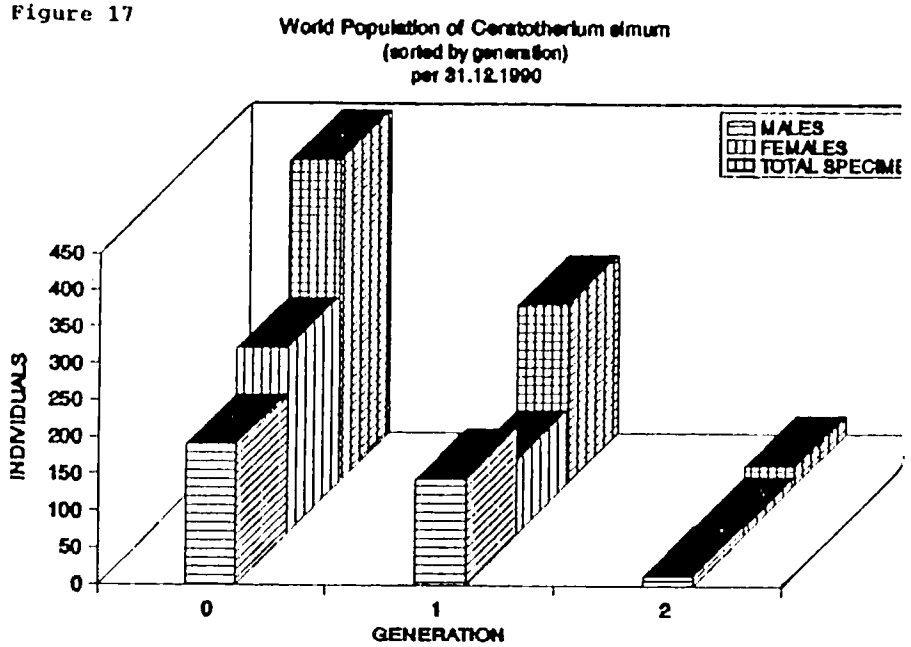
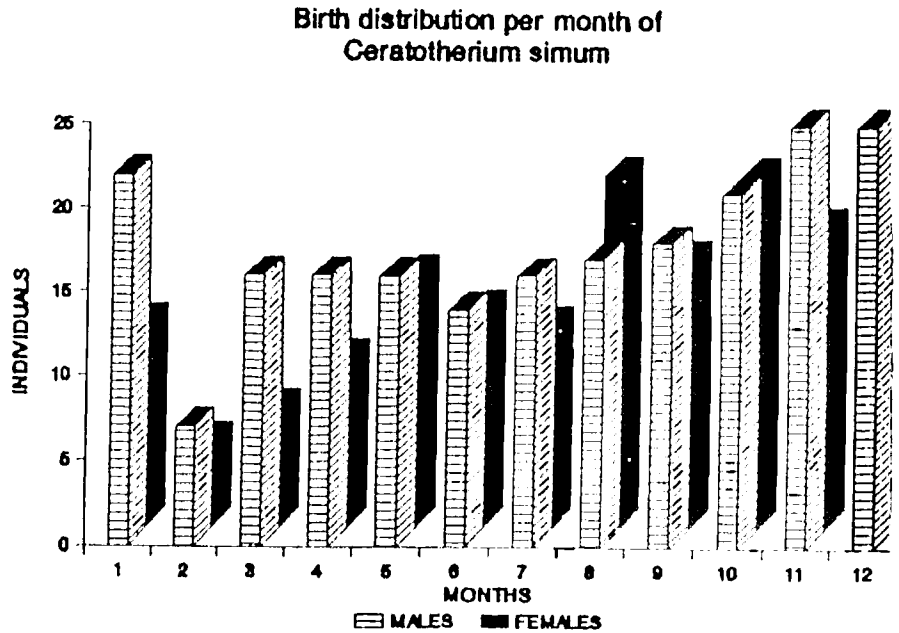
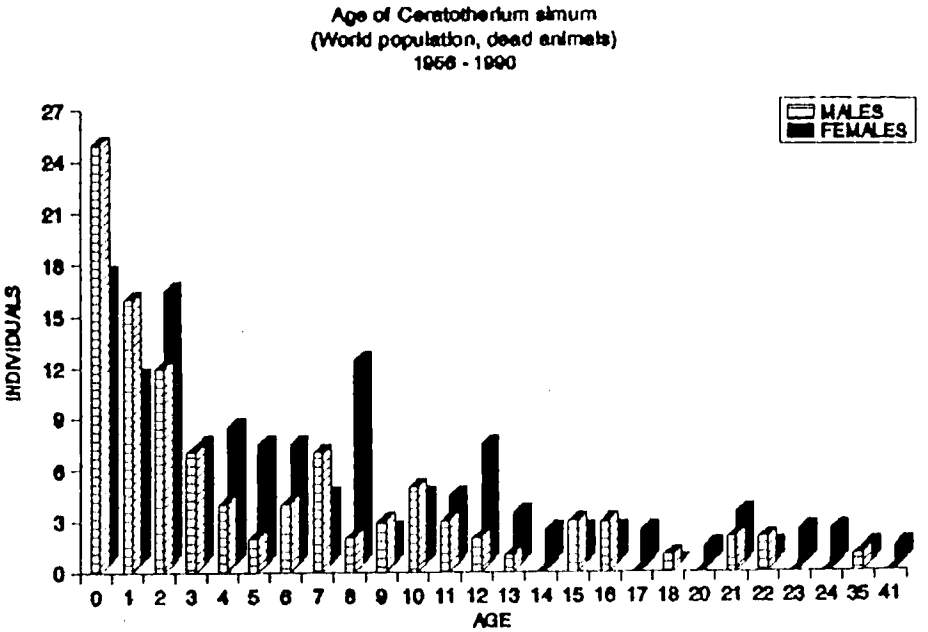


Figure 18



A decline of births is noted in February. An increase of births can be noted throughout spring and fall.
Most births occur from November through January (figure 18).

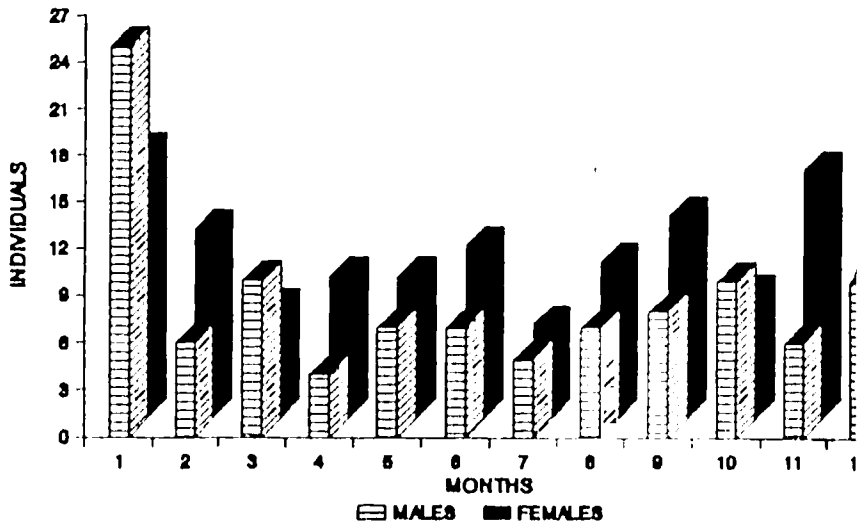
Figure 19



Death-rate is highest in subadult white rhinos, mainly in those under 2 years of age.
Highest death-rate occures in animals under the age of 1, above all in males.
A surprisingly high death-rate is found in 8 year old females.
One female died at the age of 41 (figure 19).
Death-rate is highest in January. For the rest of the year no specific trend shows (figure 20).

Figure 20

Death distribution per month of Ceratotherium simum (1958 - 1990)



Through non co-operative conduct of some US animal dealers problems arise keeping updated the International Studbook of White Rhinoceroses.

For years now EARL TATUM refuses to open line with the studbook keeper - although contacted on a regular basis. Whereabouts of a number of white rhino individuals thus remain in the dark. It is rather disturbing to us that members of AAZPA aware of this fact still do business with a man not caring to comply with internationally approved conservation demands.
I therefore wish to address a plea to the chairman of AAZPA to bring to bear his influence in that connection!

In the past years co-operation of INTERNATIONAL ANIMAL EXCHANGE (IAE) has gone off considerably!

Literatur:

BROOKS, P. M. (1989): Proposed conservation plan for the black rhinoceros *Diceros bicornis* in South Africa, the TBVC states and Namibia. Koedoe 32/2, 1 - 30

REECE, R. W. (1990): Encouraging news from Zaire. The Rhino conservation newsletter Vol. 1, No 2, page 4

Berlin, January 1991

Heinz-Georg Klös

Bernhard Blaszkiewitz

Anmerkungen zu Lebensalter und Reproduktionsrate Berliner Nashörner*

von Bernhard Blaszkiewitz

Eingeg. 7. 3. 1991

Nashörner (*Rhinocerotidae*) werden seit 1870 im Zoologischen Garten Berlin gehalten, als Direktor BODINUS die Spitzmaulnashornkuh (*Diceros bicornis*) "Molly" von HAGENBECK kaufte. "Molly" gastierte 1870 mit einer der berühmten "Tier-Mensch-Karawane" der Firma HAGENBECK im Berliner Zoo.
1871 traf das erste Panzernashorn (*Rhinoceros unicornis*) im Berliner Zoo ein, und 1879 war dann kurzfristig sogar ein Sumatra-Nashorn (*Dicerorhinus sumatrensis*) zu sehen. Als vierte Art kamen Breitmaulnashörner (*Ceratotherium simum*) 1963 hinzu. Mit Ausnahme der Jahre 1918 - 1927 und kriegsbedingt 1944 - 1953 wurden immer Vertreter dieser Unpaarhuferfamilie im Berliner Zoo gepflegt. Innerhalb dieses Zeitraumes wurden zum Teil beachtliche Haltungsdauern erzielt. So lebte ein Panzernashornbulle 37 Jahre in Berlin (1872 - 1909); der 1928 von Lutz HECK importierte Spitzmaulnashornbulle "M'toto" kam am 22. 11. 1943 bei einem schweren Luftangriff ums Leben. Die 1954 ungefähr vierjährig eingetroffene Spitzmaulnashornkuh "Arusha" wurde 1976 an einen afrikanischen Zoo weitergeleitet; dort wurde sie 1978 von einem Nashornbullen getötet (28jährig). "Arushas" Partner in der Berliner Zeit, der Spitzmaulnashornbulle "Meru", erreichte ein Alter von 20 Jahren (geboren ca. 1955 in Ostafrika, in Berlin seit 1957, gestorben 1975 in Berlin). Und schließlich sei noch "Arjun" erwähnt, das erste Panzernashorn, das nach dem Kriege in den Berliner Zoo gelangte. Der Bulle stammte aus dem Kaziranga-Reservat und traf am 22. 9. 1959 im Zoo Berlin ein. Noch im Jahr der Ankunft wurde "Arjun" in Bild und Text in der Literatur vorgestellt (KLÖS, 1959), wobei der schon recht gut entwickelte Körperbau des jungen Bullen auffällt, so daß das später eingetragene Geburtsjahr 1958 nicht glaubhaft erscheint. "Arjun" dürfte mindestens dreijährig gewesen sein. 1965 ging er an den Zoo Basel weiter, um dort die Stelle des gestorbenen Zuchtbullen "Gadadhar" einzunehmen.
1967 - 1984 wurden insgesamt 19 von "Arjun" gezeugte Kälber geboren (in Basel, Hamburg, Berlin und Stuttgart). Am 15. 4. 1983 mußte "Arjun" euthanasiert werden (chronisches Lungenemphysem), er war ungefähr 27 Jahre alt geworden. Wie sich aus den Zuchtbuchdaten ersehen läßt, war "Arjun" mit seiner "Zuchtleistung" einer der bedeutendsten Panzernashornbullen in Menschenhand (RÜEDI, 1988).

Gegenwärtig leben 12 Nashörner im Berliner Zoo:
1,1 *Ceratotherium simum simum*,
3,6 *Diceros bicornis*,
1,2 *Rhinoceros unicornis*.

---

* Herrn Prof. Dr. Dr. h. c. Heinz-Georg Klös zur Vollendung seines 65. Lebensjahres in herzlicher Verbundenheit gewidmet.

Abkürzungen für Ländernamen

Abbreviations for name of countries

Land	Abkürzung	Country	Abbreviation
Abu Dhabi	AEM	Abu Dhabi	AEM
Äthopien	ET	Ethopia	ET
Argentinien	ARG	Argentina	ARG
Australien	AU	Australia	AU
Belgien	B	Belgium	B
Brasilien	BR	Brazil	BR
Bulgarien	BUL	Bulgaria	BUL
Burma	BUR	Burma	BUR
China	PRC	China	PRC
CSFR	CSS	Czechoslovakia	CSS
Dänemark	DK	Denmark	DK
Deutschland	FRG	Germany	FRG
Dominikanischen Republik	DOR	Dominican Republic	DOR
Frankreich	F	France	F
Großbritannien	GB	United Kingdom	GB
Guatemala	GUA	Guatemala	GUA
Holland	NL	Netherlands	NL
Indien	IND	India	IND
Indonesien	IDS	Indonesia	IDS
Iran	IRN	Iran	IRN
Irland	EIR	Eireland	EIR
Israel	IL	Israel	IL
Italien	I	Italy	I
Japan	J	Japan	J
Jugoslawien	YU	Yugoslavia	YU
Kanada	CND	Canada	CND
Korea	KOR	Korea	KOR
Kuba	C	Cuba	C
Malaysia	MAL	Malaysia	MAL
Marokko	MAR	Morocco	MAR
Mexiko	MEX	Mexico	MEX
Neuseeland	NZL	New Zealand	NZL
Nigeria	NIG	Nigeria	NIG
Polen	PL	Poland	PL
Portugal	P	Portugal	P
Puerto Rico	PUE	Puerto Rico	PUE
Qatar	QAT	Qatar	QAT
Rumänien	RUM	Rumania	RUM
Saudi Arabien	SAU	Saudi Arabia	SAU
Schweiz	CH	Switzerland	CH
Singapur	SIN	Singapore	SIN
Spanien	E	Spain	E
Sri Lanka	SRL	Sri Lanka	SRL
S-Afrika	RSA	S-Africa	RSA
Taiwan	TW	Taiwan	TW
Thailand	THA	Thailand	THA
Tunesien	TUN	Tunisia	TUN
unbekannt	UNK	unknown	UNK
Ungarn	H	Hungary	H
Uruguay	URU	Uruguay	URU
USSR	USR	USSR	USR
Venezuela	VEN	Venezuela	VEN
Vereinigte Staaten von Amerika	USA	United States of America	USA

ÜBERBLICK ÜBER DEN SPITZMAULNASHORN-WELTBESTAND

PER 31.12.1990

SYRVEY ON BLACK RHINO WORLDPOPULATION

PER 31.12.1990

WORLD POPULATION OF BLACK RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
ADDO	2	1	1
ASA ZOO	4	2	2
ATLANTA	1	1	0
BASS RANCH	3	1	2
BERLIN ZOO	8	3	5
BROOKFIELD	4	2	2
BUENOS AIRES	1	0	1
CAIRO	1	1	0
CHESTER	2	1	1
CHICAGO	3	1	2
CINCINNATI	3	1	2
COLOMBO	4	2	2
COLORADO SPRING	2	1	1
COLUMBUS ZOO	4	2	2
DALLAS	5	1	4
DENVER	5	3	2
DETROIT	2	1	1
DVUR KRALOVE	10	3	7
FORT WORTH	3	2	1
FRANKFURT/M	3	2	1
GARDEN CITY	1	1	0
HIGASHIYAMA ZOO	1	1	0
JOS	1	1	0
KAMINE ZOO	4	2	2
LA HABANA	2	1	1
LINN	4	1	3
LISBON	4	2	2
LONDON ZOO	3	1	2

WORLD POPULATION OF BLACK RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
LOS ANGELES	6	2	4
MAGDEBURG	4	2	2
MAIDUGURI	2	0	2
MEXICO CITY	2	1	1
MIAMI METRO	5	2	3
MILWAUKEE	4	2	2
MYSORE	4	2	2
NAGOYA	2	0	2
NAPLES	3	1	2
NEGARA ZOO	1	1	0
NEW DELHI	2	1	1
OKLAHOMA	2	0	2
OSAKA	2	1	1
PEKING	3	1	2
PORT LYMPNE	9	4	5
POTGIETERSRUS	1	0	1
POTTER PARK ZOO	1	1	0
PRETORIA	1	1	0
PYONGYANG	4	2	2
ROME	1	0	1
SAN ANTONIO	3	1	2
SAN DIEGO WILD	6	4	2
SAN DIEGO ZOO	4	2	2
SAN FRANCISCO	3	1	2
SANDTON	1	1	0
SAO LEOPOLDO	1	0	1
SEITO ZOO	1	1	0
SEOUL	1	1	0

WORLD POPULATION OF BLACK RHINOCEROS
(Survey per 31.12.1990)

LOCATION	TOTAL	MALES	FEMALES
ST.LOUIS	3	1	2
SYDNEY	2	0	2
TAIPEI	3	1	2
TALLINN	2	1	1
TAMPA	2	1	1
TEHERAN	5	2	3
TYLER	3	2	1
WASHINGTON	2	1	1
WICHITA	1	1	0
ZURICH	6	2	4
			110
		88	
	198		
66			

SPITZMAULNASHORN-WELTBESTAND

PER 31.12.1990

BLACK RHINO WORLDPOPULATION

PER 31.12.1990

WORLD POPULATION OF BLACK RHINOCEROS per 31.12.1990
(sorted by continent, country, location and race)

CONTINENT	COUNTRY	LOCATION	RACE	SEX	AGE	STB-CODE	BREEDER	SIRE	DAM	FCOEF	GENERATION
AF	ET	CAIRO	michaeli	M	31	0080	CAI 01	WILD	WILD	0	0
	NIG	JOS	michaeli	M	16	0222	BE 06	WILD	WILD	0	0
		MAIDUGURI	michaeli	F	15	0230	MDG 03	0228	0229	0	1
					16	0229	MDG 02	WILD	WILD	0	0
	RSA	ADDO	michaeli								
				F	15	0249	PRY 04	WILD	WILD	0	0
		POTGIETERSRUS	minor	F	1	0429	PRY 08	WILD	WILD	0	0
		PRETORIA	minor	M	8	0339	PRY 06	WILD	WILD	0	0
		SANDTON	michaeli	M	25	0128	TLV 01	WILD	WILD	0	0
AS	IND	MYSORE	michaeli	M	19	0223	MYS 04	0086	0087	0	1
					35	0086	MYS 01	WILD	WILD	0	0
				F	16	0224	MYS 05	0086	0087	0	1
					35	0087	MYS 02	WILD	WILD	0	0
		NEW DELHI	michaeli	M	16	0261	NDL 01	WILD	WILD	0	0
				F	16	0262	NDL 02	WILD	WILD	0	0
	IRN	TEHERAN	michaeli	M	20	0160	TEH 03	WILD	WILD	0	0
					27	0158	TEH 01	WILD	WILD	0	0
				F	14	0315	TEH 06	0158	0159	0	1
					18	0313	TEH 04	0158	0159	0	1
					23	0159	TEH 02	WILD	WILD	0	0
	J	ASA ZOO	michaeli	M	3	0420	HIR 10	0182	0181	0	1
					20	0182	HIR 01	WILD	WILD	0	0
				F	5	0374	HIR 09	0182	0181	0	1
					20	0181	HIR 02	WILD	WILD	0	0
		HIGASHIYAMA ZOO	mixed breed	M	8	0352	OSA 06	0209	0183	0	2
		KAMINE ZOO	michaeli	M	1	0434	HIT 07	0323	0185	0	1

WORLD POPULATION OF BLACK RHINOCEROS per 31.12.1990
(sorted by continent, country, location and race)

CONTINENT	COUNTRY	LOCATION	RACE	SEX	AGE	STB-CODE	BREEDER	SIRE	DAM	FCOEF	GENERATION
AS	J	KAMINE ZOO	michaeli	M	17	0323	HIT 01	WILD	WILD	0	0
			minor	F	3	0421	HIT 06	0323	0185	0	1
					26	0185	OSA 04	WILD	WILD	0	0
		NAGOYA	michaeli	F	23	0237	NGO 04	WILD	WILD	0	0
					23	0236	NGO 03	WILD	WILD	0	0
		OSAKA	michaeli	M	9	0346	HIR 06	0182	0181	0	1
			minor	F	19	0183	OSA 05	0184	0185	0	1
	KOR	PYONGYANG	minor	M	6	0370	PYO 03	WILD	WILD	0	0
					6	0371	PYO 04	WILD	WILD	0	0
				F	6	0368	PYO 01	WILD	WILD	0	0
					6	0369	PYO 02	WILD	WILD	0	0
		SEOUL	michaeli	M	13	0266	WAS 05	0046	0139	250	2
	MAL	NEGARA ZOO	michaeli	M	23	0253	KUA 01	WILD	WILD	0	0
	PRC	PEKING	michaeli	M	14	0291	PKG 05	UNKN	UNKN	0	1
				F	21	0265	PKG 03	0276	0263	0	1
					34	0263	PKG 01	WILD	WILD	0	0
		SEITO ZOO	michaeli	M	11	0288	NGO 07	0238	0237	0	1
	SRL	COLOMBO	michaeli	M	14	0250	SFO 06	0074	0213	0	1
					31	0132	CEY 01	WILD	WILD	0	0
				F	23	0134	CEY 03	0132	0133	0	1
					25	0133	CEY 02	WILD	WILD	0	0
	TW	TAIPEI	michaeli	M	7	0350	NGO 08	0238	0237	0	1
				F	7	0354	HIR 06	0182	0181	0	1
					12	0284	HIR 04	0182	0181	0	1
AU	AU	SYDNEY	michaeli	F	33	0197	SID 07	0099	0100	0	1
				F	40	0096	PER 01	WILD	WILD	0	0

WORLD POPULATION OF BLACK RHINOCEROS per 31.12.1990
(sorted by continent, country, location and race)

CONTINENT	COUNTRY	LOCATION	RACE	SEX	AGE	STB-CODE	BREEDER	SIRE	DAM	FCOEF	GENERATION
EU	CH	ZURICH	michaeli	M	1	0430	ZRH 09	0252	0217	0	2
					15	0252	STL 09	UNKN	0121	0	1
				F	2	0422	ZRH 08	0252	0150	0	2
					17	0217	DVU 12	WILD	WILD	0	0
					21	0150	ZRH 04	0031	0032	0	1
					26	0032	ZRH 02	WILD	WILD	0	0
	CSS	DVUR KRALOVE	michaeli	M	7	0386	DVU 17	0268	0244	0	3
					12	0283	DVU 16	0172	0175	0	1
					14	0268	CVG 09	0247	0180	0	2
				F	1	0431	DVU 22	0268	0244	0	3
					2	0417	DVU 21	0268	0282	0	3
					7	0387	DVU 18	0268	0175	0	3
					13	0282	DVU 15	0170	0217	0	1
					14	0244	DVU 14	0170	0174	0	1
					20	0178	DVU 10	WILD	WILD	0	0
					20	0175	DVU 07	WILD	WILD	0	0
	FRG	BERLIN ZOO	michaeli	M	7	0347	BE 10	0219	0240	0	1
					16	0260	SID 08	0099	0101	250	2
					20	0166	LEJ 01	WILD	WILD	0	0
				F	1	0428	BE 14	0166	0298	0	2
					5	0366	BE 11	0219	0220	0	1
					10	0298	BE 08	0219	0221	0	1
					16	0220	BE 04	WILD	WILD	0	0
					16	0240	BE 07	WILD	WILD	0	0
		FRANKFURT/M	michaeli	M	7	0349	ZRH 07	0171	0150	0	2
			minor	M	2	0394	FRA 06	WILD	WILD	0	0
				F	2	0393	FRA 05	WILD	WILD	0	0
		MAGDEBURG	michaeli	M	12	0277	MAG 02	0009	0153	0	1
					25	0009	MAJ 03	WILD	WILD	0	0
				F	10	0295	MAG 03	0009	0153	0	1
					21	0153	MAG 01	WILD	WILD	0	0
	GB	CHESTER	michaeli	M	9	0318	WHI 06	0022	0019	0	2
				F	9	0312	LON 07	0018	0017	0	1
		LONDON ZOO	michaeli	M	2	0391	DVU 20	0268	0175	0	3
					14	0245	BEK 03	0142	0194	0	3

WORLD POPULATION OF BLACK RHINOCEROS per 31.12.1990
(sorted by continent, country, location and race)

CONTINENT	COUNTRY	LOCATION	RACE	SEX	AGE	STB-CODE	BREEDER	SIRE	DAM	FCOEF	GENERATION
EU	GB	LONDON ZOO	michaeli	F	3	0384	LON 08	0018	0019	0	1
					25	0017	LON 02	WILD	WILD	0	0
		PORT LYMPNE	michaeli	M	8	0341	HYT 02	0142	0195	0	3
					20	0164	CHE 04	0024	0025	0	2
					22	0142	DUB 03	0028	0029	0	2
					25	0018	WHI 01	WILD	WILD	0	0
				F	2	0408	HYT 04	0018	0195	0	1
					8	0342	HYT 03	0142	0194	0	3
					20	0194	BEK 01	WILD	WILD	0	0
					20	0195	BEK 02	WILD	WILD	0	0
					28	0019	WHI 02	WILD	WILD	0	0
	I	NAPLES	michaeli	M	27	0036	NAP 01	WILD	WILD	0	0
				F	8	0345	NAP 07	0036	0037	0	1
					31	0037	NAP 02	WILD	WILD	0	0
		ROME	michaeli	F	20	0165	NAP 04	0036	0037	0	1
	P	LISBON	minor	M	14	0286	LIS 07	0113	0114	0	1
					36	0113	LIS 01	WILD	WILD	0	0
				F	17	0211	LIS 06	0113	0114	0	1
					33	0114	LIS 02	WILD	WILD	0	0
	USR	TALLINN	michaeli	M	20	0171	DVU 03	WILD	WILD	0	0
				F	21	0035	TOR 02	WILD	WILD	0	0
NA	USA	ATLANTA	michaeli	M	5	0388	DVU 19	0268	0282	0	3
		BASS RANCH	minor	M	2	0413	BAS 01	WILD	WILD	0	0
				F	2	0424	BAS 03	WILD	0414	0	1
					2	0414	BAS 02	WILD	WILD	0	0
		BROOKFIELD	michaeli	M	6	0363	CVG 14	0247	0180	0	2
					13	0271	ZRH 06	0241	0150	0	2
				F	6	0365	CHI 06	0271	0235	0	3
					18	0235	CHI 05	WILD	WILD	0	0
		CHICAGO	michaeli	M	10	0308	SFO 07	0074	0213	0	1
				F	9	0317	CVG 12	0056	0207	0	1
					10	0294	STA 03	0169	0190	0	2

WORLD POPULATION OF BLACK RHINOCEROS per 31.12.1990
(sorted by continent, country, location and race)

CONTINENT	COUNTRY	LOCATION	RACE	SEX	AGE	STB-CODE	BREEDER	SIRE	DAM	FCOEF	GENERATION
AA	USA	CINCINNATI	michaeli	M	19	0247	CVG 07	WILD	WILD	0	0
				F	20	0225	TAM 02	WILD	WILD	0	0
					21	0180	CVG 05	0056	0057	0	1
		COLORADO SPRING	michaeli	M	10	0305	MIR 05	0182	0181	0	1
				F	9	0331	STA 05	0169	0190	0	2
		COLUMBUS ZOO	michaeli	M	3	0389	SAN 03	0292	0233	0	2
					37	0068	CMH 01	WILD	WILD	0	0
				F	3	0397	CVG 16	0247	0180	0	2
					19	0188	SAN 04	WILD	WILD	0	0
		DALLAS	michaeli	F	17	0311	MAI 01	WILD	WILD	0	0
					35	0067	DAL 02	WILD	WILD	0	0
			minor	M	2	0399	DAL 03	WILD	WILD	0	0
				F	1	0433	DAL 05	WILD	0400	0	1
					2	0400	DAL 04	WILD	WILD	0	0
		DENVER	michaeli	M	2	0432	DEN 11	0161	0163	0	2
					8	0332	CVG 13	0247	0180	0	2
					19	0161	SFO 03	0074	0075	0	1
				F	9	0328	DEN 09	0161	0163	0	2
					20	0163	DEN 04	0124	0125	0	1
		DETROIT	michaeli	M	37	0409	PRO 01	WILD	WILD	0	0
				F	30	0055	OKC 02	0056	0057	0	1
		FORT WORTH	minor	M	2	0401	FOW	WILD	WILD	0	0
					2	0403	FOW 03	WILD	0402	0	1
				F	2	0402	FOW 02	WILD	WILD	0	0
		GARDEN CITY	michaeli	M	2	0419	CHI 01	0308	0317	0	2
		LINN	minor	M	7	0378	LIN 01	WILD	WILD	0	0
				F	2	0410	Lin 04	WILD	WILD	0	0
					7	0379	LIN 02	WILD	WILD	0	0
			mixed breed	F	2	0411	LIN 05	0388	0379	0	4
		LOS ANGELES	michaeli	M	13	0285	MEM 03	0199	0126	0	2
				F	15	0267	CVG 08	0056	0207	0	1
					25	0076	LAX 01	WILD	WILD	0	0
			minor	M	9	0333	LAX 06	WILD	WILD	0	0
				F	8	0336	LAX 08	UNKN	0334	0	1
					9	0334	LAX 07	WILD	WILD	0	0

WORLD POPULATION OF BLACK RHINOCEROS per 31.12.1990
(sorted by continent, country, location and race)

CONTINENT	COUNTRY	LOCATION	RACE	SEX	AGE	STB-CODE	BREEDER	SIRE	DAM	FCOEF	GENERATION
AA	USA	MIAMI METRO	michaeli	M	3	0395	MIA 06	0052	0202	0	1
					14	0259	MIR 03	0182	0181	0	1
				F	6	0351	SFO 08	0074	0213	0	1
					18	0202	MIA 02	WILD	WILD	0	0
					21	0255	BOS 02	WILD	WILD	0	0
		MILWAUKEE	michaeli	M	5	0381	LAX 10	0285	0076	0	3
				F	3	0383	SFO 09	0074	0213	0	1
			minor	M	2	0404	MKE 01	WILD	WILD	0	0
				F	2	0405	MKE 02	WILD	WILD	0	0
		OKLAHOMA	michaeli	F	10	0330	MDL 04	0261	0262	0	1
					26	0053	DTT 02	WILD	WILD	0	0
		POTTER PARK ZOO	michaeli	M	4	0377	SAN 02	0302	0239	0	3
		SAN ANTONIO	michaeli	M	20	0169	DVU 01	WILD	WILD	0	0
				F	6	0364	CVG 15	0056	0207	0	1
					22	0190	LON 03	0016	0017	0	1
		SAN DIEGO WILD	michaeli	M	1	0435	SAN 05	0292	0233	0	2
					1	0427	SAN 04	0292	0239	0	3
					11	0302	CVG 11	0247	0180	0	2
					12	0292	GRA 03	0079	0293	0	1
				F	15	0239	SAN 01	0110	0188	0	2
					18	0233	CHI 03	WILD	WILD	0	0
		SAN DIEGO ZOO	michaeli	M	24	0110	WAS 03	0046	0047	0	1
				F	19	0192	OKC 04	0054	0055	0	2
			minor	M	4	0390	SAN 05	WILD	WILD	0	0
				F	2	0392	SAN 06	WILD	WILD	0	0
		SAN FRANCISCO	michaeli	M	35	0074	SFO 01	WILD	WILD	0	0
				F	1	0426	SFO 11	0074	0213	0	1
					20	0213	SFO 04	WILD	WILD	0	0
		ST.LOUIS	michaeli	M	15	0251	STL 08	WILD	WILD	0	0
				F	16	0212	DTT 04	0052	0053	0	1
					26	0121	STL 02	WILD	WILD	0	0
		TAMPA	michaeli	M	5	0356	TAM 07	0155	0225	0	1
				F	2	0418	OKC 9	0281	0055	0	2

WORLD POPULATION OF BLACK RHINOCEROS per 31.12.1990
(sorted by continent, country, location and race)

CONTINENT	COUNTRY	LOCATION	RACE	SEX	AGE	STB-CODE	BREEDER	SIRE	DAM	FCOEF	GENERATION
NA	USA	TYLER	michaeli	M	5	0372	CHI 07	0271	0235	0	3
					5	0362	MIA 04	0259	0202	0	2
				F	5	0359	STA 06	0169	0190	0	2
		WASHINGTON	michaeli	M	4	0376	DEN 10	0161	0163	0	2
				F	3	0396	CHI 08	0271	0235	0	3
		WICHITA	michaeli	M	11	0301	CVG 10	0056	0207	0	1
SA	ARG	BUENOS AIRES	michaeli	F	18	0231	BUE 04	0118	0119	125	2
	BR	SAO LEOPOLDO	michaeli	F	16	0242	NAP 05	0036	0037	0	1
	C	LA HABANA	michaeli	M	14	0258	OKC 06	0054	0055	0	2
				F	15	0299	LNC 01	WILD	WILD	0	0
	MEX	MEXICO CITY	michaeli	M	20	0296	MEX 01	WILD	WILD	0	0
				F	20	0297	MEX 02	WILD	WILD	0	0

SPITZMAULNASHORN-ZUCHTBUCH

PER 31.12.1990

PEDIGREE OF BLACK RHINOCEROSES

PER 31.12.1990

1987 AAZPA Great Lakes Regional Meeting (St. Louis, MO)

BLACK RHINOCEROS CONSERVATION IN KENYA--A FIELD SSP?

R. Eric Miller, D.V.M.
Associate Veterinarian
St. Louis Zoological Park
St. Louis, MO 63110

In nearly all of Africa, the population decline of the black rhinoceros has been precipitous. Poaching for rhino horn has been relentless, often fueled by money generated in the Middle Eastern oil economy. Spears, traps and rifles have been replaced by semi-automatic AK-47 fire, as many game departments find themselves outmanned and outgunned. The result has been a drop in the African rhinoceros population from an estimated 65,000 in 1970 to 4,000 or fewer today. The black rhinoceros population in Kenya has not been exempt from the slaughter; in 1986, 377 animals remained of an estimated 20,000 in 1970.

In many countries of the African continent, current political, economic and environmental events do not bode well for the reversal of this downward trend, though at present, at least three countries appear to have the active plans for conservation of their remaining rhinos--Kenya, Zimbabwe and South Africa.

Note: This report is based on a one-week study tour in August 1986 of Kenyan black rhinoceros facilities and interviews with Kenyans working in various aspects of their conservation program. The tour was supported by the St. Louis Zoo as an extension of a St. Louis Zoo Friends Kenya/Tanzania photosafari. Much of the numerical data and sanctuary information is drawn from an interview and reports supplied by Mr. Peter Jenkins, senior game warden in the "Save the Rhino Project." Additional information is drawn from the African Rhinoceros Workshop held at the Cincinnati Zoo in October 1986. Any opinions presented are those of the author.

South African game protection efforts have resulted in stable, and perhaps increasing populations of this species (estimated 640). Zimbabwe has suffered heavy poaching losses in the Zambezi River Valley, but government support has allowed increased protection of the remaining animals. President Mugabe has given orders that game officials may shoot first at suspected poachers, and the government has funded a relocation program from the Zambezi Valley to more protected parks within Zimbabwe. An estimated 1,680 Zimbabwe black rhinoceroses remain.

The Kenyan conservation program will be based on a "sanctuary" concept--the maintenance of small (30-40) herds of black rhinoceroses in fenced game parks and reserves, patrolled by armed guards. The precedent for the plan exists on several "rhino ranches" in central and northern Kenya. The plight of the black rhinoceros in Kenya has not only received governmental and international attention, but also increasing attention from the Kenyan populace. The successful fund-raising walks from Kampala to Mombasa of Michael Werikhe, the "rhino man," were perhaps even more valuable in raising the level of problem recognition with the East African press and public.

Tsavo National Park is an example of some of the problems faced. As late as 1969, 6,000-9,000 black rhinos lived in Tsavo--a park that possesses some of the choicest rhino habitat in Africa. A population of one rhino per square kilometer was considered carrying capacity in many areas. At this time, and previously, rhinos had been widely translocated within Kenya in a government program in which dealers were required to translocate an animal at the wildlife department's request for each animal they shipped. By the mid-1970's, Peter Jenkins, a senior game warden, had noted a rapid decline in the black rhinoceros numbers in Kenya. In 1979, he began drafting a "Proposal for Black Rhinoceros Sanctuaries in Kenya," and a census of the remaining animals was undertaken. Combinations of drought, unknown die-offs and poaching have plunged the current Tsavo population to as low as 100-150 widely scattered animals--animals so widely separated that their ability to successfully find mates is in doubt. The decline was not unique to Tsavo and was repeated in most other parks.

In the early 1970's, Courtland Parfet, an American who owns Solio Ranch in Kenya's central highlands, became interested in stocking his 14,000 acre game resèrve with black rhinocoerses. Electrified fencing powered by generators contains the animals. Effective policing, currently supervised by Major Rodney Eliot, who spent a career as a game warden in the Northwest Frontier, combined with rumors of man-eating lions within the preserve created a successful record--no animals have been poached to date. The initial 23 animals have increased to an estimated 85-90 in 1986, a number that many, including Major Eliot, consider a likely overpopulation. This herd will supply 25-30 animals for translocation to the initial government project at Lake Nakuru. Dr. Dieter Rottcher, a veterinarian with ILRAD, an international veterinary research group in Kabete, will anesthetize the rhinos

for movement to field enclosures on Solio, prior to their road trip to Nakuru. He also provides veterinary service for rhinos on several of the other ranches and in government projects. In addition to the black rhinoceroses, 30-40 white rhinos also inhabit the Solio preserve.

A newer facility exists at Lewa Downs, near Isiolo. On a 40,000 acre ranch owned by David and Delia Craig, Anna Mertz has the use of 5,000 acres for the creation of a rhino preserve. She has financed the enclosure of the semi-arid terrain with a solar-powered electric fence. Two substations power it, and alarms are triggered if it is broken. Mrs. Mertz employs 12 local Kenyans as guards. If a breech in the fence is suspected, the ranch manager has a light plane to patrol the perimeter. In 1986, 11 black rhinos lived in the preserve, including two calves. One was being bottle raised, for it was born shortly after its dam's translocation and was neglected. Subsequent calves born at Lewa are being dam raised. Poaching is a present threat; in July 1986 20-plus elephants from a herd of 80 were killed in one raid by poachers on an adjacent ranch. Mrs. Mertz would like to fence an additional 1,500 acres, as she considers the present area near carrying capacity, but the additional capital and operating costs are major considerations.

Laikipia Ranch, located near Rumruti and managed by Colin Francombe, is an additional rhino facility. It is unfenced, dense thornbush terrain. The population there is estimated to be 40 rhinos, but a range of 10-60 is considered possible due to census difficulties in the thornbush. In addition, Pokot tribesmen of the Rift Valley are in possession of weapons that have spilled across the border from the Ugandan war, and present a poaching threat. Laikipia has received financial support form Rhino Rescue UK, and the London Zoological Society is sponsoring a field researcher, Dr. Brett, on the ranch. He is attempting to identify individual rhino by their spoor and study their social behavior. Preliminary studies indicate that one bull may roam over large areas of the ranch, including numerous other bull territories. The work will hopefully provide data regarding field rhino identification and social structure that will be invaluable to the long-term management of these small wild populations. All black rhinos at Laikipia, at Solio and Lewa Downs, as well as the game reserves and parks, are considered government property.

Lake Nakuru, famed for its vast flocks of flamingos, is to be the first Kenyan park recipient of translocated black rhinos in the sanctuary plan. Nakuru is a relatively small park (39,500 acres land, 14,800, water) and in close proximity to the city of Nakuru. The area historically has had rhino (they were described as numerous in reports c. 1900). Though it appears to have adequate rhino habitat, only one to two animals remain in the park today. In an effort parallel to that of the ranches, the park's perimeter has been enclosed with solar-powered electric fence, a capital outlay funded in part by the World Wildlife Fund. The Kenyan government is to fund new ranger outposts,

roads and increased personnel to protect the animals. According to Andrew Koyo, warden at Nakuru, a major concern of the restocking effort is the nutritional status of the available browse at Nakuru. Lake Nakuru is a Rift Valley alkali lake with a fresh water inflow, but no outflow. The lake has become alkali by the subsequent concentration of minerals by evaporation, and the surrounding soils have become deficient in many minerals by the leaching action of the water. The Nakuru area is known to be deficient in copper, cobalt, iron, phosphorous and selenium. Antelope in the area have shown signs of posterior incoordination (enzootic ataxia) and rough, faded haircoats typical of copper deficiency. On an adjacent ranch that supplements trace mineral salt to its domestic stock, the antelope that reside there do not manifest these symptoms. The Imperial College of Science and Technology (Great Britain) is scheduled to study the pre- and post-translocation nutritional status of the black rhinoceroses. Placement of trace mineral blocks within the park is under consideration. Additionally, the freshwater streams that supply the lake and serve as a water source for the wildlife are seasonal, so supplementation of springs at the north end of the lake and possible windmill-powered wells are in the planning stages.

If the Lake Nakuru project meets with success, other Kenyan parks and reserves are scheduled for inclusion in the sanctuary master plan as future translocation sites. Several already have projects underway. Thirty-two black rhinoceroses from multiple past translocations currently reside in Nairobi National Park. That population appears to be stable, though further studies may more clearly define the population dynamics of that group. Plans exist to upgrade the current perimeter fence, and perhaps enclose the remaining open perimeter of the park that borders the developing Athi plains. In Tsavo National Park, four rhinos are protected in a 3 square km fenced area in a project funded in part by the British group, Zoo Check. As previously noted, the remaining Tsavo populations are widely scattered and in the initial phase; only three female rhinos were located for inclusion in the protected area. However, in August 1986, wardens were alarmed to find the perimeter fence broken. An immediate check of the compound's inhabitants found four animals, the intruder being a male black rhinoceros. According to Patrick Hamilton, head of the Wildlife Department's translocation efforts, the government would like to increase the area to 140 square km, capable of holding up to 100 animals. If at some future time, the park would become safe again, the gates could be opened and the relatively limitless spaces of Tsavo could become a "sink" for surplus rhinos in the sanctuary.

The Aberdare Park in the central mountains of Kenya is home to an estimated 37 black rhinoceroses. Plans are underway to reinforce a partial trench and fencing system already in place and to totally enclose the Salient area, once a rhino stronghold. Some poaching continues with local groups using dog packs, but according to Ian Hardy, game specialist at the Ark, predation of rhino calves by hyenas may also play a significant role in this

population. Hyena sightings at the Ark have increased nine-fold from 1970-1976, and Hans Crocker of the Serengeti Research Institute is slated to study the Aberdare hyena population and its effects on the wildlife in the park.

Masai Mara is also included in the program. It is not a national park, but a game reserve under control of the local (Narok) county council. A plan was developed to protect the remaining rhinos in situ, for any attempts to move them away from the park are politically unlikely to succeed. Though the current population in the Mara is 14, down from 27 in 1984, the decline appears to have stopped with changes in the protective forces for the rhinos. At least one female is known to be breeding, but she has lost two calves to lion and hyena predation. A fenced rhino sanctuary in a triangle at the northern edge of the park has been proposed. Site selection was complicated by several factors. First, suitable habitat had to be located, as a varity of factors in the Mara have reduced the bush and woodland thickets favored by the rhino. Additionally, problems were faced placing the sanctuary in such a way that fencing would not interfere with the migratory paths of the wildebeest and zebra.

An additional sanctuary is proposed for Meru National Park, once home to the highest density of black rhinos in northern Kenya. A population of 200-300 in the early 1970's was represented by five animals in 1986. Additions to the existing perimeter fence near the Kindani area would create a second triangular sanctuary. Other populations are difficult, if not impossible, to deal with. The Mt. Kenya population is a case in point. It is estimated to be 30 animals, but the number is uncertain due to rugged terrain. It is terrain that would also greatly hinder any effort to manage the animals for protection or for translocations.

The black rhinoceros situation in neighboring Tanzania may be even more tenuous. Ngongorogoro Conservation Area may contain only five adult black rhinos--a number exceeded by the inventory of several U.S. zoos. Perhaps most tragic is the fate of the rhino population in the Selous Game Reserve in southern Tanzania. An estimated population of several thousand had been reduced to an estimated 200-300 in 1986, and more recent estimates put the number as low as 50. A forthcoming plan to enhance protection of this vital reserve is to be jointly funded by the World Wildlife Fund, the African Wildlife Federation, and the Frankfurt and New York Zoological Societies.

In response to the increasing endangerment of the black rhinoceros, field zoologists, representatives of five AFrican governments, veterinary researchers, population scientists and zoo managers all met in Cincinnati in October 1986 to review the current situation for all species of African rhinoceroses and to identify areas of mutual interest and cooperation. As became clear at the Rhino Workshop in Cincinnati, the fate of the Selous may illustrate the future for many of the black rhinoceros populations in Africa. Where large and remote black rhinoceros

populations were once thought to be relatively safe vis-a-vis poachers; in fact, they were not. Vast, remote, and poorly defended areas such as the Selous of Tanazania or the Luangwa Valley of Zambia have been the sites of massive poaching, and in the process, their large and contiguous populations have been decimated.

In contrast, the rhino populations of several small, relatively urban parks, e.g., Nairobi National Park, have remained comparatively stable. Many field workers expressed the opinion that similar small, protected populations may be the best hope for the immediate future of the black rhinoceros in eastern Africa. The possible success of such projects can be viewed in the growing herd at Solio. However, the creation of pockets of 30-50 animals in national parks and reserves will in itself create problems of separation by intervening farmed, populated and unprotected areas. These rhino populations risk effectively becoming "islands," and attendant with that will come the problems of small population demographics. The cooperative and scientific aspects of the Species Survival Plans (SSP's) in zoos, may be required for the effective maintenance of genetic diversity in these wild populations.

The Cincinnati Rhino Workshop established conservation priorities for four subspecies of the black rhinoceros: 1) the southwestern population in Namibia, 2) the south central population that extends from Natal to Zimbabwe to southern Tanzania, 3) the northwestern population that extends from the Horn of Africa to the Cameroons, and 4) the eastern population represented in Kenya and northern Tanzania. Of these four, only the eastern population is well represented in zoos. Population modeling applied to these black rhinoceros subspecies suggests that in order to maintain a desired genetically effective population of 500 animals, a minimum total population of 2,000 will be required for each group. The current total black rhinoceros population (4,000 or less) is clearly below the 8,000 needed for the maintenance of four subspecies. Only the south-central group approaches 2,000 animals, and in none of the groups are 2,000 contiguous animals likely to occur in the foreseeable future. These smaller, and often fragmented, populations will require genetic interchange to maintain their effective population size. Thus, the genetically planned transfers of SSP animals from zoo to zoo may be mirrored in future rhino exchanges from sanctuary to sanctuary, often crossing political boundaries.

According to Peter Jenkins in 1983, "It is no exaggeration to say that the fate of the rhino will be sealed within a decade unless a long-term management policy is effected." The future not only of Kenyan, but all African black rhinoceroses, hangs in the balance. It appears that the establishment of fenced, guarded sanctuaries is one of the few resources available that will provide viable conservation alternatives for the remaining east African animals. Weighing in the future of the government sanctuaries are the tremendous costs in capital outlays and in fielding a large and effective ranger force. The future of the

ranches has to be considered in terms of the long-term outlay of funds, for they would appear to be heavily dependent on the ongoing interest and financial generosity of their present owners. However, the success of such reserves can be seen, and its repetition at Nakuru and other projects to come can be fervently hoped for. Cooperation of governments, private individuals and conservation organizations is witnessed at Lake Nakuru, and will be needed in the future. The present Kenyan government and populace would appear to have made the preservation of the black rhinoceros a high conservation priority--one that may provide a "flagship" for other conservation programs.

Assuming that the immediate problems of Kenyan rhinoceros sanctuary establishment and rhino protection are overcome, then the long term will provide the challenge of genetic management of small populations of wild black rhinoceroses; if you will, the establishment of "field SSP's." It is a forthcoming challenge that will provide new opportunities for the application of the zoo SSP experience to animals in their native habitat.

BLACK RHINOCEROS POPULATION ESTIMATE (1986)

Ngong	1 (1-7)	
*Mero	3 (5)	NP
Lewa Downs	11	Priv
Ol Jogi Ranch	7	Priv
Solio Ranch	85 (90)	Priv
Laikidia Ranch	40 (10-60)	Priv
Mt. Kenya	30 (guess)	NP
*Aberdare	37	NP
Rondyoni Mt.	1	
*Nairobi	32	NP
*Masai Mara	15	GR
Tsavo East	100 (150?)	NP
*Tsavo West	4	NP
Lewalani	4	
*Nakuru	1	NP
	377	

NP = National park

Priv = Private

GR = Game reserve

* = Suggested sanctuary site

KENYA BLACK RHINOCEROS

METAPOPULATION WORKSHOP

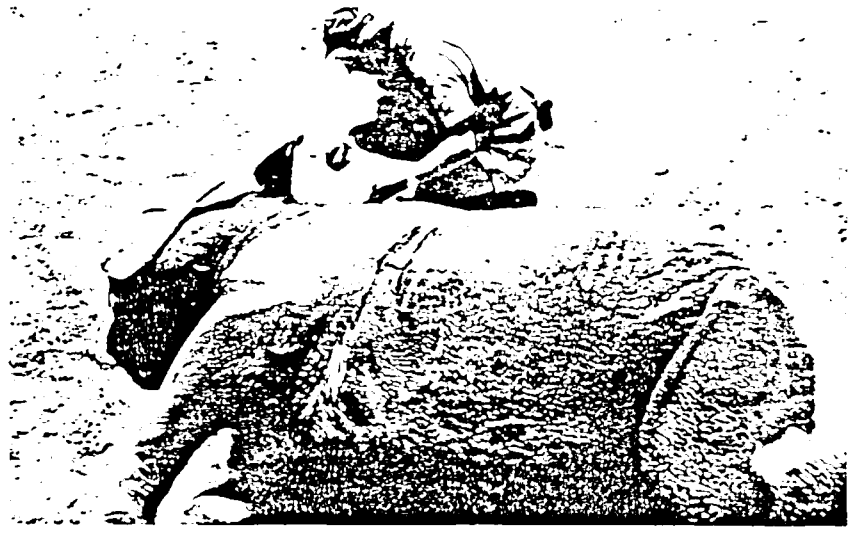
BRIEFING BOOK

SECTION 8
DISEASE

Doctoring Rhinos : Diseases seen in Kenya

John Francis Jonyo

The current number of black rhinos (*Diceros bicornis*) in Kenya stands at about 500, and some 50 white rhinos (*Ceratotherium simum*) are on private ranches. Most of the black rhinos are fragmented over a wide range reducing opportunities for breeding and genetic interchange and hence accelerating the rate of extinction. Conditions have been worsened by breeding depression caused by environmental changes and demographic fluctuations such as biased sex ratios and genetic problems. Disease can also be considered as having an effect on the rhino population in Kenya and these remarks are based on animals seen during the major rhino translocations carried out in Kenya between 1986 and 1988.



Taking blood from an immobilized rhino

The "Natural" State of Health

Wild herbivores are known to be resistant to and carriers of diseases which, while not harmful to them, can be transmitted to domestic animals in areas of mixed grazing. Examples are buffaloes (*S. caffer*), which carry protozoan parasites (*Theileria*) and the foot-and-mouth virus, and wildebeests (*C. taurinus*), known to transmit the deadly disease of malignant catarrhal fever to calving cattle. Transmission is either by intermediate hosts like ticks or directly through saliva or faecal material deposited onto the pastures and ingested by the domestic animal.

Although they seldom graze in areas where domestic animals wander around, tests have shown that rhinos are infected with many types of disease, most of which are suppressed except in times of stress. Such stress, be it due to capture, nutritional problems or even environmental change, can lower the resistance of the body so that the underlying diseases exhibit themselves as infections which can lead to death if untreated.

Blood Diseases

Once a rhino has been immobilized blood is routinely collected from either the ear-vein or a vein in the front leg into 10 ml vials containing anticoagulants or into sera bottles. When the blood is smeared onto a slide and stained with Giemsa certain protozoan parasites are seen in the thin blood films. These include *Theileria* and trypanosome parasites ranging in type with areas of capture. *Theileria* species found in rhino blood are non-pathogenic while the trypanosome, which causes Nagana in cattle, can be of various kinds such as *T. brucei* which was isolated from a clean black rhino moved from Nanyuki into Tsavo-Ngulia Sanctuary. The infection was seen within two weeks of the move and was due to heavy tsetse fly (*Glossina pallidipes*) challenge. The animal was treated with Berenil, a trypanocidal drug, and seen to improve but was found dead three weeks later, more probably due to traumatic injuries from a fight with another rhino than from infection. There has been some controversy as to the effect of trypanosomes on the black rhino which is known to be an animal indigenous to the savanna equatorial lands that have the most numbers of tsetse flies in Africa. There are black rhinos living perfectly well in Tsavo and the Masai Mara, areas with plenty of tsetse flies, and it is only when animals born and raised in "tryps-free" areas are moved into fly areas that problems arise. White rhinos are not so resistant to the fly challenge compared to black rhinos although after initial treatment five white rhinos survived well in Meru National Park -- until killed by poachers. The clinical manifestations of trypanosomiasis in the rhino include depression, increased salivation, increased body temperature and emaciation due to decreased feeding; in the later stages of the disease jaundice occurs leading to death. Treatment includes administration of several drugs, some curative, others prophylactic. Survivors do acquire some immunity to reinfection. Avoiding the transfer of clean rhinos from "tryps-free" areas to fly infected areas is the best way to avoid losses from this disease. Movement of infected rhinos from one part of the Republic to another might introduce a new type of the infection into an area clear of the parasite which may then multiply in other herbivores if a fly vector is available. It is therefore of paramount importance to screen the rhinos being moved into the different sanctuaries and treat them before release. Solio rhinos moved to Nakuru Sanctuary were trypanosome-free and they went from one non-fly zone to another.

nfectious Diseases

Bacterial infection is the most common and easiest to diagnose because it shows in the form of an abscess or as pus oozing from a wound on the skin. The bacteria which live on soil easily contaminate an injury and if not treated may spread into the blood as the thick skin of rhinos can prevent an abscess from rupturing to the surface. Pneumonia and pus from the nose can result from an infection which would be due usually to staphylococcus, streptococcus, anthrax bacilli, salmonella or brucella organisms. Young hand-reared rhinos commonly suffer from bacterial diarrhoea accompanied by loss of appetite or increased temperature. The treatment of bacteria is administering antibiotics by injection or as creams, sprays and ointment. It is routine to give such injections to captured rhinos before reviving them.

Most rhinos are carriers of viruses but, unless the animal is stressed by capture and translocation, are usually resistant to infection. Sometimes, if transportation under sedation is of prolonged duration, upon revival the rhino is observed to be listless, with increased respiration, nasal discharge and lack of appetite. It does not respond to the antibiotics and vitamins administered and sometimes dies in the pen.

Mostly seen as skin-patches, fungal infections are picked up when rhinos scratch on trees or in pens which have held infected animals: anti-fungal creams and injections are available for their treatment. Warts have been seen on captured rhinos. Usually of small size, just raised above the level of the skin, they can be surgically removed while the rhino is under sedation. Any bleeding is arrested and the site sprayed with antibiotics to stop any secondary bacterial invasion.

Parasitic Diseases

The principal internal parasites are worms which live in the gut of the rhino and are ingested with the browse in the form of eggs or larvae. Parasites range from bot-larvae in the oesophagus, lung worms of different types in the rumen, small and large intestines and lungs to even liver flukes in rhinos which feed in marshy areas. Assessment of parasitic load is determined by measuring the amount of eggs shed by the helminths in a gramme of fresh rhino faeces. Animals in pens are known to develop a high egg count per gramme and treatment with anti-helminths is therefore essential. The drug is given in drinking water or by hiding the tablets in a piece of sugar cane. Tapeworms have also been reported and treated in these animals.

Domestic and biting flies, ticks, mites, fleas and lice all have been observed on the skin of rhinos. Open wounds provide entry points for bacteria and enable flies to lay their eggs or deposit micro-filariae nematodes in the skin while tsetse flies introduce mechanically the trypanosome. Every black rhino in Kenya has wounds which vary in number with the fly zone and the age of the rhino and can in fact help in estimating how old a particular animal is. Treatment is with healing oils and antibiotic creams.

Breeding Diseases

Breeding is most important for the rhinos translocated into sanctuaries. Oestrus in female rhinos occurs at intervals of 38-58 days and is characterized by frequent urination and increased respiration, both visible and audible. Oestrus lasts 24 hours and, if copulation is successful, after 474-488 days of gestation a single calf is born. Some diseases interrupt the normal reproductive cycle and cause premature birth or infertility. Two such, brucellosis and vibriosis, were tested for in the sera of all Solio rhinos sent to Nakuru; no animal was positive, giving high hopes for successful breeding. In future all areas of rhino capture will be tested for breeding diseases.

Inflicted Wounds

Fighting between males for territory or females sometimes causes serious injury and nearly all rhinos captured from the wild are found to have old traumatic wounds from fighting, rubbing on trees, thorns, arrow heads or even bullet wounds. Most of the wounds become infected by invading bacteria but with time heal leaving scars on the skin. More serious wounds should be treated with antibiotics.

Nutritional Deficiency Diseases

The number of rhinos moved into a new sanctuary has to be balanced with the availability of rhino browse in the area and the availability of fresh water. The level of fluoride in the water and the levels of different essential mineral salts available in the water, soil and vegetation must be all taken into account. A deficiency in the feed, water or mineral salts will be exhibited either as a loss of body condition, uncoordinated movement, infertility or, in extreme cases, death. Corrections can be made by supplementing the feed with salts containing minerals such as copper, selenium, molybdenum and magnesium.

Typical suppurating wound caused by bacterial infection

either dangerously close to or below viable population levels. He saw the future for rhinos lying in managed metapopulations consisting of *in situ* subpopulations and *ex situ* captive breeding subpopulations between which controlled movement of breeding animals would be necessary to maintain genetic diversity and demographic security. Highest priority should be placed on increasing both wild and captive bred populations immediately to escape deleterious stochastic threats. Foose felt that the situation had reached a stage where it was undesirable that any taxa of rhino should be reliant on a single political authority for its survival. While advocating the value of captive breeding programs, Foose observed the need for improvement in husbandry.

Leader-Williams presented a powerful case that the only effective conservation of rhinos to date had occurred *in situ* in areas where adequate budgets and manpower had been provided. He presented data to show that, to date, the contribution of *ex situ* captive breeding programmes to conservation of rhinos (and several other species) had been negligible and costly. He expressed caution at experimenting with captive breeding at a stage when many populations needed immediately to be increased to more secure levels.

Martin, also, felt that *in situ* protection of rhinos was of the utmost priority. He highlighted the fact that adequate budgets for such efforts could be obtained sustainably within the three southern African countries which now contain over 90% of Africa's black and white rhinos by taking advantage of the inherent economic value of rhino. A controlled trade in legal government stocks of rhino horn and/or the raising of revenues from a small quota of animals for sport hunting could provide the necessary funds. Current contributions to rhino conservation from the international community were small compared to the budgets allocated by those African governments who had achieved successful conservation of rhino, and these governments sought to remain self-sufficient in funding through sustainable conservation measures. Zimbabwe had made a secondary commitment to *ex situ* captive breeding by its intent to provide a viable founder population of black rhino. It saw this as an ultimate form of insurance in the very long term against extinction possibilities but did not in any way view this as reducing the *in situ* conservation requirements.

In summary:

1. The paramount goal should be the maintenance or restoration of viable wild rhino populations.
2. More money needs to be directed toward this effort either by greater donor involvement or by sustainable utilization of the species including the use of its high economic value.
3. Captive propagation could offer an ultimate insurance against extinction provided that better husbandry, management, and breeding performance can be achieved.

Plenary VIII - Summary and Working Group Report

Health, Disease, Nutrition and Pharmacology: Veterinary Aspects of Rhinoceros Conservation

E. Miller, chair: *Health concerns and veterinary research in the North American black rhinoceros (*Diceros bicornis*) population*
C. Furley: *Diseases and management of black and Sumatran rhinoceroses at the Howletts and Port Lympne zoos*
L. Geldenhuys: *Capture and translocation of black rhino in Namibia*
D. Jessup: *Health data gained from black rhinoceroses immobilized for relocation*
M. Kock: *Capture and translocation of the black rhinoceroses (Diceros bicornis) in Zimbabwe: Management modifications to reduce stress and mortalities*
R. Kock: *Veterinary management of three species of rhinoceroses in zoological collections*
R. Montali: *Pathological findings in captive rhinoceroses*
P. Morkel: *Translocation and dehorning of wild black rhinoceroses*
L. Munson: *Mucosal and cutaneous ulcerative syndrome in black rhinocerso (Diceros bicornis)*

In view of the role that health and nutritional problems in the maintenance of captive rhinoceros populations (eg, as a limiting factor in the growth of the captive black rhinoceros population), and that they have presented concerns in wild populations and their translocations, the following points for consideration and action are recommended:

1. Continued investigation of health problems in wild and captive rhinoceroses. New and continued research should be organized and encouraged in the following areas:

All morbidity and mortality data from captive, and where possible, wild populations should be compiled and reviewed annually under the auspices of the regional species management plans and national wildlife programs, and those regional data reviewed under the auspices of the IUCN/CBSG Rhinoceros Action Plan. Such studies should include evaluation of post-capture and post-translocation mortalities.

Investigation of fertility and the incidence and prevention of management related disease and trauma.

Additionally, monitoring the fertility of all rhinoceros populations with particular attention to fertility in Indian rhinoceroses and abortion rates in black rhinoceroses.

Enhancement of baseline data for normal values from free-ranging and captive rhinoceroses of all species is of critical importance to all fields of research.

Epidemiology of health problems in captive and wild rhinoceros populations and comparison of patterns in each. Such research should include seropreyalence surveys for infectious diseases and evaluation of internal and external parasites and their health significance.

Continued sharing and refinement of immobilization regimens between wildlife and zoo veterinarians should take place. Narcotic agents (etorphine and carfentanil) are the primary drugs used for immobilization, and further investigations are needed to establish preferable supplemental tranquilizers, particularly long-acting neuroleptic agents.

Metabolic consequences of anesthesia and the stresses associated with capture and the sequelae of both should be assessed.

Studies to address the immunocompetency of wild and captive black rhinoceroses and the role that immunology may play in several of their diseases, eg, fungal pneumonia of black rhinoceroses.

Nutritional research should include general review of the feeding practices used in all species in captivity with particular attention to minimal requirements. Basic nutritional evaluations should focus attention on both the nutrition of wild and captive populations. Research to establish effective dietary supplementation with α-tocopherol should be encouraged.

In black rhinoceroses further research should be designed to evaluate the following diseases and syndromes:

Hemolytic anemia - Current recommenda-tions for the prevention of acute hemolytic anemia include vaccination of captive animals with a bacterin containing 5 leptospiral serovars. Research to an underlying cause for the hemolysis should continue.

Oral/skin ulcers

Further evaluation of iron metabolism due to the accumulation of hepatic iron in captive and newly captured black rhinoceroses.

Fungal pneumonia

Encephalomalacia.

2. In conjunction with the above proposals, identification of additional funding resources to support health research in rhinoceroses is vital.

3. Continued maintenance and enhanced participation in regional biomaterial banks (tissue, sera, urine, etc) with materials from both captive and wild rhinoceroses of all available species is vital to future comparative studies.

4. Continued and enhanced collection of genetic samples from anesthetized animals whenever possible.

5. Continued and improved communication between veterinarians working with both wild and captive rhinoceroses should be enhanced through future meetings. Special effort should be applied to the maintenance of continuous medical histories for rhinoceroses translocated from the wild to captivity.

In summary, there should be veterinary participation in the management of captive and wild rhinoceros populations. This participation should be an integral part of a multidisciplinary approach to their care, and is particularly relevant to their capture and translocation. Such efforts will contribute to the long term survival of both *in situ* and *ex situ* rhinoceros populations.

Planning for Rhinoceros Conservation

Proposed consensus items and/or issues for discussion and clarification:

1) There should be a greater flow of funds from international development agencies to projects that conserve biological diversity.

2) There is a need for increased flow of information concerning the costs of *ex situ* and *in situ* conservation.

3) There is a need for more accurate and timely reporting of data concerning population abundance, especially for *in situ* populations of black, Sumatran and Javan rhino.

4) Civil and military conflicts within and between nations pose a proximate threat to rhino populations.Demographic vulnerability due to small population size poses the most immediate threat to wild populations of rhinos where poaching activities are under control and where negative civil and military impacts on rhino populations are precluded.

5) A closer examination of husbandry regimes for rhinos in zoological parks is warranted in order to gain insights into their apparently less-than-maximal reproduction rates.

6) Non-invasive reproductive monitoring of rhinos in zoological parks should be expanded and, as possible, compared with data obtained from *in situ* sanctuary and *ex situ* sanctuary populations of rhinos.

7) The development of a simple pregnancy test, especially one that could be employed under field conditions would be of use in both *in situ* and *ex situ* management of rhinos.

8) It is worthwhile at this time to conduct experiments in the introduction of black rhinos into existing populations. The existing populations should be derived from demographically and genetically secure sources so that their reproduction is not considered essential for meeting gene pool conservation goals in the region. The introduced rhinos could include individuals of either sex and be derived from zoological parks or *in situ* populations. (i.e., it is valuable now to begin to develop successful approaches for the creation of metapopulations).

9) A Second International Conference on Rhinoceros Biology and Conservation is warranted as in three years' time new information on disease, reproduction and the development of sanctuary programs is anticipated.

Working Group Report
Conservation of the Northern white rhinoceros

Ceratotherium simum cottoni

At the International Conference on Rhinoceros Biology and Conservation the most recent information available was exchanged. A Northern white rhinoceros working group met and presented their report at a conference plenary session.

Recommendations are made in three areas: conservation of the *in situ* population, conservation of the *ex situ* population, and coordination of these efforts.

In situ population

The success of the conservation efforts for the Northern white rhinoceros in Garamba National Park taken by the government of Zaire is recognized and those responsible are to be commended for their actions.

Continuation or increase in the levels of international funding for the Garamba ecosystem and an increase in the level of research efforts in support of the Northern white rhinoceros is recommended.

External assistance is recommended for the further training of park staff in techniques of wildlife protection.

Further research should be undertaken on nutrition and feeding ecology. Research should also be undertaken on the genetic status of the Garamba population. Collection of samples for genetic analyses, including examination of the levels of genetic diversity and in methods of parentage determination, should be encouraged. Research should be initiated on the role of infrasonic vocalizations in communication between and among individual rhinos in the park.

INTERNATIONAL RHINOCEROS CONFERENCE - SAN DIEGO 1991
VETERINARY WORKING GROUP/SESSION REPORT

In view of the role that health and nutritional problems in the maintenance of captive rhinoceros populations (eg, as a limiting factor in the growth of the captive black rhinoceros population), and that they have presented concerns in wild populations and their translocations, the following points for consideration and action are recommended:

1. Continued investigation of health problems in wild and captive rhinoceroses. New and continued research should be organized and encouraged in the following areas:

   All morbidity and mortality data from captive, and where possible, wild populations should be compiled and reviewed annually under the auspices of the regional species management plans and national wildlife programs, and those regional data reviewed under the auspices of the IUCN/CBSG Rhinoceros Action Plan. Such studies should include evaluation of post-capture and post-translocation mortalities.

   Investigation of the incidence and prevention of management related disease, trauma and fertility.

   Additionally, monitoring the fertility of all rhinoceros populations with particular attention to fertility in Indian rhinoceroses and abortion rates in black rhinoceroses.

   Enhancement of baseline data for normal values from free-ranging and captive rhinoceroses of all species is of critical importance to all fields of research.

   Epidemiology of health problems in captive and wild rhinoceros populations and comparison of patterns in each. Such research should include seroprevalence surveys for infectious diseases and evaluation of internal and external parasites and their health significance.

   Continued sharing and refinement of immobilization regimens between wildlife and zoo veterinarians should take place. Narcotic agents (etorphine and carfentanil) are the primary drugs used for immobilization, and further investigations are needed to establish preferable supplemental tranquilizers, particularly long-acting neuroleptic agents.

   Metabolic consequences of anesthesia and the stresses associated with capture and the sequelae of both should be assessed.

Studies to address the immunocompetency of wild and captive black rhinoceroses and the role that immunology may play in several of their diseases, eg, fungal pneumonia of black rhinoceroses.

Nutritional research should include general review of the feeding practices used in all species in captivity with particular attention to minimal requirements. Basic nutritional evaluations should focus attention on both the nutrition of wild and captive populations. Research to establish effective dietary supplementation with alpha-tocopherol should be encouraged.

In black rhinoceroses further research should be designed to evaluate the following diseases and syndromes:

- Hemolytic anemia -Current recommendations for the prevention of acute hemolytic anemia include vaccination of captive animals with a bacterin containing 5 leptospiral serovars. Research to identify an underlying cause for the hemolysis should continue.
- Oral/skin ulcers
- Further evaluation of iron metabolism due to the accumulation of hepatic iron in captive an newly captured black rhinoceroses.
- Fungal pneumonia
- Encephalomalacia

2. In conjunction with the above proposals, identification of additional funding resources to support health research in rhinoceroses is vital.

3. Continued maintenance and enhanced participation in regional biomaterial banks (tissue,sera, urine, etc) with materials from both captive and wild rhinoceroses of all available species is vital to future comparative studies.

4. Continued and enhanced collection of genetic samples from anesthetized animals whenever possible.

5. Continued and improved communication between veterinarians working with both wild and captive rhinoceroses and should be enhanced through future meetings. Special effort should be applied to the maintenance of continuous medical histories for rhinoceroses translocated from the wild to captivity.

In summary, there should be veterinary participation the management of captive and wild rhinoceros populations. This participation should be an integral part of a multidisciplinary approach to their care, and is particularly relevant to their capture and translocation. Such efforts will contribute to the long term survival of both <u>in situ</u> and <u>ex situ</u> rhinoceros populations.

Submitted by: R. Eric Miller, DVM
Working Group/Session Chair

SEP - 3 1991

Saint Louis ZOO

Forest Park
Saint Louis, Missouri 63110
(314) 781 0900
Fax (314) 647 7969

September 1, 1991

Dear Rhinoceros Researcher:

Due to your interest in black rhinoceros research, please find enclosed a copy of this year's Black Rhinoceros Veterinary Research Update. In abstract form, this report describes projects that have been either active or initiated in the past year. For your interest, I have also enclosed a copy of the report of the Veterinary Working Group from the 1991 Rhinoceros Conference in San Diego, and a list of speakers and presentations in the Veterinary/Nutrition Session there.

Thank you for your past, present and future interest in the health of black rhinoceroses. If I can supply any further materials, or if you have any comments or suggestions, please feel free to contact me.

Sincerely,

Eric Miller

R. Eric Miller, DVM
Associate Veterinarian

Saint Louis ZOO

Forest Park
Saint Louis, Missouri 63110
(314) 781 0900
Fax (314) 647 7969

Charles H Hoessle
Director

Robert Hyland
President, Zoological Commission

BLACK RHINOCEROS VETERINARY RESEARCH UPDATE 1991

R. Eric Miller, DVM
Veterinary Advisor
Black Rhinoceros (Diceros bicornis) SSP Committee
Rhinoceros Taxon Advisory Group

Under the auspices of the SSP, animal health research in the black rhinoceros is an ongoing effort. This report will serve as an update to the 1990 veterinary report to the Black Rhinoceros SSP. Obtaining tissue and sera from all species of captive and wild rhinoceroses remains a priority. Central storage facilities exist for formalinized rhinoceros tissues (Dr. Richard Montali, National Zoological Park) and for frozen serum and tissue (Dr. Eric Miller, St. Louis Zoological Park). These banks have provided readily available sources of materials for comparative and retrospective studies. "Normal" values from wild black rhinoceroses (80+ animals) in Zimbabwe has been published by Dr. Michael Kock, Raoul du Toit, et. al. (1).

Four diseases in black rhinoceroses continue to be notable for their unusual nature and relatively high frequency of occurrence. Although hemolytic anemia has been the leading cause of death among captive animals (43 episodes of hemolysis noted in 34 rhinoceroses; 23 rhinoceroses died from their anemia), no deaths from "primary" hemolysis (not associated with other systemic disease) have been noted since 1986. It is too soon to determine the full significance of this, but it may be a hopeful sign that leptospirosis vaccination and dietary improvements have had some effect. Additionally, no new cases of encephalomalacia have been identified since 1988.

Fungal pneumonias (Aspergillus and less commonly phycomycetes) continue to be noted; at least 6 cases have been identified in black rhinoceroses in North America. Four occurred in black rhinoceroses receiving immunosuppressive therapy for other conditions and 2 cases were "spontaneous." The occurrence of these infections suggests an altered immunological response and has led to research on the immune status of black rhinoceroses (see Dr. Slavin's project below, Dr. Herron's project on the 1990 report). Last, but not least, is the occurrence of oral/skin ulcers. Twenty-six cases have been noted, ranging from mild skin ulcers to severe ulcerative lesions of the skin, mucosal junctions and gastrointestinal tract. Death may result from secondary complications. Dr.

Linda Munson is reviewing tissues from these cases (see description of her project below).

Prior to the 1991 International Rhinoceros Conference at the San Diego Zoo, Dr. David Jessup (International Wildlife Veterinary Services) organized a meeting of veterinarians active in rhinoceros medicine and research. Attendees represented zoo and wildlife veterinarians from the US, Great Britain, Zimbabwe and Namibia. The meeting presented an excellent opportunity for wildlife and zoo veterinarians to share clinical and research experiences and to identify areas of common interest and cooperation. A statement that resulted from this meeting and the Veterinary Session of the Rhinoceros Conference is attached. Two areas were identified that warrant further research: 1) immunological function (for reasons noted above) and 2) additional nutritional studies.

Following is an updated list of animal health projects that have either been initiated or active in the past year:

1. Project: T-Lymphocyte Stimulation Testing and Immunological Evaluation for Fungal Infections
Researchers: Dr. Raymond Slavin and Dr. Allan P. Knutsen, St. Louis University School of Medicine, St. Louis, MO 63104, and R. Eric Miller, DVM, St. Louis Zoological Park, St. Louis, MO 63110, USA.

   Currently being designed, this project will employ various immunological tests to identify black rhinoceroses infected with Aspergillus sp. (primarily pneumonia as noted above) and to evaluate their response to fungal organisms. A more general immunological study will evaluate the response of black rhinoceros lymphocytes to in mitogen stimulation studies.

2. Project: Nutritional studies

   Researchers: Dr. Craig Thatcher, Virginia-Maryland Regional College of Veterinary Medicine, Blacksburg, VA 24601, USA, R. Eric Miller, DVM, St. Louis Zoological Park, St. Louis, MO 63110, USA.

   See Nutritional Report to the Black Rhinoceros SSP Committee.

3. Project: Evaluation of oral and skin ulcers

   Researcher: Dr. Linda Munson, College of Veterinary Medicine, University of Tennessee, Knoxville, TN 37901-1076, USA.

   Due to the occurrence of oral and/or skin ulcers in captive black rhinoceroses (3), biopsy and postmortem tissues from all cases are being reviewed by Dr. Munson. Twenty-six captive black rhinoceroses in the US have had mucosal and/or cutaneous

ulcers; 3 cases have been noted in the past year. Most of the rhinoceroses have had recurrent ulcers. Microscopically, the oral and skin lesions appear as chronic ulcers, though, as of yet no single histologic pattern has emerged. In these captive rhinoceroses there has been no evidence of the dirofilarid parasite Stephanofilaria dinniki. The etiology remains unknown. Dr. Munson is preparing a paper describing the ulcerative "syndrome."

4. Project: Leptospirosis evaluation by microagglutination titers and fluorescent antibody testing.

Researcher: Dr. Carol Bolin, National Veterinary Services Laboratory, Ames, IA 50010, USA

On the basis of fluorescent antibody (FA) tests, infection with Leptospirosis interrogans has noted in 3 of 4 cases of fatal hemolytic anemia in black rhinoceroses (2). Additionally, in the past year, another FA+ case was noted in a female that died in 1990 at the Cincinnati Zoo with severe skin ulcers and anemia. The relationship of L. interrogans infection with disease in this animal is unclear. Currently titer data from captive and wild (Zimbabwe samples supplied by Drs. Michael and Nancy Kock and David Jessup and Raoul du Toit, Namibian samples supplied by Dr. Peter Morkel and Louis Geldenhuys) are being submitted for publication. Of interest is evidence of exposure to varying serovars (strains) of L. interrogans in different areas of Zimbabwe and Namibia (no evidence of exposure in 3 rhinoceroses from the latter's arid habitat). The presence of infection with L. interrogans in some of the hemolytic cases and the titer data continue to support the previous recommendation that all black rhinoceroses be vaccinated biannually with a bacterin that contains at least 5 serovars of L. interrogans including icterohaemorrhagiae and grippotyphosa. Leptoferm-5 (Norden Laboratories, Lincoln, NE 80809, USA) is recommended. Opportunistic postvaccinal sampling of black rhinoceros continues to demonstrate responses in microagglutination titers that would be considered appropriate and protective in domestic species.

Note: Though leptospiral infection may be indicated in 50%-75% of the fatal cases of hemolytic anemia, it is important to note that it has not been identified in all cases. Ongoing studies are attempting to identify other factors that may contribute to red blood cell instability.

5. Project: Further evaluation of red blood cell metabolism.

Researcher: Dr. Donald Paglia, University of California - Los Angeles, Los Angeles, CA 90024, USA

ATP levels in the black rhinoceros RBC are approximately 5% - 20% of those in most other mammalian species. The impact of this finding is uncertain, but it raises the possibility that the black rhinoceros RBC may use alternative energy pathways (4). Further analysis of rhinoceros RBC metabolism and substrate usage is ongoing at UCLA as heparinized blood samples become available. Funding sources need to be identified to maintain and continue this project.

6. Project: Aspergillus sp. pneumonia in black rhinoceroses.

Researcher: Dr. Scott Citino, Metro Miami Zoo, Miami, FL 33176, USA and Dr. Eric Miller, St. Louis Zoological Park, St. Louis, MO 63110, USA.

Fungal pneumonia caused by Aspergillus sp. has been noted in at least 6 captive black rhinoceroses. At least 4 of the 6 affected animals were on immunosuppressive therapy for ulcers (see Dr. Munson's project above). However, 2 of the cases were apparently spontaneous. The occurrence of fungal pneumonia in captive black rhinoceroses warrants further studies regarding their immunocompetence (see Dr. Slavin's project).

7. Project: Cross matching of black rhinoceros sera and red blood cells

Researcher: Dr. Ann Bowling, School of Veterinary Medicine, University of California, Davis, CA 95616

Red blood cells (citrated samples) from 9 black rhinoceroses have been cross-matched with sera from 18 black rhinoceroses. In agglutination testing, weak to moderate reactions have been observed in 13 of the 18 sera samples. One sera sample has produced weak lytic reactions against 7 of the 8 animals tested. Interpreted in light of experience in domestic animals, no evidence has been found that would suggest a clinically obvious problem being defined by these tests. However, it is tempting to speculate that a pattern is emerging from these reactions which may define one or more naturally occurring anti-red cell antibodies. Hopefully, further samples will help in interpreting these observations.

8. Project: Complete blood counts and serum chemistries.

Researcher: Dr. Steven Stockham, College of Veterinary Medicine, University of Missouri, Columbia, MO 65211

Because of variability between laboratory methods, a request was made that complete blood counts and serum chemistries from all rhinoceroses be submitted to a central laboratory. To date, 35 samples have been received from 15 black and 6 white rhinoceroses. Data are currently being reviewed.

9. Project: Serum iron levels and iron binding proteins

Researcher: Dr. Joseph Smith, College of Veterinary Medicine, Kansas State University, Manhattan, KS 66506

Due to the elevated tissue levels of iron noted at necropsy in many black rhinoceroses, additional tissue iron levels from necropsies and serum levels of iron and iron transporting proteins in living animals are being assayed. Thirty-seven sera samples (29 black, 7 white, and 1 Indian), and 17 liver and/or splenic samples (14 black, 3 white) samples have been evaluated. When the data from black rhinoceroses are compared to the white rhinoceroses included in the study, they do not appear to differ significantly. Further analysis is underway to determine if initial impressions that black rhinoceroses accumulate iron in the liver and spleen as they age, and if the serum iron and TIBC of adult black rhinoceroses are higher than that of younger animals or white rhinoceroses.

10. Project: Evaluation for hepadnovirus.

Researcher: Dr. Mike Worley, Zoological Society of San Diego, San Diego, CA 92103, USA.

This study continues to evaluate rhinoceros serum samples for antibodies to hepatitis B-like virus. Additional testing is in progress in an attempt to more definitively identify viral isolates.

-next page-

BLACK RHINOCEROS DEATHS IN NORTH AMERICA

1991

STDBK # NAME	SEX	DOB	DOD	CAUSE OF DEATH
239 Nanyuki SD-WAP	F	15OCT76	13JUN91	Ruptured liver, trauma
2066 No Name Bentsen	M	20JUL91	20JUL91	Weak, possibly premature

BIBLIOGRAPHY

1. Kock, MD, R du Toit, D Morton, N Kock, B Paul: Baseline biological data collected from chemically immobilized free-ranging black rhinoceroses (Diceros bicornis) in Zimbabwe. J. Zoo Wildl. Med. 21: 283-291, 1990.

2. Miller, RE, CA Bolin: Evaluation of leptospirosis in black rhinoceroses (Diceros bicornis) by microscopic agglutination and fluorescent antibody testing. Proc. Am. Assoc. Zoo Vet., pp. 161-162, 1988.

3. Ott, JE, SE McDonald, PT Robinson, FH Wright: Ulcerative stomatitis in a black rhinoceros (Diceros bicornis). Proc. Am. Assoc. Zoo Vet., pp. 68-71, 1982.

4. Paglia, DE, WN Valentine, RE Miller, M Nakatani, RA Brockway: Acute intravascular anemia in the black rhinoceros (Diceros bicornis) - II. Erythrocytic enzymes and intermediates. Am. J. Vet. Res. 47: 1321-1325, 1986.

Respectfully submitted,

R. Eric Miller, DVM
Associate Veterinarian
St. Louis Zoological Park

September 1, 1991

INTERNATIONAL RHINOCEROS CONFERENCE - SAN DIEGO 1991
VETERINARY WORKING GROUP/SESSION REPORT

In view of the role that health and nutritional problems have had in the maintenance of captive rhinoceros populations (eg, as a limiting factor in the growth of the captive black rhinoceros population), and that they have presented concerns in wild populations and their translocations, the following points for consideration and action are recommended:

1. Continued investigation of health problems in wild and captive rhinoceroses. New and continued research should be organized and encouraged it the following areas:

   - All morbidity and mortality data from captive, and where possible, wild populations should be compiled and reviewed annually under the auspices of the regional species management plans and national wildlife programs, and those regional data reviewed under the auspices of the IUCN/CBSG Rhinoceros Action Plan. Such studies should include evaluation of post-capture and post-translocation mortalities.

   - Further investigation of the incidence and prevention of management related disease, trauma and infertility.

   - Additionally, monitoring the fertility of all rhinoceros populations with particular attention to Indian rhinoceroses and abortion rates in black rhinoceroses should be emphasized.

   - Enhancement of baseline data ("normal" values) from free-ranging and captive rhinoceroses of all species is of critical importance to all fields of research.

   - Epidemiology of health problems in captive and wild rhinoceros populations and comparison of patterns in each. Such research should include seroprevalence surveys for infectious diseases and evaluation of internal and external parasites and their significance to rhinoceros health.

   - Continued sharing and refinement of immobilization regimens between wildlife and zoo veterinarians should take place. Narcotic agents (etorphine and carfentanil) are the primary drugs used for immobilization, and further investigations are needed to establish preferable supplemental tranquilizers, particularly long-acting neuroleptic agents.

   - Metabolic consequences of anesthesia and the stresses associated with capture and the sequelae to both should be assessed.

   - Studies to address the immune status of wild and captive rhinoceroses and the role that immunology may play in several of their diseases, eg, fungal pneumonia of black rhinoceroses, should be initiated.

- Nutritional research should include a general review of the feeding practices used in all species in captivity with particular attention to establishing minimal requirements. Basic nutritional evaluations should focus attention on the nutrition of both wild and captive populations, and the resultant comparisons. Research to establish effective dietary supplementation with alpha-tocopherol should be encouraged.

- In black rhinoceroses, further research should be designed to evaluate the following diseases and syndromes:

  Hemolytic anemia - Current recommendations for the prevention of acute hemolytic anemia include the vaccination of captive animals with a bacterin containing 5 leptospiral serovars. Research to identify an underlying cause for the hemolysis should continue.

  Oral/skin ulcers - Ongoing efforts to identify the pathophysiology of the ulcers should be encouraged.

  Iron metabolism - Further evaluation due to the accumulation of hepatic iron in captive and newly captured black rhinoceroses.

  Fungal pneumonia

  Encephalomalacia

2. In conjunction with the above proposals, identification of additional funding sources to support health research in rhinoceroses is vital.

3. Continued maintenance and enhanced participation in regional biomaterial banks (tissue, sera, urine, etc.) with samples from both captive and wild rhinoceroses of all available species is vital to future comparative studies.

4. Continued and enhanced collection of genetic samples from anesthetized rhinoceroses whenever possible should continue to be encouraged.

5. Communication between veterinarians working with both wild and captive rhinoceroses should be continued and enhanced through future meetings. Special effort should be given to the maintenance of continuous medical histories for rhinoceroses translocated from the wild to captivity.

In summary, there should be veterinary participation in the management of captive and wild rhinoceros populations. This participation should be an integral part of a multidisciplinary approach to their care, and is particularly relevant to their capture and translocation. Such efforts will contribute to the long term survival of both in situ and ex situ rhinoceros populations.

Submitted by : R. Eric Miller, DVM
Veterinary Working Group/Session Chair

1. Dr. Michael Kock
"Capture and Translocation of Black Rhinoceroses in Zimbabwe, Capture and Management Modifications to Reduce Stress and Mortalities"

Department of National Parks and Wildlife Management
PO Box 8365
Causeway
Harare
Zimbabwe

2. Dr. David Jessup
"Health Data Gained from Black Rhinoceroses Immobilized for Relocation"

International Wildlife Veterinary Services
7945 Amalfi Way
Four Oaks, CA 95628

3. Louis Geldenhuys
"Black Rhinoceros Translocation in Namibia"

Etosha Wildlife Institute
Namibia Department of Nature Conservation
Private Bag 13306
Windhoek 9000
Namibia

4. Dr. Peter Morkel
"Dehorning of Wild Black Rhinoceroses in Namibia"

Etosha Wildlife Institute
Namibia Department of Nature Conservation
Private Bag 13306
Windhoek 9000
Namibia

5. Dr. Eric Miller
"Health Concerns in Captive Rhinoceroses"

St. Louis Zoological Park
1 Government Drive
Forest Park
St. Louis, MO 63110-1396

6. Dr. Richard Kock
"Veterinary Management of Rhinoceroses in Zoos"

Zoological Society of London
Whipsnade Park
Whipsnade, Bedfordshire
Great Britain

7. Dr. Christopher Furley
"Diseases and Management of Black and Sumatran Rhinoceroses at the Howletts and Port Lympne Zoos"

c/o Howletts and Port Lympne Estates Ltd.
Port Lympne
Lympne nr Hythe
Kent CT21 4PD
Great Britain

8. Dr. Richard J. Montali
"Pathological Findings in Diseases of Captive Rhinoceroses"

National Zoological Park
3000 Connecticut Ave.
Washington, DC 20008

9. Dr. Linda Munson
"Pathological Findings in Oral and Skin Ulcers in Black Rhinoceroses"

College of Veterinary Medicine
University of Tennessee
Knoxville, TN 37901

Saint Louis ZOO

Forest Park
Saint Louis, Missouri 63110
[illegible]
Fax 314 647 7969

Charles H. Hoessle
Director

Robert J. [illegible]
President, Zoological Commission

July 3, 1991

Dr. Ulysses Seal
CBSG
c/o Minnesota Zoological Garden
13000 Zoo Boulevard
Apple Valley, MN 55124

Dear Ulie:

Please find enclosed the data regarding the occurrence of hemolytic anemia in black rhinoceroses that you requested at the at the Bronx Zoo meeting. You had specifically suggested that we could have the mortality data analyzed for significance of the apparent decrease in deaths since 1986 (in New York, I forgot to mention a death that occurred in 1990 - #367 - an animal that developed hemolytic anemia after a severe caudal nasal cavity infection and I'm still not sure if to count this as a "primary" case or not, see ** on chart below).

Additionally, I could not remember if I had already sent you a copy, so I've also enclosed a draft of the paper I submitted for the upcoming version of Fowler's zoo medicine book. The numbers do not agree between the papers as I have added additional cases to the data below. I have also included copies of my data "scratch sheets" if you wish to identify individuals.

I've identified 43 episodes of presumed hemolysis (hemoglobinuria, in a few cases red discoloration to the urine associated with severe anemia), in 34 black rhinoceroses in North America, Europe and Japan. I am currently having a Japanese article translated that I believe will add additional cases due to leptospirosis, and Tom Beggs of Howletts Park reported on additional cases in Great Britain, not all of which I have been able to identify. Twenty-three deaths occurred during hemolytic events (counting #367 mentioned above as a hemolytic death).

I have listed the data as to when the hemolytic events occurred and whether or not the animals **died** (numbers listed in bold type) or survived (listed in regular type) their

episodes. By year, the occurrence of hemolytic anemia was as follows:

YEAR*	TOTAL	BREAKDOWN (DIED/SURVIVED)
1962	2	(1/1)
1963	1	(1/0)
1969	1	(0/1)
1971	2	(2/0)
1973	1	(1/0)
1975	1	(1/0)
1976	1	(0/1)
1977	3	(3/0)
1978	1	(0/1)
1979	6	(3/3)
1980	5	(3/2)
1981	2	(1/1)
1982	1	(1/0)
1984	2	(1/1)
1985	2	(1/1)
1986	4	(3/1)
1987	2	(0/2)
1990	3	(1/2)**

* Years known on 40 of the 43 episodes, not known from 2 rhinoceroses at the Nagoya Zoo (#237 and 238) and the first episode in "Katharina" at the Frankfurt Zoo.

** A male (#296) at the Mexico City Zoo accounted for the 2 episodes in which a rhinoceros survived - in both spirochetemia was noted and he presumably had leptospirosis, he was not vaccinated. The fatal case (#367) developed hemolytic anemia after a prolonged illness with a caudal sinus cavity infection. Difficult to call a "primary" hemolytic anemia - why I forgot to mention it in New York as a recent death from hemolysis. The animal had not been vaccinated for leptospirosis since OCT88. I am currently submitting liver tissue to Dr. Bolin for FA (not submitted by the Caldwell Zoo and I am checking if we have stored tissue).

The British had commented that their cases tended to occur in the winter. In past compilations, seasonality was not present, but I recalculated with the present data. Months are known for 35 of the 43 hemolytic events, they are as follows:

JAN - 2
FEB - 4
MAR - 1
APR - 5
MAY - 4
JUN - 3
JUL - 3

AUG - 2
SEP - 2
OCT - 1
NOV - 4
DEC - 4.

I've also presented these data in an attached bar graph. These data do not seem to present strong evidence of seasonality. Would you agree and can this also be statistically analyzed?

Hemolysis in 10 of the rhinoceroses above was either suspicious of or definitively diagnosed (FA+) as occurring concurrently with leptospiral infection. Liver tissue was submitted from 4 black rhinoceroses dying during hemolysis and 3 were positive (#187, Cheyenne Mountain Zoo was -). The leptospirosis cases/ suspects are:

ANIMAL	INSTITUTION	DATE	DIED OR SURVIVED	DIAGNOSTIC METHOD
#293	Granby	DEC86	D	FA+(titers were-)
#155	Tampa	JAN85	D	FA+
#186	St. Louis	MAY81	D	FA+
#179	Memphis	JUN79	S	^ titers (greater than 1:8000 to L. int. ictero-hemorrhagiae
#199	Memphis	JUN79	D	died in association with #179 above
#126	Memphis	JUN79	D	died in association with #179 above
#218	Dvur Kralove	NOV79 FEB80 MAR81	S S S	^ titers (1:12800 L. int. grippo-typhosa, died of "complications of anemia"
#170	Dvur Kralove	?78 NOV79	S D	^titers (1:6800 L. int. grippo-typhosa
#209	Osaka	?84	D	silver-stained spirochetes in tissues

#296	Mexico City	FEB90	S	spirochetemia on exam, sera to be sent to US for FA testing.
		MAY90	S	

Please contact me if I can supply any further data or answer any questions about it. You and Tom also requested neonatal mortality data and I will start work on that in the coming week and forward it to you both when I get it compiled. I will also work on drafting a letter that will serve as a "leptospirosis vaccination reminder" to be distributed to the Black Rhinoceros SSP institutions. Thank you again for your interest and your support in New York.

Sincerely,

R. Eric Miller, DVM
Associate Veterinarian

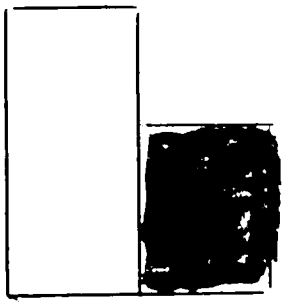
ANIMAL	SEX	ZOO	HEMOLYSIS DESCRIPTION	MONTH	YEAR	AGE
#155 JOE	M	TAMPA	DIED	1	85	20
#343 JULIETTE	F	TAMPA	SURVIVED	1	87	4
#179 OLIVE OIL	F	MEMPHIS	SURVIVED	6	79	9
#126 SNOOPY	F	MEMPHIS	DIED	6	79	11
#199 DUNION	M	MEMPHIS	DIED	6	79	7
#186 MARTINI	F	ST LOUIS	DIED	5	81	9
#232 RUBY	F	TORONTO	DIED	7	77	3
#264 SPOOK	M	TORONTO	DIED	7	77	3
#163 LIZ	F	DENVER	SURVIVED	8	85	14
			SURVIVED	4	86	15
#328 ONYX	M	DENVER	SURVIVED	5	87	5
#125 MOMBO	M	DENVER	SURVIVED	4	79	20
			SURVIVED	4	80	21
#6 LEMUTA	F	FRANK	SURVIVED		69	11
			DIED	11	71	13
#137 NABI	F	FRANK	SURVIVED		76	8

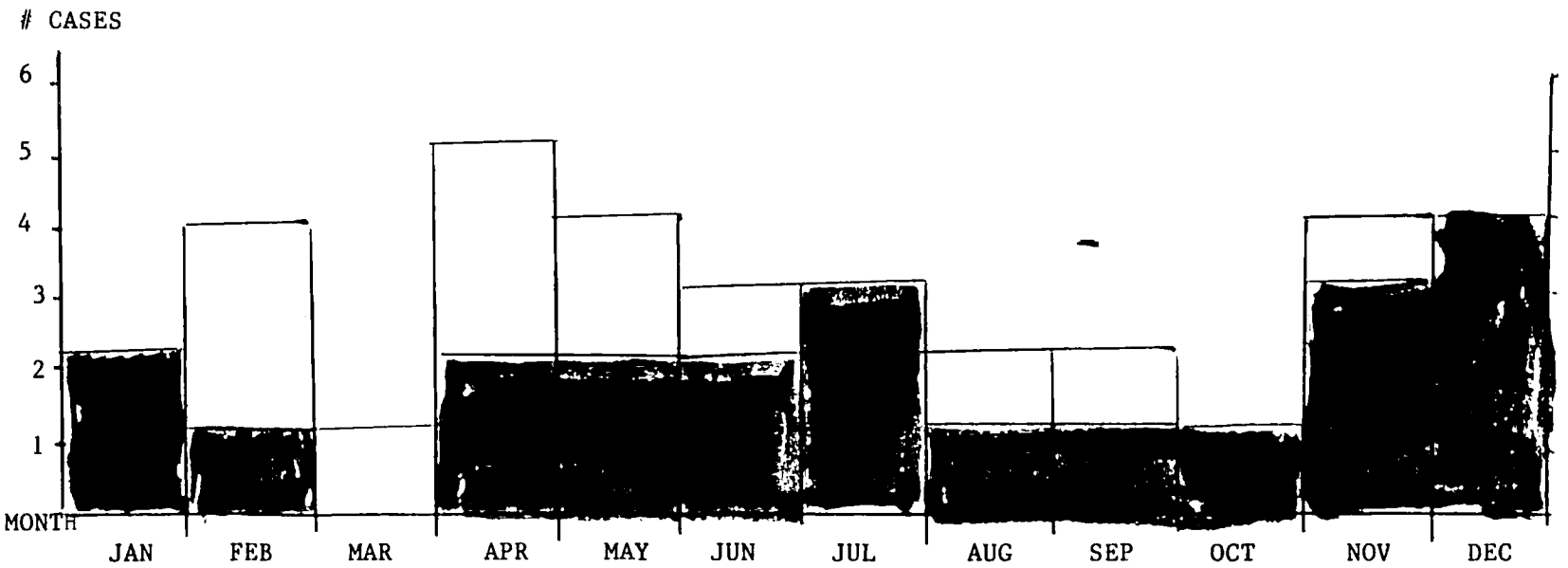
ANIMAL	SEX	ZOO	HEMOLYSIS DESCRIPTION	MONTH	YEAR	AGE
#54 CLYDE	M	OKC	DIED	11	86	24
#187 MAYBELLE	F	CHEY MT	DIED	12	86	14
SAPPORO	M	SAPPORO	DIED	5	62	13
#273 BERTHA	F	BUFFALO	DIED	9	50	9
#139 MARY	F	NAT	DIED	12	80	10
#176 BONNIE	F	COLUMBUS	DIED	4	82	12
#241 CHUNGO	M	ZURICH	DIED	8	80	11
#218 SATARA	F	D. KRALOVE	SURVIVED	11	79	9
			SURVIVED	2	80	10
			SURVIVED	3	81	11
#170 KEN	M	D. KRALOVE	SURVIVED		78	8
			DIED	11	79	9
#157 KIJANA	M	DUBLIN	DIED	2	73	3
# 38 RONALD	M	DUBLIN	DIED	10	71	10
#203 ZULU	M	CLEVE	DIED	7	77	2
# 51 JR LARGO	M	CLEVE	DIED	12	75	20

HEMOLYSIS

ANIMAL	SEX	ZOO	DESCRIPTION	MONTH	YEAR	AGE
No # KATHARINA	F	FRANK	SURVIVED			
			SURVIVED		62	16
			DIED	4	63	17
#209 SAION	M	OSAKA	DIED		84	9
#293 SUZI	F	GRANBY	DIED	12	86	16
#161 CHINESTOLE	M	DENVER	SURVIVED	9	84	12
# 296 CARLOS	M	MEXICO CITY	SURVIVED	2	90	26
			SURVIVED	5	90	26
#367 PRISCILLA	F	BALBOA	DIED OF ANEMIA + NASAL INFEN	2	90	3
#238 MONICA	F	NAGOYA	SURVIVED		~85	
#237 MEKO	F	NAGOYA	SURVIVED		~85	

SEASONAL OCCURRENCE OF HEMOLYSIS IN BLACK RHINOCEROSES

Total # cases of hemolysis =  = fatal cases



JUL - 8 1991

Saint Louis ZOO

Forest Park
Saint Louis, Missouri 63110
(314) 781-0900
Fax (314) 647-7369

Charles H. Hoessle
Director

Robert H. [illegible]
President, Zoological Commission

June 27, 1991

Dr. Tom Foose
Captive Breeding Specialist Group
c/o Minnesota Zoological Garden
13000 Zoo Boulevard
Apple Valley, MN 55124

Dear Tom:

Please find enclosed a copy of the draft of a paper on hemolytic anemia in black rhinoceroses that summarizes most of the currently known data (as I said in New York, I can't remember if I sent you a copy before). It is to appear in the next edition of Dr. Fowler's book on zoo medicine. I am compiling the data on neonatal mortality and hemolytic events that Ulie requested at the meeting.

The rhinoceros news here is that we shipped out our older, non-breeding female black rhinoceros to Oklahoma City and now are waiting for the arrival of their young female (originally from New Delhi, I believe?). Thank you again for the opportunity to attend the New York meeting, let me know whenever I can supply any further information.

Sincerely,

R. Eric Miller, DVM
Associate Veterinarian

mailed 11/27/90

DRAFT

HEMOLYTIC ANEMIA IN THE BLACK RHINOCEROS (Diceros bicornis)

R. Eric Miller, DVM
St. Louis Zoological Park
1 Government Drive
Forest Park
St. Louis, MO 63110-1396

(314) 781-0900 ext. 277

HEMOLYTIC ANEMIA IN THE BLACK RHINOCEROS

Hemolytic anemia has been a frequent and devastating disorder of black rhinoceroses (Diceros bicornis) in captivity. Currently, 39 hemolytic episodes have been identified in 31 black rhinoceroses in zoological parks in North America, Europe, and Japan. Nearly 75% (23) of these animals died during their initial or subsequent hemolytic events. In one survey, hemolytic anemia accounted for 40% of all captive adult deaths in this species (Miller and Boever, 1982). These fatalities are a disturbing factor in the maintenance of a species whose North American population currently numbers 80 animals and whose wild population is undergoing precipitous decline.

CLINICAL SIGNS

Intravascular destruction of red blood cells (RBC) leads to the release of hemoglobin into the serum (hemoglobinemia) and may result in its passage into the urine (hemoglobinuria) (Fig. 1). The latter often produces clear, dark red urine. In black rhinoceroses, hemoglobinuria is often the first clinical sign of hemolysis. At this stage, clinical signs may also include pale mucous membranes, generalized weakness, and muscle fasciculations. Frequently cases progress to recumbency and death within 24-48 hours of the initial presentation.

Hematocrits from affected black rhinoceroses range from 4.5% to 43%, no doubt due to detection at varying stages of the hemolysis. Though reticulocytes have rarely been noted in blood smears collected during hemolysis or the recovery period, circulating nucleated RBCs have been observed (fig. 2). This

finding may correspond to the anemic horse, in which peripheral reticulocytes are rare, but circulating nucleated RBCs indicate a marked regenerative response. It also correlates with erythropoietic hyperplasia noted in bone marrow from rhinoceroses that died of hemolysis.

If a rhinoceros dies from hemolytic anemia, gross lesions at necropsy are minimal. Most notable are the presence of clear dark red urine in the urinary tract, and orange-red discoloration of many parenchymal tissues. The latter is due, at least in part, to high levels of iron in the tissues (greater than 3000 ppm in some cases - Figure 3). Though the iron in these cases presumably is a product of heme breakdown, lesser, but also elevated, tissue levels of iron have also been noted in black rhinoceroses dying of nonhemolytic causes. The pattern of iron deposition suggests that a more chronic and subclinical stage of the hemolysis may exist. Additionally, histologic examination often reveals centrolobular hepatic necrosis, most likely secondary to acute hypoxia.

EPIDEMIOLOGY

There is no apparent sex predilection nor seasonality for the hemolytic crises. The age of affected black rhinoceroses ranges from 2-26 years (avg. 10.7 years). Both captive bred (19) and wild caught (11) animals have been affected. Of possible interest is the difference between the average age of affected captive bred (8.7 years) and wild caught animals (14.7 years). All affected black rhinoceroses have been of the East African subspecies (*D. b. michaeli*), but that may simply reflect the smaller numbers and shorter captive history of the southern subspecies (*D. b. minor*).

Hemolytic anemia has not been reported in captive white (Ceratotherium simum) and Indian (Rhinoceros unicornis) rhinoceroses, nor in black rhinoceroses in the wild. Two possibilities may explain the latter observation: 1) the syndrome may not occur in wild animals, or 2) under field conditions, minimal clinical signs and gross lesions could be overlooked.

At the majority of institutions, single deaths from hemolysis have occurred with apparently normal and unaffected black rhinoceroses in the same or nearby enclosures. However, 2 black rhinoceroses at the Toronto Zoo and 3 at the Memphis Zoo were affected within 1 and 10 day periods, respectively. In those cases, the pattern suggests a common agent, and indeed, leptospirosis was indicated in the Memphis "outbreak" (Douglass and Plue, 1980).

Familial groupings of affected rhinoceroses have been noted at the Denver, Frankfurt (Germany), and St. Louis Zoos. However, these families are unrelated to each other and account for only 10 of the 30 affected black rhinoceroses. Inbreeding does not appear to be a factor in these families, nor in the general captive black rhinoceroses population.

POSSIBLE ETIOLOGIES AND DIAGNOSIS

Investigations to determine the etiology of the hemolysis have been based on known causes of hemolysis in domestic animals and man. In the majority of rhinoceroses, the cause has not yet been definitively identified. However, infection with serovars of the spirochete bacterium Leptospirosis interrogans has been suggested in at least 9 cases on the basis of titers, special tisue stains,

or fluorescent antibody (FA) testing (Douglass and Plue, 1980)(Miller and Bolin, 1988) (Sebek et al., 1986).

Prior to the advent of the FA test, diagnosis of leptospiral infection has been complicated by deficiencies in available methods. Titers, the most common method of diagnosis, may vary between laboratories and often, paired titers are not possible due to the peracute and fatal nature of hemolysis in rhinoceroses. At two zoos, convalescent titers in rhinoceroses surviving hemolysis have been elevated (1:8000 to L. int. icterohemorrhagica and 1:12,800 to L. int. grippotyphosa), although surviving animals at other institutions have not experienced a titer change. Titers indicative of exposure to leptospirosis have also been noted in sera from wild black rhinoceroses in Zimbabwe.

Additionally, leptospiral organisms are difficult to grow in culture. Special (eg, silver) stains can be applied to tissue from suspect animals, but infection with low numbers of organisms may be missed. The recent availability of a fluorescent antibody (FA) test has provided a much more reliable method of diagnosis. Frozen (-75 C) liver tissue from 4 adult rhinoceroses that died of hemolytic anemia was tested, and 3 animals were positive (Miller and Bolin, 1988). Of note was the fact that concurrent titers in 2 of these 3 positive animals were negative. Most likely, death occurred before those animals had sufficient time to mount an immunological response. Preliminary results indicate that black rhinoceroses vaccinated biannually with leptospiral bacterins mount immune responses equivalent to those in domestic species.

Though perhaps a majority of the hemolytic cases will be

linked to infection with L. interrogans, clearly not al the cases are associated with this organism. The clinical similarities among the hemolytic black rhinoceroses emphasizes efforts to identify a single "common denominator" for his syndrome; a basic defect that would allow a number of factors (including leptospirosis) to trigger a peracute hemolytic crisis. To that end, a two fold approach to the study of the black rhinoceros RBC was chosen - 1) evaluation of its metabolism and 2) investigation of its structural and immunological parameters.

Study of RBC metabolism is warranted due to the association of RBC enzymatic deficiencies and hemolytic syndromes in man. In studies of aerobic glycolysis, glutathione cycling, and nucleotide metabolism in the black rhinoceros RBC, no apparent enzymological or other biochemical differences were noted between animals surviving anemia or their relatives and unaffected black rhinoceroses (Paglia et. al., 1986). However ATP levels in black rhinoceros RBCs were only 5%-20% of the levels measured in most other mammalian species. Decreased energy resources could predispose these cells to lysis. Further investigations are designed to determine if an alternative energy pathway exists for the black rhinoceros RBC and to evaluate other intracellular systems that may counter oxidative stresses.

Autoimmune hemolytic anemia (AIHA) was evaluated using Coombs reagents (an anti-black rhinoceros whole sera and a more specific anti-IgG) developed for black rhinoceroses, however, testing of normal and affected black rhinoceroses with these reagents did not indicate an immune basis for the hemolysis (Chaplin et. al., 1986). Additionally, isopropanolol and heat stability tests found no evidence that the hemolytic events were the result of an unstable

hemoglobin (Fairbanks and Miller, 1989).

Another area of investigation is the nutritional status of the captive black rhinoceroses. Though nearly an exclusive browser in the wild, captive diets for this species often predominate in feeds more closely resembling those for a grazer. Marked decreases in serum alpha-tocopherol (vitamin E) levels have been noted in captive animals when compared to wild animals in Zimbabwe (.18 ug/ml vs. .77ug/ml) (Dierenfeld et al., 1988). Though the significance of vitamin E in black rhinoceros hemolysis is unknown, it does play a role in the stability of cellular membranes, including those of the RBC. Vitamin E responsive hemolytic anemias have been reported in primates and rats, and a decrease in _in vitro_ erythrocyte stability has been noted in E-deficient horses.

Hypophosphatemia may warrant further investigation. At the Frankfurt Zoo, 2 female black rhinoceroses developed postparturient hemoglobinuria, a condition in cattle associated with hypophosphatemia (however, serum phosphorous levels were not available from the rhinoceroses). Although serum phosphorous levels have been normal in other black rhinoceroses undergoing acute hemolysis and in the general black rhinoceros population, phosphorous levels during RBC lysis may be affected by the release of intracellular ions, and it has been suggested that hypophosphatemia may be involved in chronic anemia of black rhinoceroses with skin and oral ulcers (Gillespie et al., 1990).

Even when past test results have been negative, evaluation for known causes of hemolysis should continue in future cases. Infections with _Ehrlichia_ sp. and _Babesia_ sp. have not been

identified in hemolytic rhinoceroses, though they have been noted in newly captured black rhinoceroses. Attempts to isolate the viruses of equine infectious anemia (EIA) and equine viral arteritis, as well as isolation of toxins from Clostridial sp. have been negative. Based on hepatic copper levels, copper toxicity also does not appear to be a factor.

TREATMENT

The clinical approach to a black rhinoceros in a hemolytic crisis requires astute clinical judgement on the part of the attending veterinarian. Anesthesia itself is a risk in a severely anemic animal, but without proper restraint, diagnostic evaluation and many treatments are difficult, if not impossible. Reduction in the anesthetic dose may be advisable in the anemic animal.

In a docile or depressed animal, small amounts of blood can be obtained from the ear vein. If the rhinoceros is sedated, markedly depressed, or possibly restrained in a chute, large amounts (liters) of blood can be obtained from the medial radial vein of the foreleg (Fig. 4, Miller et al., 1989). A hematocrit and preferably a complete blood count are of vital importance in monitoring the severity of the anemia. A hematocrit tube should be spun immediately as hemolysis may continue in the collected sample. If available, additional blood should be submitted for a sera chemical profile, frozen sera saved and diagnostic evaluations performed as described above. A detailed blood and tissue collection protocol for such testing has been designed and distributed to holding institutions by the Research, Nutritional and Veterinary Advisors of the Black Rhinoceros Species Survival

Plan (SSP) Committee.

When possible, a complete urinalysis should be performed. A urine test dipstick can be used to make a "field" evaluation for the presence of hemoglobin in the urine (an examination of the urine sediment can rule out hematuria). The dipstick may detect the prescence of hemoglobinuria even when present in quantities insufficient to cause discoloration. If the possibility of myopathy exists, hemoglobin should be differentiated from myoglobin as both will react on the dipstick.

Few treatments have been reported to be successful in ameliorating the condition. This may be due in part to the severity of the anemia when many cases are presented. Several rhinoceroses have had apparent responses to corticosteroid therapy. However, 3 rhinoceroses on this therapy (for other conditions) have developed fungal pneumonia. Due to this and the possibility of leptospirosis, immunosuppressive therapy should be used with extreme caution and only for short term treatment.

Due to the possibility of leptospiral infection, antibiotic therapy is indicated. Injectable penicillins and aminoglycosides may be used for the treatment of acute leptospirosis, although for both, the administration of large injections may complicate prolonged therapy. Tetracycline therapy may be more practical for animals that survive and can be treated in their feed. Injectable supplementation with vitamin E (E-Se, Bo-Se, Schering Animal Health, Union, NJ 07083) is also advisable due to its low level in captive animals. Although specific pharmacokinetic studies for these and other drugs have not been performed in the black

rhinoceros, it appears reasonable to base therapeutics on those used in horses. Black rhincoeros weights are usually estimated, but an "average" male weighed at St. Louis was 1000kg. Additional supportive therapy (fluids, warming) should be instituted as needed.

If the rhinoceros continues to deteriorate, blood transfusion can be considered as a treatment of last resort. Transfusion with 16 L of whole blood (collected from 2 adult animals) was attempted in a 3 year old rhinoceros undergoing hemolysis. The hematocrit rose from 12.4% to 18%. Major and minor cross matches were compatible, but within 3 days, the hematocrit had decreased to 9.8%. It is not known if this was due to continued hemolysis or a transfusion reaction. Further studies are in progress to determine the compatibility of black rhinoceros blood for intraspecific transfusion.

If the rhinoceros dies, formalinized tissues should be saved and consideration given to saving tissues in glutaraldehyde for electron microscopy. Standard aerobic and leptospiral cultures should be submitted. Additionally frozen liver, kidney, spleen and other appropriate tissues should be saved for further evaluation.

Perhaps the most difficult question facing those treating hemolytic black rhinoceroses is that of prevention. Although challenge studies have not (and are not likely to be) performed, biannual vaccination with a 5-way leptospiral bacterin (Leptoferm-5, Norden Laboratories, Lincoln, NE 68501) is recommended. Evaluation of diets and improved nutrition, including vitamin E supplementation, may improve the overall health status of the

animals and possibly their resistance to anemia. As more plant species (particularly of browse) are offered to captive animals, care should be taken to avoid red maple (Acer rubrum), onions, and members of the Brassica family (eg, kale, rape, cabbage) that are associated with hemolytic anemia in horses and other domestic species. Vital to prevention of the hemolysis and other diseases of undetermined etiology in the black rhinoceros is the development of a data base of "normal" values from captive and wild rhinoceroses. To that end, the Black Rhinoceros SSP Committee encourages the continued cooperation and participation of rhinoceros holding institutions in the blood and tissue collection protocol for all rhinoceros species.

BIBLIOGRAPHY

Chaplin H, Malacek AC, Miller RE, et al.: Acute intravascular hemolytic anemia in the black rhinoceros: hematologic and immunohematologic observations. Am J Vet Res 47:1313, 1986.

(Description of immune testing and general hematological observations of the black rhinoceros RBC).

Douglass EM, Plue RE: Hemolytic anemia suggestive of leptospirosis in the black rhinoceros. J Am Vet Med Assoc 177:921, 1980.

(Clinical description of 3 cases of hemolytic anemia in which titer evidence strongly suggested leptospirosis)

Dierenfeld ES, du Toit R, Miller RE: Vitamin E in captive and wild black rhinoceros (Diceros bicornis). J Wildl Dis 24:547, 1988.

(A comparative study of vitamin E levels in both captive and wild black rhinoceroses).

Fairbanks VF, Miller RE: Beta-chain hemoglobin polymorphism and hemoglobin stability in black rhinoceroses (Diceros bicornis). Am J Vet Res 51:803, 1990.

(Reports on hemoglobin stability and electrophoretic studies).

Gillespie D, Burton M, Kohn C, et al.: An unusual case of ulcerative stomatitis and prolonged pregnancy in a black rhinoceros. AAZV Ann Proc 1990, p319.

(Reports on a possible association of hypophosphatemia with chronic anemia in some black rhincoeroses with skin/oral ulcers).

Miller RE, Boever WJ: Fatal hemolytic anemia in the black rhinoceros: case report and survey. J Am Vet Med Assoc 181:1228, 1982.

(Detailed report of a hemolytic anemia in a black rhinoceros and results of a survey).

Miller RE, Bolin CA: Evaluation of leptospirosis in black rhinoceroses (Diceros bicornis) by microscopic agglutination and fluorescent antibody testing. AAZV Ann Proc 1988, p161.

(The most recently published description of leptospiral testing, including FA).

Miller, RE, McClure RC, Constantinescu G, Boever WJ: A clinical note on the vascular anatomy of the black rhinoceros (Diceros bicornis) forelimb. J Zoo and Wildl Med 20:228, 1989.

(Clinical description of blood collection site on the forelimb of black rhinoceroses).

Paglia DE, Valentine WN, Miller RE, et al.: Acute intravascular hemolysis in the black rhinoceros: erythrocytic enzymes and metabolic intermediates. Am J Vet Res 47:1321, 1986.

(Detailed description of metabolic tests performed on black rhinoceros RBC).

Sebek, VZ, Mikulica V, Valova V: Leptospirosis of exotic animals in zoological gardens. Mh Vet Med 41: 571, 1986.

(Report describing leptospirosis titers in black rhinoceroses at the Dvur Kralove, Czechoslovakia Zoo).

ILLUSTRATIONS (OPTIONAL)

Figure 1 - Hemoglobinemia in plasma from a 16 year old black rhinoceros. Hemoglobinuria was also noted. The hematocrit was 4.5% and the animal died shortly after this sample was collected.

Figure 2 - Peripheral blood smear from a 9 year old black rhinoceros during a hemolytic crisis (hematocrit = 14.8%). Note the prescence of a nucleated RBC (arrow).

Figure 3 - H&E stained liver tissue from a black rhinoceros that died of hemolytic anemia. Hepatic iron levels were 3000 ppm. Iron deposits (confirmed by special stains) are noted by arrows.

Figure 4 - Medial view of the right forelimb of a black rhinoceros. The bones and veins are outlined as follows: cephalic vein (a), radial vein (b), superficial branches of the radial vein (c), palmar (deep) branch of the radial vein (d), accessory cephalic vein (e), distal medial aspect of the radial bone (R), and suggested site for venipuncture (X). (Reprinted from JZWM 20:229. 1989).

Saint Louis ZOO

JUL 1 0 1991
Forest Park
Saint Louis, Missouri 63110
(314) 781-0900
Fax (314) 647-7969

Charles H. Hoessle
Director

Robert Hyland
President, Zoological Commission

June 28, 1991

Dr. Craig Thatcher
Virginia-Maryland Regional College of Veterinary Medicine
Phase II
Blacksburg, VA 24601

Dear Dr. Thatcher:

I enjoyed talking to you this AM. As promised, I am enclosing a number of background materials that may be of interest if you choose to help in our analysis of black rhinoceros nutrition. As we discussed, the majority of the nutritional research has focused on the analysis of individual diets, eg, our diet review here with Mary Allen (of Allen and Baer), and with vitamin E, most notably the work of Dr. Ellen Dierenfeld at the New York Zoological Society. She is also the nutritional advisor to the Black Rhinoceros Species Survival Committee (SSP), and would be the best contact in coordinating projects and avoiding overlap. Her address is:

Dr. Ellen Dierenfeld
New York Zoological Society
185th and Southern Boulevard
Bronx, NY 10460
(212) 220-7102.

Additionally, you may wish to contact either Mary Allen or Dave Baer, both of whom have analyzed rhinoceros diets in a number of zoos. Their address is:

Allen and Baer Associates
5320 Olney-Laytonsville Road
Olney, MD 20832.
(301) 330-4357.

Finally, if we get to the point of making contact with the Zimbabweans, the two names that I mentioned on the phone were Drs. Michael and Nancy Kock (he's a clinician in the wildlife department, she's a veterinary pathologist with the veterinary school in Harare). They have generated a great deal of data while translocating wild black rhinoceroses within Zimbabwe. Often their reports include 40-60 animals, and to date they have been the best source of "normals." There address is:

Dr. Michael Kock
Department of National Parks and Wildlife Management
PO Box 8365
Causeway
Harare, Zimbabwe.

An additional resource may be Purina Mills headquartered in St.Louis - they have recently moved into the commercial zoo diet field.

Much of the past and current research in black rhinoceroses has been directed towards particular diseases that have had a major negative impact on the growth of the captive population. These include hemolytic anemia, mucosal/skin ulcers, encephalomalacia and fungal pneumonia. The enclosed materials include discussion of what is known of these diseases at the present time, and other materials on black rhinoceros nutrition. I have numbered the enclosures and will give a short description of each to hopefully help you sort them out: They are as follows:

1) A paper presented to the International Rhinoceros Conference in San Diego in May of this year. It is "nutshell" summaries of the ongoing veterinary research projects.

2) The Kock's paper on baseline hematological data from wild caught black rhinoceroses in Zimbabwe.

3 -5) Our 1982 report (#3) on hemolytic anemia that described a case at St. Louis and the results of our first survey to determine its incidence. The draft paper (#4) is a compilation of what is currently known in incidence and etiology. Presently, I concur with Dr. Paglia that our "best guess" is some sort of alternative metabolic pathway in this species that allows a number of oxidative insults to "trigger" hemolysis. To date, it appears that leptospirosis has been involved in 50%-75% of the cases - the recent availability of the FA test has helped confirm this in cases that were previously only suspicious or even considered negative (paper

6-9) Papers on that tried to determine if the hemolysis was due to an autoimmnune component (#7), an unstable hemoglobin (#8), or aberrant red blood cell metabolism (#6). At the time, the latter paper by Paglia failed to note that the ATP levels of the black rhinoceroses measured were only 5%-20% of the levels of other mammalian species measured in that laboratory. Dr. Paglia is currently designing a project that will go back a step and incubate black

rhinoceros RBC on various substrates to determine if they are indeed using an alternative pathway. An additional paper (#9) by Dr. Ullrey describes some general RBC stability testing studies with hydrogen peroxide.

10) This paper describes the occurrence of massive, fatal encephalomalacia in 3 black rhinoceroses. Dr. delahunta reviewed the brains and commented that they were the worst case of encephalomalacia in mammals that he had seen in his career. The pattern was that of leucoencephalomalacia seen in horses with "moldy corn poisoning," but the etiology remains open.

11-12) These papers describe a single case of oral ulcers and systemic mycosis in a black rhinoceros at the San Diego Zoo (#12), and a draft of an updated review that Dr. Linda Munson at the University of Tennessee presented at the San Diego Rhinoceros Conference. Despite the common occurrence of Stephanofilari dinniki induced ulcers in southern Africa, such lesions have not been noted in North America. Zinc levels in a few of the ulcerative animals have been "normal" by domestic standards, and Linda is suggesting that we evaluate biotin levels to rule that out (though an unlikely cause).

13 - 16) A paper by Dr. Gillespie (#13) that suggested that hypophosphatemia was responsible for the anemia of a black rhinoceros with ulcerative stomatitis. I am not as certain of this and I have included my response (#14) to Dr. Gillespie and some the data we were able to compile regarding phosphorous levels on captive and wild black rhinoceroses (#15). I've also included a copy of a paper on phosphorous and RBC cell metabolism in cattle (#16).

17-20) Publications 17-20 are general reports and reviews of the diseases of black rhinoceroses and #20 reports possible creosote poisoning in 2 black rhinoceroses.

21) This is Dr. Dierenfeld's paper that demonstrated the dramatic differences between the vitamin E levels of the captive North American black rhinoceros population and that of wild caught animals in Zimbabwe.

22) This is Allen and Baer's proposal to evaluate black rhinoceros diets, I am not sure exactly how far they got with this.

23 - 24) Dr. Dierenfeld's summary reports to the Black Rhinoceros SSP Committee (I'm not sure what year #23 was), and in 1990.

25) A apper by Dr. Andreas Pappas describing the use and absorption of the TPSG form of vitamin E in rhinoceros in elephant trails at the Miami and Denver Zoos.

26) A sample of the questionnaire that was distributed to all zoos several years ago by the Black Rhinoceros SSP. If any of the information requested is of interest I can get you a copy of the summary report that resulted.

I hope these materials are of use in giving you a background for where we're at in the research projects. As I mentioned, nutrition and immunology were identified at the San Diego meeting as two areas that require additional efforts.

It is interesting that these rather unusual veterinary problems have not been noted in white (Ceratotherium simum) or greater one-horned Asian (Rhinoceros unicornis) rhinoceroses in captivity. As we discussed, according to the field researchers that I have talked to, the black rhinoceros is almost an exclusive browser (95+% according to the South Africans), the white rhinoceros is a grazer, and the greater one-horned Asian is intermediate. In addition to the sera samples from captive and wild caught black rhinoceroses, we may be able to obtain comparative samples from those species.

I should be able to provide samples (several mls each) from approximately 20 captive black rhinoceroses in North America and 40+ wild caught rhinoceroses from Zimbabwe (the latter samples are probably between .5-1.5ml each - our technician is out today, but I will have her check next week).

To reiterate, two possible funding sources for sample analysis come to mind within the zoo community. First is the Nixon Griffis Fund for Zoological Research administered by the New York Zoological Society. Their maximum grant is $3000. Secondly is the Conservation Endowment Fund of the American Association of Zoological Parks and Aquariums, I believe their maximum grant is $20,000. At this time, we would probably be looking at granting deadlines around the first of 1992 for both funds. If you have other suggestions, I would also be willing to help write proposals to them.

At the present time, black rhinoceroses are a high profile species in both the captive and wildlife communities and that may help us in obtaining funding. Current estimates place the

black rhinoceros population throughout Africa at 3500 or fewer animals, and to my knowledge, only South African has had a growing population in recent years. The samples from Zimbabwe have resulted from a major effort to move rhinoceroses from the difficult to defend Zambezi River Valley (shared with Zambia) to parks and ranches in the interior of the country.

The Zimbabweans are also interested in determining if vitamin E and other nutrients vary between wild caught animals and those held for periods of time in boma confinement. It is under those situations that they suspect they may have seen hemolytic anemia (unconfirmed by urinalysis at this time).

Thank you again for your interest. Your suggestions as to analyses sound promising. If I can supply any further materials (If you don't have enough already!), please do not hesitate to contact me.

Sincerely,

R. Eric Miller, DVM
Associate Veterinarian

Veterinary Advisor
Black Rhinoceros, SSP

cc: Dr. Ellen Dierenfeld
Dr. David Jessup
Dr. Ulie Seal
Dr. Tom Foose

Saint Louis ZOO

Forest Park
Saint Louis, Missouri 63110
(314) 781-0900
Fax (314) 647-7969

Charles H. Hoessle
Director

Robert Hyland
President, Zoological Commission

June 28, 1991

Dr. Craig Thatcher
Virginia-Maryland Regional College of Veterinary Medicine
Phase II
Blacksburg, VA 24601

Dear Dr. Thatcher:

I enjoyed talking to you this AM. As promised, I am enclosing a number of background materials that may be of interest if you choose to help in our analysis of black rhinoceros nutrition. As we discussed, the majority of the nutritional research has focused on the analysis of individual diets, eg, our diet review here with Mary Allen (of Allen and Baer), and with vitamin E, most notably the work of Dr. Ellen Dierenfeld at the New York Zoological Society. She is also the nutritional advisor to the Black Rhinoceros Species Survival Committee (SSP), and would be the best contact in coordinating projects and avoiding overlap. Her address is:

Dr. Ellen Dierenfeld
New York Zoological Society
185th and Southern Boulevard
Bronx, NY 10460
(212) 220-7102.

Additionally, you may wish to contact either Mary Allen or Dave Baer, both of whom have analyzed rhinoceros diets in a number of zoos. Their address is:

Allen and Baer Associates
5320 Olney-Laytonsville Road
Olney, MD 20832.
(301) 330-4357.

Finally, if we get to the point of making contact with the Zimbabweans, the two names that I mentioned on the phone were Drs. Michael and Nancy Kock (he's a clinician in the wildlife department, she's a veterinary pathologist with the veterinary school in Harare). They have generated a great deal of data while translocating wild black rhinoceroses within Zimbabwe. Often their reports include 40-60 animals, and to date they have been the best source of "normals." There address is:

Dr. Michael Kock
Department of National Parks and Wildlife Management
PO Box 8365
Causeway
Harare, Zimbabwe.

An additional resource may be Purina Mills headquartered in St.Louis - they have recently moved into the commercial zoo diet field.

Much of the past and current research in black rhinoceroses has been directed towards particular diseases that have had a major negative impact on the growth of the captive population. These include hemolytic anemia, mucosal/skin ulcers, encephalomalacia and fungal pneumonia. The enclosed materials include discussion of what is known of these diseases at the present time, and other materials on black rhinoceros nutrition. I have numbered the enclosures and will give a short description of each to hopefully help you sort them out: They are as follows:

1) A paper presented to the International Rhinoceros Conference in San Diego in May of this year. It is "nutshell" summaries of the ongoing veterinary research projects.

2) The Kock's paper on baseline hematological data from wild caught black rhinoceroses in Zimbabwe.

3 -5) Our 1982 report (#3) on hemolytic anemia that described a case at St. Louis and the results of our first survey to determine its incidence. The draft paper (#4) is a compilation of what is currently known in incidence and etiology. Presently, I concur with Dr. Paglia that our "best guess" is some sort of alternative metabolic pathway in this species that allows a number of oxidative insults to "trigger" hemolysis. To date, it appears that leptospirosis has been involved in 50%-75% of the cases - the recent availability of the FA test has helped confirm this in cases that were previously only suspicious or even considered negative (paper

6-9) Papers on that tried to determine if the hemolysis was due to an autoimmnune component (#7), an unstable hemoglobin (#8), or aberrant red blood cell metabolism (#6). At the time, the latter paper by Paglia failed to note that the ATP levels of the black rhinoceroses measured were only 5%-20% of the levels of other mammalian species measured in that laboratory. Dr. Paglia is currently designing a project that will go back a step and incubate black

rhinoceros RBC on various substrates to determine if they are indeed using an alternative pathway. An additional paper (#9) by Dr. Ullrey describes some general RBC stability testing studies with hydrogen peroxide.

10) This paper describes the occurrence of massive, fatal encephalomalacia in 3 black rhinoceroses. Dr. delahunta reviewed the brains and commented that they were the worst case of encephalomalacia in mammals that he had seen in his career. The pattern was that of leucoencephalomalacia seen in horses with "moldy corn poisoning," but the etiology remains open.

11-12) These papers describe a single case of oral ulcers and systemic mycosis in a black rhinoceros at the San Diego Zoo (#12), and a draft of an updated review that Dr. Linda Munson at the University of Tennessee presented at the San Diego Rhinoceros Conference. Despite the common occurrence of Stephanofilari dinniki induced ulcers in southern Africa, such lesions have not been noted in North America. Zinc levels in a few of the ulcerative animals have been "normal" by domestic standards, and Linda is suggesting that we evaluate biotin levels to rule that out (though an unlikely cause).

13 - 16) A paper by Dr. Gillespie (#13) that suggested that hypophosphatemia was responsible for the anemia of a black rhinoceros with ulcerative stomatitis. I am not as certain of this and I have included my response (#14) to Dr. Gillespie and some the data we were able to compile regarding phosphorous levels on captive and wild black rhinoceroses (#15). I've also included a copy of a paper on phosphorous and RBC cell metabolism in cattle (#16).

17-20) Publications 17-20 are general reports and reviews of the diseases of black rhinoceroses and #20 reports possible creosote poisoning in 2 black rhinoceroses.

21) This is Dr. Dierenfeld's paper that demonstrated the dramatic differences between the vitamin E levels of the captive North American black rhinoceros population and that of wild caught animals in Zimbabwe.

22) This is Allen and Baer's proposal to evaluate black rhinoceros diets, I am not sure exactly how far they got with this.

23 - 24) Dr. Dierenfeld's summary reports to the Black Rhinoceros SSP Committee (I'm not sure what year #23 was), and in 1990.

25) A apper by Dr. Andreas Pappas describing the use and absorption of the TPSG form of vitamin E in rhinoceros in elephant trails at the Miami and Denver Zoos.

26) A sample of the questionnaire that was distributed to all zoos several years ago by the Black Rhinoceros SSP. If any of the information requested is of interest I can get you a copy of the summary report that resulted.

I hope these materials are of use in giving you a background for where we're at in the research projects. As I mentioned, nutrition and immunology were identified at the San Diego meeting as two areas that require additional efforts.

It is interesting that these rather unusual veterinary problems have not been noted in white (Ceratotherium simum) or greater one-horned Asian (Rhinoceros unicornis) rhinoceroses in captivity. As we discussed, according to the field researchers that I have talked to, the black rhinoceros is almost an exclusive browser (95+% according to the South Africans), the white rhinoceros is a grazer, and the greater one-horned Asian is intermediate. In addition to the sera samples from captive and wild caught black rhinoceroses, we may be able to obtain comparative samples from those species.

I should be able to provide samples (several mls each) from approximately 20 captive black rhinoceroses in North America and 40+ wild caught rhinoceroses from Zimbabwe (the latter samples are probably between .5-1.5ml each - our technician is out today, but I will have her check next week).

To reiterate, two possible funding sources for sample analysis come to mind within the zoo community. First is the Nixon Griffis Fund for Zoological Research administered by the New York Zoological Society. Their maximum grant is $3000. Secondly is the Conservation Endowment Fund of the American Association of Zoological Parks and Aquariums, I believe their maximum grant is $20,000. At this time, we would probably be looking at granting deadlines around the first of 1992 for both funds. If you have other suggestions, I would also be willing to help write proposals to them.

At the present time, black rhinoceroses are a high profile species in both the captive and wildlife communities and that may help us in obtaining funding. Current estimates place the

black rhinoceros population throughout Africa at 3500 or fewer animals, and to my knowledge, only South African has had a growing population in recent years. The samples from Zimbabwe have resulted from a major effort to move rhinoceroses from the difficult to defend Zambezi River Valley (shared with Zambia) to parks and ranches in the interior of the country.

The Zimbabweans are also interested in determining if vitamin E and other nutrients vary between wild caught animals and those held for periods of time in boma confinement. It is under those situations that they suspect they may have seen hemolytic anemia (unconfirmed by urinalysis at this time).

Thank you again for your interest. Your suggestions as to analyses sound promising. If I can supply any further materials (If you don't have enough already!), please do not hesitate to contact me.

Sincerely,

R. Eric Miller, DVM
Associate Veterinarian

Veterinary Advisor
Black Rhinoceros, SSP

cc: Dr. Ellen Dierenfeld
Dr. David Jessup
Dr. Ulie Seal
Dr. Tom Foose

Saint Louis ZOO

Forest Park
Saint Louis, Missouri 63110
(314) 781-0900
Fax (314) 647-7969

JUL 19 1991

Charles H. Hoessle
Director

Robert Hyland
President, Zoological Commission

July 15, 1991

Dr. Tom Foose
CBSG
c/o Minnesota Zoological Garden
13000 Zoo Boulevard
Apple Valley, MN 55124

Dear Tom:

As promised, please find enclosed copies of the manuscripts that I received from the participants in the veterinary session of the International Rhinoceros Conference. I thought it would be helpful to distribute them to all speakers and interested parties now, prior to their publication in the proceedings.

You may be particularly interested in Richard Kock's paper, as it contains a great deal of disease and mortality data from Europe and further (negative) comments about the advisability of obtaining additional black rhinoceroses for captivity.

Thanks again for the invitation to attend the New York "follow-up" meeting; please do not hesitate to contact me if I can supply any further materials.

Sincerely,

R. Eric Miller, D.V.M.
Associate Veterinarian

REM:jtg

1991 RHINOCEROS CONFERENCE
VETERINARY AND NUTRITIONAL MANAGEMENT SECTION
TENTATIVE SCHEDULE - MARCH 1991

---

1. Dr. Michael Kock
Department of National Parks and Wildlife Management
PO Box 8365
Causeway
Harare
Zimbabwe

"Capture and Translocation of Black Rhinoceroses in Zimbabwe, Capture and Management Modifications to Reduce Stress and Mortalities"

2. Dr. David Jessup
International Wildlife Veterinary Services
7945 Amalfi Way
Four Oaks, CA 95628
(916) 355-0124 or (916) 966-4309 (H)

"Health Data Gained from Black Rhinoceroses Immobilized for Relocation"

3. Louis Geldenhuys
Etosha Wildlife Institute
Namibia Department of Nature Conservation
Private Bag 13306
Windhoek 9000
Namibia
FAX 264-61-63195

"Black Rhinoceros Translocation in Namibia"

4. Dr. Peter Morkel
Etosha Wildlife Institute
Namibia Department of Nature Conservation
Private Bag 13306
Windhoek 9000
Namibia

FAX 264-61-63195

"Dehorning of Wild Black Rhinoceroses in Namibia"

5. Dr. Eric Miller
St. Louis Zoological Park
1 Government Drive
Forest Park
St. Louis, MO 63110-1396

"Health Concerns in Captive Rhinoceroses"

5. Dr. Richard Kock
Zoological Society of London
Whipsnade Park
Whipsnade, Bedfordshire
Great Britain

"Veterinary Management in Zoos"

6. Dr. Christopher Furley
c/o Howletts and Port Lympne Estates Ltd.
Port Lympne
Lympne nr Hythe
Kent CT21 4PD
Great Britain

0303-264646
FAX 0303-264944 or 44-71-2354701

"Diseases and Management of Black and Sumatran Rhinoceroses at the Howletts and Port Lympne Zoos"

7. Dr. Richard J. Montali
National Zoological Park
3000 Connecticut Ave.
Washington, DC 20008

"Pathological Findings in Diseases of Captive Rhinoceroses"

8. Dr. Linda Munson
College of Veterinary Medicine
University of Tennessee
Knoxville, TN 37901

"Pathological Findings in Oral and Skin Ulcers in Black Rhinoceroses"

REVISED

DISEASE AND CONSERVATION OF THREATENED SPECIES

Report of A Working Group Meeting

28-29 May 1991

National Zoo, Washington, D.C.

Arranged by CBSG/SSC/IUCN in collaboration with AAZPA, AAZV and VSG.

Supported, in part, by a grant from AAZPA

8 October 1991

Introduction

There has arisen, in the captive breeding and the conservation communities, a concern about the risk of diseases acquired in captivity being introduced into wild populations with the release or reintroduction of captive held, and captive-bred wild animals. There is also concern that diseases endemic in wild populations may adversely affect released animals, jeopardizing the entire effort. Disease risks need to be addressed in the planning of any captive breeding - release/translocation program so that appropriate pre- and post-release health monitoring procedures can be developed, thereby reducing the potential on the released and native populations.

Disease, whether induced by viruses, procaryotes, or eucaryotes has long been recognized as an important selective factor in the evolution of all organisms. Mechanisms for recognition and defense against invasion by foreign organisms and mechanisms for the repair of damage are prominent in vertebrates and present in all eucaryotes. The challenges of disease may sometimes be the most powerful evolutionary selection forces acting on all life forms.

A general lack of data or information on (1) the incidence, distribution and risks of disease in captive populations, (2) the distribution and incidence of disease in wild populations, (3) effective quarantine requirements, and (4) detection and monitoring of disease, has resulted in a lack of a working database for informed risk assessment.

In an attempt to clarify the scope of the problem, a disease working group was formed, comprised of representatives from the following affiliations or institutions: American Association of Zoo Veterinarians, Association of Avian Veterinarians, American College of Zoological Medicine, American Association of Zoological Parks and Aquariums, Captive Breeding Specialist Group SSC/IUCN, Center for Reproduction of Endangered Species, Desert Tortoise Recovery Team, IUCN Veterinary Specialist Group, Pathologists, USFWS National Wildlife Health Research Center, University of Washington Veterinary College, Wildlife Disease Association, Zoological Society of London.

This working group meeting defined the following issues and recommended that:

A. Events be defined that may lead to potential situations for disease spread and instances described where disease transmission has occurred between populations. There is a need to fund a short-term project to assemble the literature and anecdotal information on such events

B. Information on disease processes in captive collections needs to be collected in a central location. There is an immediate need to fund the further development of MEDARKS for use by zoos as a standard record system and for a central database

C. Information on disease processes in wild populations needs to be collected on a current basis, assessed and monitored, and maintained in a central location. An agency and mechanisms to accomplish this task need to be identified.

D. Disease diagnosis has a central role in monitoring and assessment. Needs, limitations, current capabilities and future directions of disease diagnosis were outlined. Specific research and development needs were identified to utilize current technology to enhance our diagnostic capabilities

E. Effective quarantine procedures to prevent the spread of diseases between populations is essential. Protocols will need to be developed on a taxon, project, and geographic basis

F. Research resources available to further study disease processes and transmission in exotic species are limited. More resources are needed for targeted research to enhance our knowledge

G. The working group recommended that an international symposium be held to further discuss and explore the issues at hand and to begin drafting preliminary guidelines for the recognition, assessment and long-term monitoring of infectious disease processes and their impact on the conservation of captive and wild populations.

A. Disease Event Categories, Potential Problems, and Examples

1. Zoo to zoo animal movements (local and global) and zoo to private sector and private sector to zoo animal movements
   a. Regulatory inconsistencies of diagnostic screening (e.g. tuberculosis in non-domestic hoofstock)
   b. Lack of uniformity of preshipment procedures and quarantine (e.g. screening for chlamydia, salmonella, parasites; vaccinations and other preventative procedures, etc.)
   c. Lack of adequate transfer of medical records with animal movements (e.g., health certificate and medical history do not always accompany animal)
   d. Disease exposure during transportation (e.g., canids contracting viral diseases during transport; potential exposure during off-loading or zoonotic exposure)
   e. Lack of recognition of specific transmissible diseases in a collection prior to designated SSP moves (e.g., Herpes in many species,FIP, TB, etc.)
   f. Permanent identification of each animal (tattoos, bands or transponders)
   g. Lack of awareness and routine screening for potential hereditary defects and diseases

2. Translocations
   a. Contamination of naive population by infected animals and vice versus. (e.g., Leptospirosis in black rhino)
   b. Lack of recognition of specific transmissible diseases in the old and new environment prior to designated moves (e.g., parasites, canine distemper in black footed ferrets)

c. Appropriate long term monitoring of the health status of both populations
d. See 1a, 1b, 1d, 1f, 1g

3. Supplementation of Wild Populations by translocation of individual animals.
   a. 1f, 1g, 2a, 2b, 2c, 2d.

4. Supplementation of wild populations by utilizing artificial breeding techniques to enhance genetic diversity
   a. Determine health status of gamete donors and recipient
   b. Determine possible diseases transferred by genetic material (e.g., FMD, Brucella, viruses.)
   c. 1f, 1g, 2d

5. Supplementation of wild populations with captive animals
   a. Prior to release, determine health status of the captive animals and the receiving population, and other species (including domestic animals and humans) in the ecosystem (e.g., TB, Pasteurella, lung worms in Arabian Oryx)
   b. 1a, 1d, 1f, 1g, 2a, 2d.

6. Supplementation of captive population with wild populations by utilizing artificial breeding techniques and/or through individual animals
   a. 1f, 1g, 4a, 4b, 5a, 5b, 2d.

7. Introducing captive animals into suitable ecosystems
   a. Predict the disease impact of the animal on the existing resident species (including domestic and humans) and the reverse
   b. 1a, 1b, 1d, 1f, 1g, 2d.

8. Introduction of captive animals to repopulate an historic ecosystem
   a. Prior to release, determine health status of the captive animals and the receiving population, and other species (including domestic animals and humans) in the ecosystem (e.g., meningeal worm in cervids)
   b. 1a, 1b, 1d, 1e, 1f, 1g, 2a, 2c, 2d,

9. Rehabilitation of wild and confiscated individuals with return to the wild habitat, be it at or distant from the original collection point. (Pancake Tortoises, Monk Seals)
   a. 1a, 1b, 1d, 1f, 2a, 5a (e.g. confiscated Pancake Tortoises, Monk Seals)

10. Private sector and agency animal release programs and/or escapes, (including native and non-native species) in their home range or an appropriate or inappropriate ecosystem, (e.g., Desert Tortoises)
    a. acknowledgment of our inability to always control and monitor the impact of these events.

11. Research Resources
    a. Identify key personnel who have expertise with particular species and/or disease problems.
    b. Obtain overviews of research resources from other organizations(e.g. AAZV, ACZM, WDA, AAV, etc.)

B. Lack of Biomedical Data Collection Across Captive Collections

Problem: Critical medical information affecting decisions that concern the movement of animals is currently limited.

1. There are no universally used standardized programs of biomedical data collection (clinical and pathology records) in captive collections. Existing Programs: a. medARKS; b. Individual zoo computerized record keeping system; c. Individual zoo handwritten record keeping systems; d. No medical records or scanty medical records

2. Within existing programs there is limited centralized processing of collected data between institutions. Existing Programs: a. ISIS (clinical pathology, pathology codes); b. Studbooks, SSPs and TAGs; c. AAZV (infectious disease committee.); d. Surveys performed by an individual with a particular disease or species interest

3. Priorities: a. Identification and incidence of infectious diseases that are affecting the living collection; b. Identification and incidence of infectious diseases that are causing mortality in captive collections; c. Standardization of data collection between institutions; d. Centralization of collected data; e. Methods of data availability

4. Recommendations
    a. SSPs and TAGs should have veterinary advisors (medical, pathology)
    b. Gathering of biomedical information should begin with species that have studbooks, SSPs or TAGs
    c. Develop a task force comprised of veterinary advisors, ISIS and medARKS representatives, other knowledgeable groups and individuals to develop a standardized format for data collection, centralization and distribution. This task force should be sanctioned and given high priority and funding by AAZPA in concert with other groups.

C. Collection of Information on the Health of Captive Species

For most endangered species, a centralized medical comparative data base does not exist. Developing an epidemiological data base is the foundation for comparison of disease risks in captive and wild populations, and translocations between and within each. Within the captive community, generation of such a data base should be given top priority and instituted via the following steps:

1. A veterinary advisor should be appointed to each regional captive management plan (e.g., SSPs, EEPs, etc.,). Such advisors should review all mortalities annually, evaluate the incidence of disease in the living population, and make recommendations regarding anesthesia, the prevention and monitoring of disease. Data collection should be standardized. An advisor should identify areas that require further research and assist in the identification of interested researchers and centralized facilities. Cooperation of regional management program veterinary advisors should take place through the auspices of the CBSG, including the distribution of annual regional reports for each species.
   a. CBSG should petition SSP through this report and other means to effect the addition of veterinary advisors to all SSP Committees.
   b. AAZV should also effect a similar petition and assist in the identification of interested veterinarians.

2. For each species, the Veterinary Advisor should supervise the establishment of centralized biomaterial (sera/tissue) banks to aid present and future research. These banks should be established in cooperation with ongoing projects.
   a. Letters of support from CBSG and AAZV as above.
   b. Identification of central funding resources.
   c. Commitment of directors of SSP institutions to make not only funding commitments (e.g., shipment costs of materials to the central banks), but also the manpower commitments for increased participation in such programs on the individual and supervisory levels (e.g., time for veterinarians to coordinate these activities and attend related meetings).

3. Centralized data banks, such as MedARKS should be encouraged, and further effort should be made to design appropriate software for these programs (such as was done with the orangutan medical management survey - similar studies with black lemurs and elephants are in progress).
   a. Encourage more rapid development of MedARKS, in particular, rapid development of the text medical record keeping system that would allow for the evaluation of medical problems in the living population.
   b. request that all medical data be submitted to the regional program Veterinary Advisor in MedARKS format, if not in the program itself.

4. Regional program veterinary coordinators should be included in any review evaluating disease risks in the reintroduction of captive species.

5. Additional contact and cooperation with the private community holding endangered species should be encouraged by:
   a. Identifying private holders that are listed in studbooks.
   b. Veterinary contact with holders of key species.
   c. Contact with private interest groups.
   d. Dissemination of information through lay publications.

D. Wild Population Concerns

All "translocation" activities have the potential to adversely impact wild populations. Generally, there is a paucity of information pertaining to the existence of diseases in a habitat, and if the data does exist it is difficult to assemble. Therefore, before any translocations occur, the following should be considered:

1. There are no universally used standardized programs of biomedical data collection (clinical and pathology records) for wild populations. Existing Programs: a. USFWS National Health Wildlife Laboratory; b. Individual national record keeping system; c. Individual regional, state and local record keeping systems; d. No international databases or systems except for diseases of domestic animals (FAO).

2. Translocation guidelines should apply to all species as resources are available.

3. Governments should identify or assign and agency or individual to serve as a central information source and central repository for disease related information. This office should be responsible for promoting public awareness and distribution of the guidelines.

4. During the planning of a translocation project, all interested parties should be assembled to discuss disease concerns, in relation to the entire project.

5. Disease related questions (handout) should be answered with regard to the prevalence of agents of concern in a habitat and potential impact on endemic species. a. This should be done after review of pertinent literature and diagnostic databases; b. Consideration should be given to undertaking significant specific surveys or monitoring efforts to address unanswered questions.

6. The benefits to the species should be considered with respect to the potential uncontrollable disease risks: a. An individual or agency should be designated to make the final decision.

7. If a decision is made for a translocation, consideration should be given to establish a monitoring program for both the introduced animals, the endemic population and other ecosystem components.

E. Quarantine Considerations for Reintroduction Programs as a Component of an Overall Health Screening Procedure

There is a recognized need and obligation to develop a Model Procedures Manual/Guidebook to address infectious disease-related issues in the release of captive wildlife. This document should include advice on a number of basic procedures including general standards for quarantine and diagnostic test which will probably be applicable at the taxon level, such a document has been started by the AAZPA (attached). It is understood that quarantine is one of several components of an overall health screening procedure to prevent the transfer of infectious diseases to various animals in the ecosystem where the reintroduced animals are released. It should be also recognized that the type and length of a quarantine is dependant upon: 1- species 2- disease concerns 3- facilities available. There are documented situations where a quarantine had a negative effect on the animals (e.g. introduction of Gould's Wild Turkey from Mexico to Arizona where the USDA required quarantine resulted in self-destruction of the bird).

For an effective quarantine the medical advisors must be aware of the infectious diseases of concern for this species and /or diseases that the animals may have been exposed to while in captivity. This information must be derived from a systematic gathering and review of medical and pathology data generated on the species while in captivity. The regulatory and unofficial concerns of the country receiving the animals must also be known and addressed.

The quarantine period will serve as a time to collect and process the necessary samples from these animal to assure their health status and hopefully detect animals who may be incubating or carriers of infectious diseases of concern. The reliability of the testing procedures is a concern of medical advisors and has been addressed elsewhere.

The quarantine process will occur on several levels and may have varied functions at each level. The first level of quarantine occurs at the captive animal's home institution. It may also be necessary to collect the animal at a central location prior to shipment to their final destination and it will be necessary to continue and possibly augment the quarantine procedure. The final area of quarantine will occur in the area of reintroduction where appropriate testing will also occur.

The standards of the quarantine should be guided by the following concepts:

1. Decisions should be made on pre-entry vs post-entry quarantines. Usually both are needed.

2. Quarantines by definition should be all-in/all-out.

3. Quarantines by definition should isolate the animals from known routes of exposure for the primary diseases and parasites of concern, and/or treatments of animals in quarantine should be conducted to remove diseases or parasites.

4. Quarantines must be both general and specific . During the quarantine period, any abnormal health condition must be investigated and documented. In addition, specific testing required to document freedom of disease or parasites in question should be conducted (serology, culture, blood smears, fecals, ectoparasite infections, etc.)

5. Whenever possible, length of pre-entry and post-entry quarantine should be longer than incubation periods of any of the acute infectious diseases or parasites in question.

6. Freedom from a specific disease or parasites in the source population, when adequately documented, should be considered as an acceptable alternative to testing of animals in quarantine when such testing may be overly harmful to the animal or if no testing methods are available.

7. Quarantine standards for translocation of wild species should be formulated with consideration of current standards for the same potential disease problems in domestic animals so that wildlife restoration programs are not burdened with unreasonable restriction.

8. Prior to initiating a quarantine, a decision must be reached regarding the disposition of animals that test positive. In particular, whether entire groups of animals will be disqualified if one animal is positive.

F. Diagnostic Capabilities

1. Summary of the Problem
Limited resources available to evaluate samples and interpretation of the data.

   a. Limited facilities;

b. Lack of a priority list of high risk, low risk and undefined diseases. Define list of realistic goals in terms of disease diagnosis and captive management.
c. Limited diagnostic reagents available for making disease diagnosis.
d. Lack of quality assurance programs at the laboratory level.

2. Solutions

a. For limited facilities
   1) List of currently available labs to do wildlife diagnosis
   2) Support the development of wildlife disease centers with specialty areas.
      a) Reptiles - Florida
      b) Avian - Wisconsin
      c) Cooperation between universities and zoological parks and aquariums - San Diego and Washington State University
   3) Support quality control programs

b. Prepare a priority list through the various SSP groups
c. Improve the quality of diagnostic reagents via biotechnology
d. Standardized list of sample selection via handouts and workshops.
e. Increase the validity of laboratory interpretation by increasing sensitivity and specificity. This increased validity will increase compliance of veterinarians and biologists working with SSP groups.

3. Implementation and Interactions with Other Working Groups

a. Prepare directory of currently available diagnostic laboratories.

b. Recommend use of a letter to be sent to Colleges of Veterinary Medicine inquiring about interest in developing centers for wildlife disease management. Letter also to biotechnology centers stating our needs. Request listing of contact individuals within each institution interested in wildlife disease. Also need to send letter to AVMA.

c. Request the top 5 diseases from each SSP group. Request a report on causes of mortality and morbidity from each SSP group.

d. Bring together individuals involved in wildlife disease/conservation with researchers in biotechnology. This would be best achieved through a meeting.

e. Need to identify a person or persons within each SSP group to develop a handout for collection and handling of biologic specimens for evaluation. This should de done in consultation with a contact person in the lab receiving the samples.

Essentially there would be a brochure for each of the SSP programs developed.

f. Put together a list of papers in the literature that are relevant to the diseases of concern to the SSP groups. Need to keep this file up to date. Needs to be a centralized repository - possibly Minnesota. Needs to be an active computerized file. This file would center on diagnostic tests and infectious diseases.

g. Quality assurance - routine test checks between various laboratories. Need to establish serum and tissue banks for various specimens.

h. Need to send out letter to universities inquiring about existence of various tissue/serum banks.

G. International Symposium

The working group recommended that an International Symposium be held to assemble current and state-of-the-art information on the past, present and future impact of infectious diseases as they relate to the captive management, introduction, reintroduction and supplementation of populations of captive and free-roaming species. There has not been a symposium on these topics for 10 years. One goal of the symposium is to generate guidelines to be used by captive and free ranging wildlife managers in an attempt to minimize the spread of human and captivity induced disease events.

Title: **Implications of Infectious Diseases for Captive Propagation and Reintroduction Programs of Threatened Species.**

Outline of Sessions

0. Introduction to Problem
1. Review of translocations: rationale and types; reintroductions; translocations
2. Historical survey of disease problems associated with releases; Sections on mammals, birds, reptiles, amphibians, freshwater fish, marine vertebrates (fish, reptiles, mammals).
3. Investigation, monitoring and surveillance of disease in captive animals
4. Investigation, monitoring and surveillance of disease in free-ranging animals
5. Interspecies transmission of infectious agents
6. Emerging infectious diseases
7. Future thrusts in diagnostic technology
8. Information and data collection systems
9. Impact of infectious disease on population dynamics

10. Predisposing factors to infectious diseases: genetic, immunologic, nutritional
11. Economic considerations of monitoring and screening programs
12. Vaccination and prevention
13. Government and international interactions
14. Planning and risk assessment for release programs

We have suggestions for session leaders (chair persons). Each session would include a few papers and a discussion period. There would be poster displays and workshops (e.g., informatics, diagnostics).

The suggested symposium sessions originated from the issues identified during the working group. Sessions will expand on these issues by drawing on international experts in a particular field. Proceedings from the symposium will be published in such a manner so that they are universally available to those most in need of the information. This will be accomplished by publishing the proceedings in an internationally recognized journal.

Disease Working Group Meeting Participant List

Mitch Bush
Dept of Animal Health, National Zoo
Washington, D.C. 20008
Ph=202-673-4793; Fax=202-673-4733

Joshua Dein
USFWS National Wildlife Health Research Center
6006 Schroeder Road
Madison, WI 53571
Ph=608-271-4640; FTS=364-5418; Fax=same

Scott Derrickson
NZP Conservation and Research CTR
Front Royal, VA 22630
Ph=703-635-6510; Fax=703-635-6551