investigation of rhino blood parasites and haematology is Intended In the hope of clarifying these health problems before more animals are lost In translocation operations, which will become an increasingly important part of rhino conservation In Africa.

POPULATION AND VETERINARY STATUS OF BLACK RHINOS IN THE UNITED KINGDOM

Summary of presentation by Richard Kock
(Zoological Society of London)

Introduction

The black rhino population in the British isles numbers 12 at present: five wild-caught and seven captive-bred individuals. The latter derive from two genetic lines. One pair came direct from East Africa to the United Kingdom In 1950. The other genetic line is derived from a pair at Hannover which were wild-caught in 1955 and 1957, and two Whipsnade animals and one London animal which were also wild-caught. Fifteen animals In total were caught from the wild. Twenty-four individuals have been born in captivity since 1958. From 1969-1986, 24 deaths occurred including both captive-bred and wild-caught individuals. The major reason for this poor record includes a high mortality in both sexually Immature and mature individuals. A relatively short reproductive period over the life span and a long calving internal are also problematic. Deaths In this species, when compared to the white rhinoceros in captivity, are premature.

Of the 24 deaths recorded, 21 died between October and May, there was one still-birth in July and two deaths between May and October, but both of these had been Ill during the previous winter. In general the clinical syndromes recorded are associated with winter management, i.e. indoor housing, fluctuating climatic conditions, dry fodder nutrition and inactivity. There appears to be no sex or age susceptibility to Illness.

Nine collections have exhibited the black rhino, including 5 currently.

From 1969-1986, 20 deaths occurred in collections as follows:

Chester (5), Marwell (2), Bristol (6), Dublin (3), Paignton (1), Manchester (2), Whipsnade (2), London (1) and Howletts (2). The most "successful" records are from London/ Whipsnade and Howletts/Port Lympne. Only three post-natal deaths (two juveniles and one adult which was Ill on arrival from Bristol) occurred in these collections. Five offspring from these two zoos are at present alive In Great Britain. The two animals at Howletts are in their sixteenth year of captivity and include a captive born animal. The animals at London/Whipsnade are over 20 years old. A major difference between these two collections and the rest is in feeding management, with more browse and green foods being provided during the summer due to a rural location.

Clinical histories 1969-1986

From the case records available only a few individuals died without clinical signs prior to death. The clinical signs have included nasal discharges; with muco-purulent material, serosanguinous fluid and frequently whole blood clots. Skin ulcers, diffuse and punctate in appearance and with a remarkably regular patterning over the skin surface, were common. A few cases presented with diarrhoea, laminitis or haemoglobinurea. During periods of illness animals were in general lethargic and on occasions inappetant. Many of the animals have shown respiratory distress In the last two or three days of illness particularly where recumbency was evident.

Due to the difficulty of clinical examination without anaesthesia in this species clinicians rarely performed extensive diagnostics.

Haematology

The information available is primarily from the Zoological Society's collections (Table 13). It appears that the red cell numbers, haemoglobin concentrations, packed cell volumes and mean cell volumes are extremely variable in the individuals examined when compared with the white rhino. There appears to be no correlation between the time of year and the red cell/mean cell volume values or the presence of heinz bodies. The heinz body findings are unlikely to be significant as they are a common occurrence in white rhinos. High mean cell volumes have been recorded in several animals and this was suggested to be due to a vitamin B or folate deficiency. it may have been an indication of a response to red cell loss by haemolysis. In general, the black rhinoceros has lower red cell haemoglobin values, packed cell volumes and higher mean cell volumes than the while rhinoceros. The only comparative data to hand are from an individual case in another collection which showed dramatically lower red cell haemoglobin and packed cell volume values to those in the collection. it is worth noting here that none of-the deaths in the Society's collections have been during a haemolytic crisis, as has occurred in other collections in this country and abroad.

Table 13. Haematological data from African rhinos, obtained by the Zoological Society of London.

	Black rhino (n = 7)			White rhino (n = 16)		
	Lowest	Mean	Highest	Lowest	Mean	Highest
Red cell count (x 1012/1)	2.69	4.80	6.90	5.48	6.82	8.16
White cell count (x10^9/1)	3.0	8.5	14.0	4.7	8.6	12.5
HaemoglobIn (g/l)	9.76	14.70	19.64	13.94	17.03	20.13
Packed cell volume (%)	30.7	41.6	52.6	37.9	46.4	54.9
Mean cell volume (f1)	76.1	86.8	114.2	67.3	68.0	69.1
Mean cell HaemoglobIn (pg)	28.5	30.6	36.3	24.7	25.0	25.4
Erythrocyte Sedimentation rate (mm/hr)	2.00	22.50	54.00	5.00	16.98	33.00
Platelets (x 10^9/I)	14.3	314.2	614.1	2.28	5.34	8.41
Reticulocytes						
Neutrophils (x10^9/I)	0	0	0	0	0	0
Lymphocytes (x 10^9/I)	2.38	5.09	7.79	2.28	5.43	8.41
Monocytes (x 10^9/I)	0.00	0.24	0.95	0.00	0.32	0.83
Eosinophils (x10^9/I)	0.00	0.22	0.72	0.16	0.41	1.00

Biochemistry

The biochemical parameters did not show any consistent abnormality except for very low plasma vitamin E levels of less than 0.1 mu/ml. Low values are seen frequently in white rhinos and elephants so this is difficult to interpret. Plasma vitamin A levels varied between 15-140 iu/litre. Very little

biochemistry is available from animals terminally; one case showed raised creatine kinase and urea, a very high calcium/phosphorus ratio and hyperglobulinaemia.

Bacteriology, etc.

The bacteriology of oral and skin ulcers was inconsistent and bacteriology of post-mortem materials was inconclusive. In general virological investigations have not been performed. No evidence of fungal infections of any significance was recorded.

Pathology

Relatively few cases were investigated thoroughly at post-mortem. For example, only viscera was examined from certain individuals. Full histological series were rarely obtained with tissues taken according to the gross post-mortem.

Fortunately a few cases were thoroughly examined and provide valuable information. General comments on the table of pathological findings (Table 14) follow.

There appears to be a pattern of pathological change with similarities between individuals. The suggestion is that a number of animals suffered from a similar condition. This was not recognized hitherto due to the scattered nature of the cases and inconsistent examination through the involvement of many individual clinicians and pathologists.

A significant number of animals were found on histology, to have heavy haemosiderin deposition in a variety of tissues which, although not an uncommon finding in normal horses, is rarely seen to the extent in evidence in the rhinoceroses. This suggests haemolysis during life. These changes have also been noted in zoo equids to a lesser extent.

An interesting finding was glomerulopathy which requires further investigation. Fortunately a number of tissues are available for this purpose from previous cases. The possibility of immune complex deposition in the kidney is under investigation. The ulcerative dermatoses were frequently encountered but rarely investigated histologically. The range of findings in the skin suggest low grade dermatitis unlikely to be infectious in origin with hyperkeratosis, vesication, arterial changes (including endarteritis obliterans) and deposition of pigments amongst other pathological findings. Ulcerative and inflammatory changes of the alimentary tract were common. One case of a typical myopathy was reported, one liver hepatosis and two cases with pathology in the respiratory system other than emphysema. Two cases which died acutely with apparently no preliminary signs showed evidence of acute haemolysis, one with extensive alimentary tract ulceration and the other with apparent acidosis in the colon.

In summary, the pathogenesis of the ‘condition’ (if it is one condition) involves the development of ulcers in the skin and alimentary tract with mild inflammatory changes suggesting ischiemia rather than infectious agents and glomerulopathy, the cause of which is undetermined at present. in addition the deposition of pigments (predominantly haemosiderin) suggests haemolysis may be an important component of the syndrome.

Conclusion

In the opinion of the author there is sufficient evidence of a syndrome affecting black rhinos in captivity in the British Isles and leading to abnormal mortality in the species in captivity. The most likely predisposing factors or causes are winter nutrition and possibly stresses at this time of the year including enclosed housing, inactivity and fluctuating environmental temperature. The black rhino is almost exclusively a browser and the rations in captivity during the winter have been based on dry matter (primarily lucerne hays) and concentrated foods based on cereals. These diets are not consistent with the natural dietary intake and might lead to malnutrition in the species. The clinical response in a few cases to vitamin supplementation, particularly A and E, is

Table 14. Summary of pathological findings ——black rhinos———British Isles ——1969-1986

Local ID	Birthdate	Sex	Location	Skin Ulcers	Ulcers/ inflammation Alimentary Tract	Pigment Deposition Haemosiderin/ Lipofuschin or unidentified	Kidney Pathology (Giomerulopathy)
Willie	01.07.50	M	Bristol	*	*	*	*
Stephanie	01.07.50	F	Bristol	*	*	*	No histo
Rebecca	17.05.70	F	Bristol	*	*		
Rupert	28.06.65	M	Whipsnade	*	*	*	*
Kes		20.09.78	M	Marwell	*	*	* *
Joanna	15.11.72	F	Paignton	+	+		
Susie	01.07.56	M	Chester	*	*	*	*
Paul	01.07.63	F	London	*	*	*	+
Laura	01.07.60	M	Dublin?	+	+*	*	*
Johnny	01.07.65	F	Dublin	No histo			
M’kuzl	31.08.73	M	Whipsnade	No histo	+*	No histo	No histo
Linda	20.11.73	F	Chester	+			+ (myoglobin deposits)
Kijana	25.11. 70	M	DublinNo histology. Gross evidence of acute haemolysis and ulcers (skin & gut)				
Katie	16.09.79	F	MarwellAcute haemolysIs and colon acidosis. No histology.				

• Histology reported — positive findings
+ Gross findings
No histo: Histology not completed or reported

suggestive of a deficiency. These elements are liable to degradation in dry forage during the winter and may be a component of the syndrome. It is notable that the collections which have been most successful have provided large amounts of green food in the form of cut grass or browse during spring, summer and autumn.

Two facts are clear from this review. There needs to be an improved coordination between collections to ensure optimal investigation of cases and a more detailed examination of available tissues is necessary.

In the Society we have initiated a change in the nutritional management of the rhinos which includes an attempt at a browser ration for the black rhino and an improved supplementation of elements considered to be deficient in winter diets. The browser concentrate is fed at approximately 6 kg per day and the analysis is shown in Table 15. Lucerne hay is also provided plus vitamin E cubes to a level ensuring an intake of 6 000 international units per day per animal.

Table 15. Analyses of diets of black rhinos at London/ Whipsnade. All values are calculated to nominal 10% moisture content; all values are total calculated values; 1 mcg retinol = 3.3 i.u. vitamin A activity; total retinol content includes the retinol equivalent of carotene; 1 mcg B-carotene = 1.6 i.u. vitamin A activity: 1 mcg cholecalciferol = 40.0 i.u. vitamin D3 activity; 1 mg tocopherol = 1.1 i.u. vitamin E activity; 1 MJ = 239.23 calorIes.

General Purpose Diets

1. Bovine (Browser) Breeder Pellets
2. Bovine (Browser) Maintenance Pallets

		1	2			1	2
Crude Oil	%	4.5	2.8	Glycine	%	1.07	0.65
Crude Protein	%	16.4	12.9	Aspartic Acid	%	1.03	0.71
Crude Fibre	%	10.6	15.2	Glutamic Acid	%	2.98	2.36
Ash	%	10.9	10.7	Proline	%	1.04	0.88
N.F.E	%	47.6	48.4	Serine	%	0.66	0.47
				Hydroxyproline	%	–	—
Dig. Crude Oil	%	4.2	2.5	Hydroxylysine	%	—	—
Dig. Crude Protein	%	14.4	10.5	Alanine	%	0.12	0.12
Tot. Dietary Fibre	%	28.5	35.6				
Pectin	%	2.7	2.7	Calcium	%	1.20	1.24
Hemicellulose	%	13.2	14.2	Phosphorous	%	1.14	1.05
Cellulose	%	10.0	11.7	Phytate Phosphorous	%	0.33	0.30
Lignin	%	2.6	7.0	Sodium	%	0.73	0.72
Starches	%	16.8	16.4	Chlorine	%	1.11	1.09
Sugars	%	12.9	11.6	Magnesium	%	0.65	0.55
				Potassium	%	1.41	1.26
Gross Energy	MJ/kg	14.6	14.1				
Dig.. Energy	MJ/kg	9.4	7.7	Iron	mg/kg	194	153
Met. Energy	MJ/kg	8.5	6.9	Copper	mg/kg	18	16
				Manganese	mg/kg	117	116
Myristoleic Acid	%	–	—	Zinc	mg/kg	114	108
Palmitoleic Acid	%	0.05	0.02	Cobalt	mcg/kg	1104	1107
Oleic Acid	%	1.02	0.71	Iodine	mcg/kg	1431	1419
Linoleic Acid	%	1.19	0.58	Selenium	mcg/kg	356	314
Linolenic Acid	%	0.71	0.40	Fluorine	mg/kg	69	69
Arachidonic Acid	%	0.35	0.13				
Clupenodonic Acid	%	–	—	Retinol	mcg/kg	27889	26667
				Cholecalciferol	mcg/kg	103	52
Lauric Acid	%	0.06	0.03	dl %Tocopherol	mg/kg	116	69
Myristic Acid	%	0.20	0.15				
Palmitic Acid	%	0.44	0.33	Vitamin B1	mg/kg	13.8	9.5
Stearic Acid	%	0.13	0.07	Vitamin B2	mg/kg	10.3	6.3
				Vitamin B6	mg/kg	9.1	5.5
Arginine	%	1.10	0.76	Vitamin B12	mcg/kg	81.0	40.7
Lysine	%	0.80	0.54	Vitamin C	mg/kg	160.0	111.0
Methionine	%	0.22	0.16	Menadione	mg/kg	41.4	36.7
Cystine	%	0.24	0.18	Folic Acid	mg/kg	72.5	61.0
Tryptophan	%	0.24	0.18	Nicotinic Acid	mg/kg	45.1	31.6
Histdine	%	0.39	0.28	Pantothenic Acid	mg/kg	35.5	24.6
Threonine	%	0.60	0.42	Choline	mg/kg	1248.0	902.0
Isoleucine	%	0.66	0.46	Inositol	mg/kg	995.0	879.0
Leucine	%	1.13	0.79	Biotin	mcg/kg	519.0	378.0
Phenylalanine	%	0.71	0.50	p Aminobenzoic Acid	mg/kg	—	—
Valine	%	0.78	0.57				
Tyrosine	%	0.55	0.38	6 Carotene	mg/kg	49.6	50.2
Taurine	%	—	—	Carophyll Red	mg/kg	—	—

Vitamin E Supplementary Foods

1. Vitamin E Cubes
2. High Potency Vitamin E Pellets

		1	2			1	2
Crude Oil	%	6.4	16.8	Glycine	%	1.26	0.37
Crude Protein	%	17.4	9.3	Aspartic Acid	%	1.40	0.45
Crude Fibre	%	7.1	8.2	Glutamic Acid	%	2.76	1.50
Ash	%	9.1	15.6	Proline	%	0.91	0.61
N.F.E	%	50.0	40.1	Serine	%	0.72	0.29
				Hydroxyproline	%	0.02	—
Dig. Crude Oil	%	5.6	16.3	Hydroxylysine	%	—	—
Dig. Crude Protein	%	15.7	7.3	Alanine	%	—	0.09
Tot. Dietary Fibre	%	19.5	24.0				
Pectin	%	3.4	2.2	Calcium	%	0.85	0.34
Hemicellulose	%	8.5	12.6	Phosphorous	%	0.47	0.34
Cellulose	%	6.5	7.8	Phytate Phosphorous	%	0.23	0.20
Lignin	%	1.1	1.4	Sodium	%	0.08	0.14
Starches	%	31.0	9.2	Chlorine	%	0.15	0.24
Sugars	%	6.6	15.1	Magnesium	%	0.27	0.35
Gross Energy	MJ/kg	15.4	16.3	Potassium	%	1.03	0.96
Dig.. Energy	MJ/kg	11.5	11.8	Iron	mg/kg	145	61
Met. Energy	MJ/kg	10.4	10.6	Copper	mg/kg	10	7
Myristoleic Acid	%	0.04	—	Manganese	mg/kg	31	43
				Zinc	mg/kg	25	7
Palmitoleic Acid	%	0.22	0.08	Cobalt	mcg/kg	48	36
Oleic Acid	%	0.48	1.34	Iodine	mcg/kg	241	85
Linoleic Acid	%	0.66	2.18	Selenium	mcg/kg	120	163
Linolenic Acid	%	0.71	0.40	Fluorine	mg/kg	17	6
Arachidonic Acid	%	0.06	0.09				
Clupenodonic Acid	%	0.01	—	Retinol	mcg/kg	24799	24501
				Cholecalciferol	mcg/kg	10	—
Lauric Acid	%	0.01	0.09	dl %Tocopherol	mg/kg	23342	92651
Myristic Acid	%	0.07	0.25				
Palmitic Acid	%	0.25	0.49	Vitamin B1	mg/kg	4.0	4.0
Stearic Acid	%	0.10	0.20	Vitamin B2	mg/kg	4.1	2.0
				Vitamin B6	mg/kg	3.1	1.2
Arginine	%	1.25	0.47	Vitamin B12	mcg/kg	4.9	0.4
Lysine	%	0.71	0.34	Vitamin C	mg/kg	57.0	58.0
Methionine	%	0.32	0.12	Menadione	mg/kg	31.1	30.7
Cystine	%	0.29	0.12	Folic Acid	mg/kg	1.2	0.5
Tryptophan	%	0.25	0.13	Nicotinic Acid	mg/kg	45.1	31.6
Histdine	%	0.36	0.19	Pantothenic Acid	mg/kg	12.0	9.7
Threonine	%	0.62	0.27	Choline	mg/kg	1149.0	459.0
Isoleucine	%	0.67	0.28	Inositol	mg/kg	2349.0	509.0
Leucine	%	1.09	0.51	Biotin	mcg/kg	270.0	183.0
Phenylalanine	%	0.77	0.34	p Aminobenzoic Acid	mg/kg	—	—
Valine	%	0.84	0.38				
Tyrosine	%	0.51	0.25	6 Carotene	mg/kg	49.5	49.0
Taurine	%	—	—	Carophyll Red	mg/kg	—	—

Supplementary Foods

1. Rhino Cubes
2. Zebra Cubes

		1	2			1	2
Crude Oil	%	7.3	5.8	Glycine	%	0.41	1.48
Crude Protein	%	9.4	17.5	Aspartic Acid	%	0.64	1.25
Crude Fibre	%	18.7	11.8	Glutamic Acid	%	1.57	3.09
Ash	%	9.9	7.8	Proline	%	0.62	1.01
N.F.E	%	44.7	47.1	Serine	%	0.35	0.74
				Hydroxyproline	%	–	—
Dig. Crude Oil	%	6.9	5.4	Hydroxylysine	%	—	—
Dig. Crude Protein	%	7.5	15.6	Alanine	%	0.09	0.07
Tot. Dietary Fibre	%	43.9	30.2				
Pectin	%	2.4	3.2	Calcium	%	1.06	1.56
Hemicellulose	%	18.0	13.5	Phosphorous	%	0.53	0.66
Cellulose	%	18.1	11.0	Phytate Phosphorous	%	0.26	0.28
Lignin	%	5.4	2.5	Sodium	%	0.67	0.48
Starches	%	10.1	21.7	Chlorine	%	1.05	0.70
Sugars	%	9.4	7.0	Magnesium	%	1.20	0.47
				Potassium	%	1.97	1.21
Gross Energy	MJ/kg	15.2	15.5				
Dig.. Energy	MJ/kg	7.4	10.0	Iron	mg/kg	233	230
Met. Energy	MJ/kg	6.7	9.0	Copper	mg/kg	23	32
				Manganese	mg/kg	197	342
Myristoleic Acid	%	0.01	0.03	Zinc	mg/kg	153	437
Palmitoleic Acid	%	0.12	0.15	Cobalt	mcg/kg	10128	5207
Oleic Acid	%	1.50	0.82	Iodine	mcg/kg	15777	19236
Linoleic Acid	%	2.35	0.53	Selenium	mcg/kg	196	362
Linolenic Acid	%	0.47	0.36	Fluorine	mg/kg	40	30
Arachidonic Acid	%	0.10	0.08				
Clupenodonic Acid	%	–	—	Retinol	mcg/kg	80065	30951
				Cholecalciferol	mcg/kg	377	51
Lauric Acid	%	0.12	0.11	dl %Tocopherol	mg/kg	123	258
Myristic Acid	%	0.29	0.09				
Palmitic Acid	%	0.57	0.33	Vitamin B1	mg/kg	44.6	26.3
Stearic Acid	%	0.21	0.06	Vitamin B2	mg/kg	84.3	23.4
				Vitamin B6	mg/kg	21.7	17.3
Arginine	%	1.55	1.31	Vitamin B12	mcg/kg	1916.8	251.6
Lysine	%	0.41	0.84	Vitamin C	mg/kg	108.0	310.0
Methionine	%	0.15	0.29	Menadione	mg/kg	62.1	51.6
Cystine	%	0.14	0.25	Folic Acid	mg/kg	15.7	11.7
Tryptophan	%	0.14	0.25	Nicotinic Acid	mg/kg	237.4	62.1
Histdine	%	0.21	0.42	Pantothenic Acid	mg/kg	87.9	39.2
Threonine	%	0.37	0.65	Choline	mg/kg	1282.0	1330.0
Isoleucine	%	0.34	0.73	Inositol	mg/kg	722.0	1643.0
Leucine	%	0.60	1.18	Biotin	mcg/kg	217.0	483.0
Phenylalanine	%	0.40	0.83	p Aminobenzoic Acid	mg/kg	—	—
Valine	%	0.45	0.87				
Tyrosine	%	0.27	0.59	6 Carotene	mg/kg	99.2	49.5
Taurine	%	—	—	Carophyll Red	mg/kg	—	—