International Zoo News Vol. 44, No. 1 (1997), pp. 24–34

AGEING THE SUMATRAN RHINOCEROS: PRELIMINARY RESULTS

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Introduction

The Sumatran rhinoceros (*Dicerorhinus sumatrensis*) is highly endangered. Recent population estimates indicated that only 500–900 animals survived in often small isolated populations in Sumatra, Sabah (Borneo), peninsular Malaya and Burma (Van Strien, 1986; Nowak, 1991). There have been two attempts to establish a captive population. In the 1960s and in the late 1980s, several animals were caught in Sumatra, but high post-capture mortality and a sex ratio skewed towards females in the captured animals has meant that no captive breeding has occurred. This is somewhat surprising given that the Sumatran rhinoceros was one of the first species of rhinoceros to breed successfully in captivity (Sanyal, 1892).

On 4th November 1994 a female Sumatran rhinoceros, Meranti, died at Port Lympne Wild Animal Park and was donated to the National Museums of Scotland (NMS) by Mr John Aspinall. This animal had been caught in the wild in late July 1987 in Riau Province, Sumatra, and arrived at Port Lympne in April 1988 to join a solitary male, also wild-caught. The skin has been preserved to mount for a future educational display and the skeleton was prepared for the research collections (register no. NMS Z1994.131). Several features of the skull suggested that this female was very old, which may explain why no breeding occurred at Port Lympne with this compatible pairing. It was important to establish as accurately as possible the age of the female to see if this was a possible reason for non-breeding.

Few data are available for the accurate ageing of Asian rhinoceroses. Hitchins (1978) used tooth-wear morphology and presumed annual incremental lines in the pad of cementum beneath the molars to establish ageing criteria for the black rhinoceros (*Diceros bicornis*) in South Africa, based on a sample of 148 skulls. Hillman *et al.* (1986) have elucidated similar criteria for the white rhinoceros (*Ceratotherium s. simum*). However, little is known about even the most basic aspects of the biology of Asian species. Dinerstein (1991) states that young adults (4–6 years old) of the Indian rhinoceros (*Rhinoceros unicornis*) exhibit little wear on their molars and have small lower incisors. Adults aged 12–20 years show moderate wear of their molars, while animals older than 20 years show extensive wear. Groves (1967) established ageing criteria for Sumatran and Javan (*R. sondaicus*) rhinoceroses based on tooth eruption patterns, but these provide no method for even approximate absolute ageing of adults.

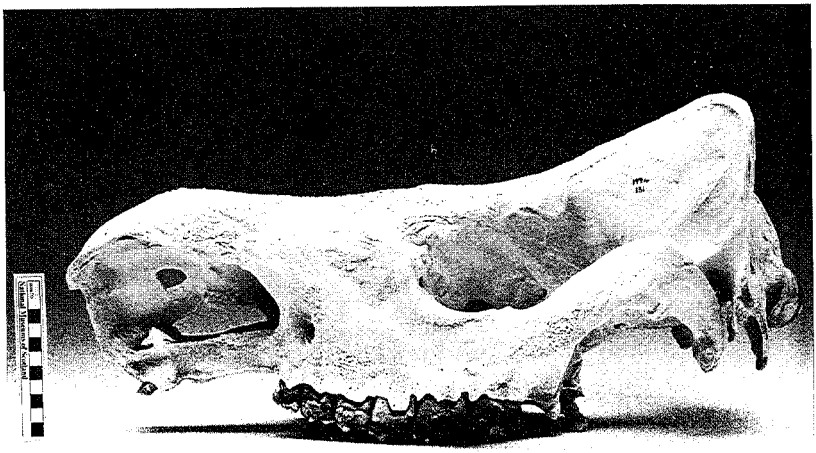

Plate 1 a. Lateral view of the skull of the Port Lympne female Sumatran rhinoceros (NMS Z1994.131), showing high degree of skull surface rugosity and ossified septum.

Plate 1 b. Lateral view of the skull of a young male Sumatran rhinoceros (NMS Z1902.78), showing smooth skull surface and absence of ossified nasal septum. (Photos: Ken Smith, NMS).

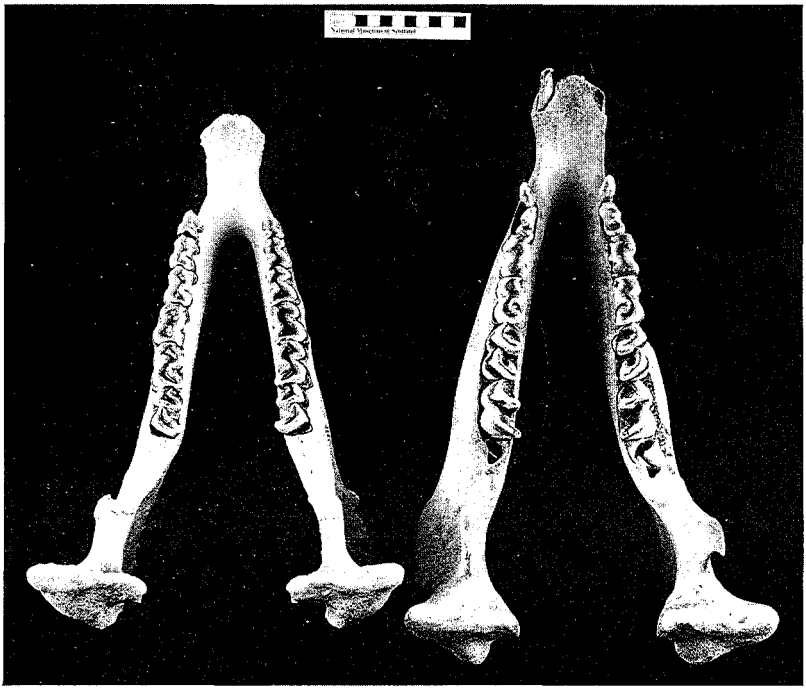

Plate 2. Dorsal views of the mandibles of the Port Lympne female (left) and the young male (see Plate 1), showing high degree of tooth wear and lack of incisors in the old female. (Photo: Ken Smith, NMS).

Establishing Ageing Criteria

Spinage (1973) and Klein (1979) have both used the relatively constant rate of wear of the molars in various bovid species to establish estimates of the absolute ages of samples based on some known-age individuals. This method was applied to skulls of Sumatran rhinoceros in the collections of the Natural History Museum, London (BMNH), and the National Museums of Scotland. However, it was necessary to find (1) independent ageing criteria which would allow skulls to be sequenced in order of chronological age, and (2) known-age captives to calibrate rates of tooth wear.

This preliminary analysis was restricted to females only, because male skulls were generally larger and might have displayed a different pattern and rate of tooth wear relative to the greater size of their teeth. However, despite the presence of a cline in size from larger animals in East Bengal and Burma to smaller animals in Borneo, no account was taken of geographical variation in size owing to the small sample size (only six skulls) of known females that was available. A number of skull features were noted, which seemed to be correlated with increasing age and wear of the premolars and molars in the maxillae and mandibles:

1. Eruption of the upper incisors.
2. Fusion of the premaxillae.
3. Ossification of the nasal septum.
4. Increasing skull surface rugosity.
5. Loss of the lower incisors.

Plates 1 and 2 show two skulls in the NMS collection (including the Port Lympne female) which show these key characters listed above.

The six skulls were placed in apparent order of increasing age with respect to the presence/absence or development of these characters (Table 1). It should be noted that some of the specimens used in this preliminary analysis were used by Groves (1967) to establish his age classes, e.g. BMNH 1901.8.15.1 corresponds to Groves's stage 4 and BMNH 1868.4.15.1 is an adult.

The minimum crown height at the mid-point of the buccal aspect of all premolars and molars was measured using dial callipers. In many cases this was difficult to measure accurately owing to damage to teeth and resorption of alveolar bone, especially in old, often captive, animals, so that some measurement error was inevitable. Owing to small differences in crown height between left and right halves of the jaws, means were calculated for each tooth in each animal. Tooth-wear patterns were clearer and smoother for the maxillary teeth, so that only data for these are presented here. The mandibular teeth often showed aberrant tooth wear, suggesting highly individual patterns of chewing. The mean minimum crown height for all maxillary premolars and molars are shown for the six BMNH females in Figure 1. Curves of rate of tooth wear with increasing age of animal for each maxillary premolar and molar across all six specimens are shown in Figure 2. Given the very small sample size, these results must be taken with some degree of caution, but they do indicate, in general, a reduction in crown height of the molars with increasing age. The premolars show a different pattern of wear with an apparent increase in crown height followed by a decrease. This reflects the replacement of the deciduous premolars by the erupting permanent premolars before their eventual wear once fully erupted (Fig. 2).

Calibration

The relatively smooth rate of wear of the molars of female Sumatran rhinoceroses provides a potential method for absolute ageing, if they can be calibrated with known-age individuals. The oldest animal is the type specimen of the hairy-eared rhinoceros (*D. s. lasiotis*), captured in 1868 near Chittagong in East Bengal (present-day Bangladesh), who lived in captivity (mostly at London Zoo) for 32 years 8 months (Andersen, 1872; Thomas, 1901). She arrived at London Zoo in 1872 when she was estimated to be at least six years old (Sclater, 1872), so that she was unlikely to have been more than 35 years old at her death in 1900.

The main problem here is that no other animal has a known age. However, it may be possible to calibrate the tooth-wear curves in two other ways. Very little is known about the basic reproductive and developmental biology of the Sumatran rhinoceros. Van Strien (1986) stated on the basis of the dimensions of footprints that calves become independent of their mothers at between 400 and 700 days old, grow rapidly for the first two

Table 1. Key characters used to arrange female Sumatran rhinoceros skulls in order of increasing age. Juvenile characters (1) are contrasted with adult characters (2). The Port Lympne female (NMS Z1994.131) is included for comparison.

Character	CBL (mm)	1	2	3	4	5
Specimen/ Origin						
1921.2.8.3 Malaya	505	1	1	1	1	1
1901.8.15.1 Borneo	476	2	1	1	1	1
1868.4.5.1 Burma	592	2	1	1	1	1
1872.12.31.1 Malay Peninsula	514	2	2	2	2	1
1921.28.4 Malay Peninsula	523	2	2	2	2+	2
1901.1.22.1 East Bengal	–	2	2	2	2++	1/2
NMS Z1994.131 Sumatra	482	2	2	2	2++	2

CBL – condylobasal length
1 – Eruption of upper incisors
2 – Fusion of premaxillae
3 – Ossification of nasal septum
4 – Skull surface rugosity (+ indicates degree of roughness)
5 – Loss of lower incisors

to three years, but continue to grow slowly after this time until they reach full adult size at an unknown age. He estimated that they did not reach sexual maturity until perhaps seven or eight years. If it is assumed that this more or less coincides with reaching full adult size, it is possible to estimate that tooth-wear rate for some of the premolars and all molars varies between 0.45 and 0.62 mm/year (Table 2), if it is assumed that BMNH 1868.4.5.1 is a young adult of 7.5 years. These estimates of tooth-wear rate suggest an age for the Port Lympne female varying between 28 and 47 years, but mostly about 28 to 32 years (Table 2).

Sanyal (1892) stated that a Sumatran rhinoceros calf born at Calcutta Zoo had reached the size of its mother at two years seven months and that its upper incisors had not erupted. However, Sclater (1872) stated that the London Zoo female still did not have upper incisors at an age of at least

Table 2. Estimates of rates of tooth wear for maxillary teeth of Sumatran rhinos, based on two methods, and estimates of the age of the Port Lympne female:

a. Assuming young female, BMNH 1868.4.5.1, was approximately 7.5 years at death and the London Zoo female, 1901.1.22.1, was 35 years old at death.

Tooth	Tooth wear (mm)	Age difference (yr)	Rate (mm/yr)	Estimated age (yr)
PM2	14.2	27.5	0.52	32.0
PM3	16.9	27.5	0.61	31.6
M1	12.25	27.5	0.44	47.2
M2	11.7	27.5	0.425	38.1
M3	13.0	27.5	0.47	28.2

b. Assuming that the youngest female skull, 1921.28.3, varies between 31 and 72 months of age.

i. 31 months				
M2	14.5	32.42	0.45	37.7
ii. 72 months				
M2	14.5	29.0	0.5	37.6

six years. The skull of the youngest female in the sample had unerupted upper incisors, so that her age could be roughly approximated to a minimum of 31 months and a maximum of 72 months, to give a tooth-wear rate for M2 of 0.45–0.5 mm/year and an estimated age for the Port Lympne female of about 37 years (Table 2).

The tooth-wear curves of the young adult female from Burma, the old London Zoo female from East Bengal, and the Port Lympne female are compared in Figure 3. Apart from PM 1, the degree of wear in all teeth is similar for the Port Lympne and London Zoo females, both of which show considerably more wear than the young wild female. It has been suggested that it is inappropriate to use the teeth of captive animals in ageing studies. However, Spinage (1973) argues that rates of tooth wear are unlikely to differ significantly between captivity and the wild without fairly major dental problems. The tooth-wear curves suggest that the rate of wear in captivity may be slightly less than in the wild, and that wild animals would be unlikely to live as long as the London Zoo female before their teeth would completely wear out. As a worst-case scenario, the estimated tooth-wear rates are most applicable to captive Sumatran rhinoceroses, even if they cannot be used to calculate the ages of wild animals with any accuracy.

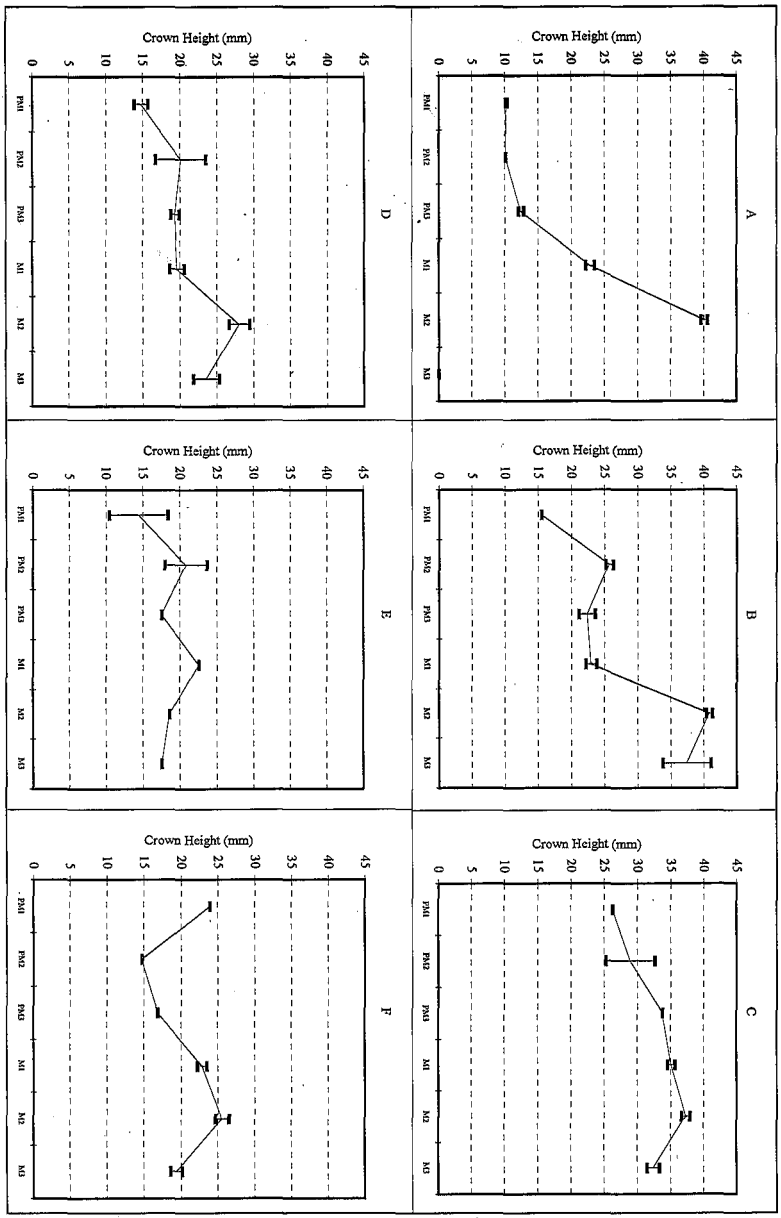

Figure 1. Mean minimum crown heights of the upper premolars (PM1–PM3) and upper molars (M1–M3) of six female Sumatran rhinoceroses in nominal order of increasing age. A – BMNH 1921.2.8.3 (1); B – BMNH 1901.8.15.1 (2); C – BMNH 1868.4.15.1 (3); D – BMNH 1872.12.31.1 (4); E – 1921.2.8.4 (5); F – BMNH 1901.1.22.1 (6).

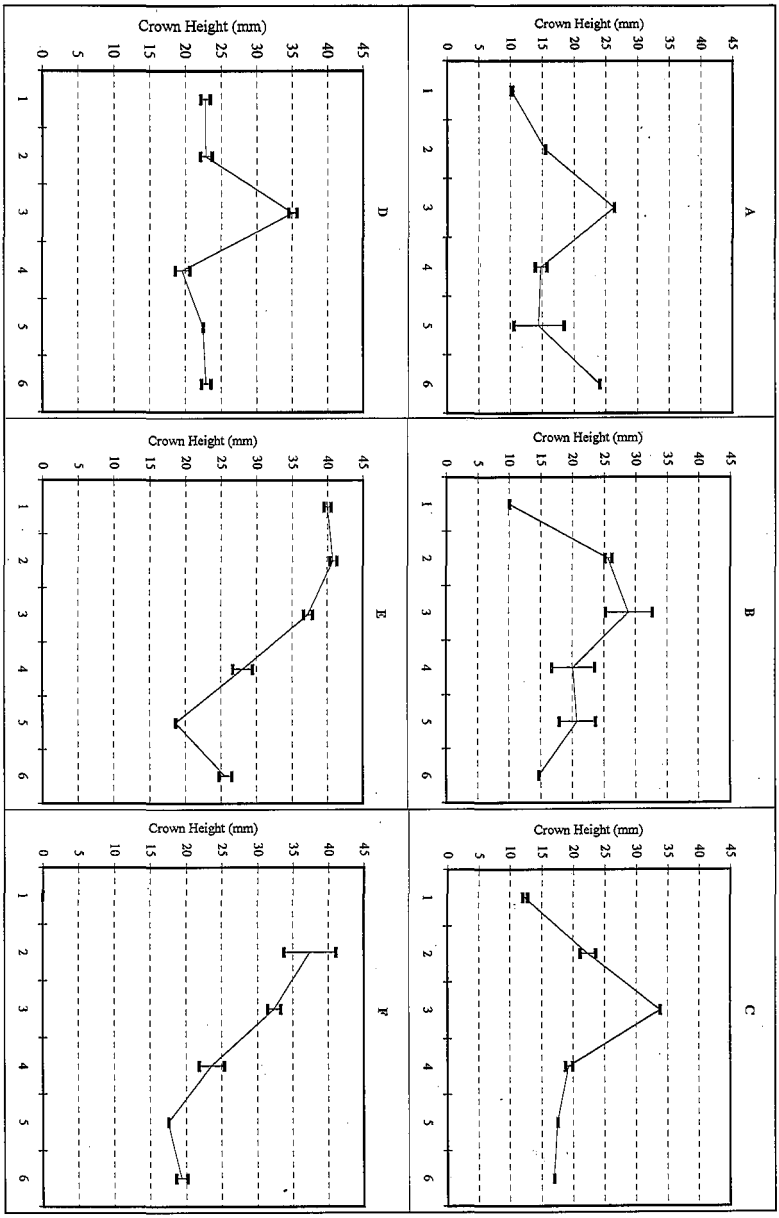

Figure 2. Mean minimum crown heights for each upper premolar and upper molar of female Sumatran rhinoceroses arranged in nominal order of increasing age (see text). A – PMI; B –PM2; C – PM3; D – MI; E – M2; F – M3. Specimen numbers as in Figure 1.

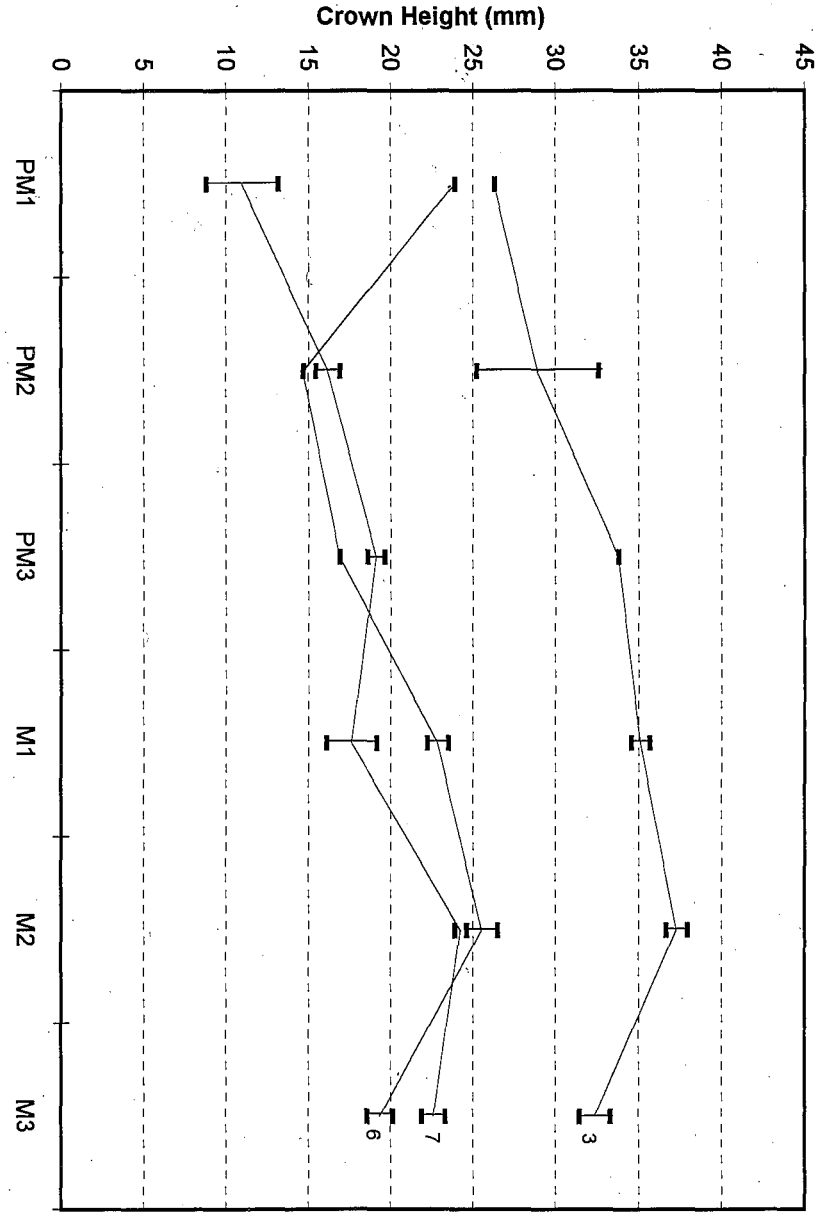

Figure 3. A comparison of mean minimum crown heights of the upper premolars and upper molars of female Sumatran rhinoceroses nos. 3 and 6 with the Port Lympne female (specimen 7).

The Estimated Age of the Port Lympne Female

In many respects the basic skull morphology of the Port Lympne female matches that of the London Zoo female. Both have a heavily rugose skull surface with deep ridges on the mandible and the occipital region of the cranium for the attachment of jaw musculature. They also have fused premaxillae, a heavily ossified nasal septum, very worn molars and premolars, and significant resorption of alveolar bone. The only noticeable difference is that whereas only one lower incisor has been lost by the London Zoo female, both are missing in the Port Lympne animal. Based on estimates of tooth-wear rate in Table 2 and similarity in crown heights in Figure 3, the age of the Port Lympne female would vary between 28 and 47 years, but most probably about 28–37 years. This suggests that the Port Lympne female was as old as the London Zoo female and was quite likely to be too old to breed.

These estimates should be regarded as preliminary, since these ageing criteria are based on only six specimens. I would be grateful for information as to the whereabouts of skulls of other recently captive Sumatran rhinoceroses, so that this scheme can be developed further. I would also be interested in tracking down the skull of the captive-bred animal that lived at Calcutta Zoo (Sanyal, 1892), so that further refinements to this scheme can be undertaken.

Acknowledgements

I am most grateful to Mr John Aspinall for donating Meranti to the National Museums of Scotland, which initiated this study. I would also like to thank Mr Mike Lockyer and his colleagues for their considerable assistance in transporting her to Edinburgh.

I thank Paula Jenkins and Richard Sabin of the Natural History Museum, London, for access to specimens in their care. I thank also Douglas Russell for preparing the figures and Ken Smith for the excellent photographs. I am most grateful to Professor A.J.E. Cave for his comments on an earlier version of this paper.

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After more than four years of research, planning and production, Fort Worth Zoo, Texas, has recently published the AZA Rhinoceros Husbandry Resource Manual (eds. Michael Fouraker and Tarren Wagener). Funding and support for this publication was provided by the International Rhino Foundation, the AZA Rhino TAG, White Oak Conservation Center and Fort Worth Zoo. All U.S. and international institutions holding rhinos, as well as contributors and meeting participants, were forwarded complimentary copies.

This manual was designed as a guide to captive management of the three most common species of rhinos currently held in institutions worldwide: the white, the black, and the greater one-horned rhino. It includes chapters on Taxonomy and Conservation Status, Management and Behavior, Design, Health, Nutrition and Research, as well as appendices on general rhinoceros behavior (a manager's ethogram), information specific to Sumatran rhinos, and data needed.

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