The North American Experience: Female Hormonal Cycles in Southern White Rhinoceros

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Our understanding of the reproductive biology of the southern white rhinoceros is at best fragmentary. There is still disagreement, for example, on the length of the reproductive cycle. Hindle and coworkers (1992) report a 32-day cycle based on urinary hormone analysis of total oestrogen and 20 α-dihydroxy-progesterone from one animal. Combined serial ultrasonographic evaluations and faecal pregnane analysis of a single female showed two non-conceptive cycles of 31 and 35 days (Radcliffe *et al.*, 1997). In contrast, a recent study of 16 southern white rhinoceroses led researchers to suggest a 10-week cycle based on faecal pregnanes (Schwarzenberger *et al.*, in press), whereas Wagner (1986) suggests cycle lengths to vary from 38 to 58 days based on urinary hormone analysis, vaginal cytology and rectal examination. Behavioural observations in the wild (Owen-Smith, 1973, 1975) indicate a cycle period of approximately 30 days. Similarly, a multi-institutional survey (Lindemann, 1982) provided evidence for cycle length to vary by multiples of about 30 days.

There are several reasons for the paucity of endocrine data for southern white rhinoceros. Sample collection in group-housed animals is difficult because defecation and urination must be observed to insure accurate sample identification, a task made more difficult by the rhinoceroses' habit of defecating in communal dung heaps. Another problem is that many of the reproductively active females are pregnant most of the time and do not often exhibit non-conceptive cycles, while the remaining animals available for study are often non-reproductive and may exhibit erratic cycles or none at all (Schwarzenberger *et al.*, in press). Consequently, research in this area suffers from small sample size and lack of data representative of normal reproductive patterns.

In this brief review, we present data from hormonal faecal analyses of 27 female rhinoceros maintained at 12 institutions in North America. At least three samples/week were collected from each female over a period of at least 10 months. Samples were analyzed for progesterone metabolites using a monoclonal antibody that has broad cross reactivity to a number of pregnanes.

We applied both behavioural and endocrine data to characterize cycle length. At least 12 out of the 27 females examined showed no hormonal evidence of reproductive cycles. In these animals pregnane concentrations in the feces remained at baseline. Two females became pregnant shortly after giving birth and thus did not reveal any non-conceptive cycles. The remainder of the rhinos exhibited erratic cycles, cycles of approximately 30 days or cycles of approximately 70 days. Some animals went through both 30 and 70 day cycles.

A few females exhibited unambiguous cyclic patterns of pregnane excretion in the feces, suggesting ovulatory cycles. Many animals, however, had erratic cycles that did not give a clear indication of ovulation, and many animals remained acyclic. Consequently, our data suggest that during the course of several cumulative non-pregnant rhinoceros years, few reproductive cycles occurred. Schwarzenberger and coworkers (in press) monitored pregnane

levels in several females and found endocrine patterns strikingly similar to ours, with the majority of females demonstrating acyclic or irregular cycles.

These studies suggest that lack of regular ovarian activity is a prevalent cause of reproductive failure in most captive southern white rhinoceros (Table 1). Despite periods of erratic and acyclic ovarian activity observed in many females, other females exhibited two clear patterns of reproductive cycle. The first pattern (Type I cycle) suggests a typical reproductive cycle length of 35.0 ± 2.1 days. This finding is consistent with previous physiological and behavioural research supporting a cycle length of approximately one month (Owen-Smith, 1973, 1975; Lindemann, 1982; Hindle *et al.*, 1992; Radcliffe *et al.*, 1997). Our endocrine and behavioural data revealed that a significant proportion of reproductively animals showed a cycle of between 29 and 41 days. The second pattern (Type II cycle) is characterized by an extended luteal phase and lasts approximately 70 days (Schwarzenberger, *et al.*, in press).

Further corroboration of our argument for a typical cycle of approximately one month is found in the observation that one female conceived at the end of three cycles, each about one month in duration. In addition, a recent study of a single southern white rhinoceros female documented two circa 30-day ovulatory non-conceptive cycles, confirmed with ultrasonography (Radcliffe, *et al.*, 1997). Conception followed the second cycle. Clearly, cycles followed by confirmed ovulation and/or conception are more likely to represent "normal" (i.e., fertile) reproductive cycles.

Although more than half of our data indicate cycles of approximately one month, a large number were of the Type II. The frequent occurrence of extended luteal phases found in both of these studies could be attributed to several factors. Radcliffe and coworkers (1997) used ultrasonography to document two conceptions followed by embryonic loss approximately one month post-conception. In both cases, pregnane values remained elevated for 70-80 days post conception, producing an endocrine profile remarkably similar to those observed in this and Schwarzenberger and colleagues' (in press) study. This phenomenon appears independent of breeding activity since females that are breeding and many that are not exhibit similar extended cycles. The frequency of these extended luteal phase cycles suggests that a physiological mechanism is involved and is occurring with some consistency among the captive female white rhino population.

Our conclusion is that the captive white rhino is exhibiting two primary types of reproductive cyclicity. Type I cycles are ~30 days and appear to be fertile cycles. Type II cycles are 60-70 days and are likely to be infertile cycles.

The challenge ahead for scientists and rhinoceros managers is to determine why a significant portion of animals are exhibiting these extended reproductive cycles and what we can do to overcome what appears to be an unusual infertility problem.

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Table I. FECAL HORMONAL PATTERNS IN CAPTIVE WHITE RHINOS.

Reproductive Category	TYPE I CYCLES*	TYPE II CYCLES*	TYPE I and II CYCLES	PREGNANT	ACYCLIC
Number of Rhinos	3	5	4	4	12
Number of Rhinos That Breed	1**	2	4**	4	
Age Range (Yrs)	3 to 20	26 to 28	7 to 35	3 to 30	12 to 35

* some animals represented in these numbers are not in a breeding situation
** one animals is also represented in the pregnant group