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Challenges of Breeding and Caring for Sumatran Rhinos in Captivity

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The Sumatran rhinoceros (*Dicerorhinus sumatrensis*) is considered the most endangered of the rhinos because its population has been reduced to just 300 animals in the forests of Malaysia and Indonesia, and it continues to decline. The commitment and success of the Rhino Protection Units in arresting poachers and reducing encroachment into the forests seems all that stand between this species and extinction. Making matters even more challenging, the species has proven to be the most difficult of the rhino species to maintain and breed in captivity. However, recent successes and the wealth of knowledge acquired over the years provide hope that the Sumatran rhino program now is headed in a more positive direction.

The intensive effort to establish a captive breeding program for the Sumatran rhino as a back up to the dwindling wild population was initiated in 1984. A total of 40 animals was captured for the program from forests where logging was destroying their habitat. Eighteen rhinos were captured in Indonesia, and 11 of these were exported to the US (n=7), the UK (n=3) and Thailand (n=1), whereas 7 animals remained in Indonesia. The 22 animals captured in Malaysia stayed in that country. Unfortunately, keeping Sumatran rhinos alive in captivity initially was difficult, and by 1998, only 16 of the founder animals remained. Many had died of digestive disorders that in retrospect were probably dietary in nature.

Sumatran rhinos are deep forest dwelling animals that survive by browsing. We now know their diets cannot consist solely of hay and grain. Instead, browse, in particular ficus, must be the staple of their diet with produce, hay and grain added as supplements. For the past decade, captive Sumatran rhinos have been fed this ficus diet and have been free of digestive disorders.

Although aggressive behavior is not uncommon when rhinos are paired for breeding, it often is excessive and leads to serious physical

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injury if Sumatran rhinos are introduced when the female is not in estrus. Furthermore, Sumatran rhinos do not exhibit any obvious, reliable behavioral signs of estrus. Because of these characteristics and the complete lack of information available regarding the reproductive physiology of this species, breeding these rhinos appeared an insurmountable challenge for animal managers. By 1994, the only three Sumatran rhinos surviving in the U.S. had been moved to the Cincinnati Zoo & Botanical Garden for one last all out effort to breed the species in North America. In the fall of 1996, an intensive research effort was initiated with the primary goal to produce a Sumatran rhino calf.

The two female rhinos were conditioned to allow rectal ultrasound examinations. These exams were critical for evaluating the reproductive tracts and directly monitoring ovarian activity. Additionally, animals were conditioned to allow blood collection from an ear vein so that serum could be collected regularly and hormone concentrations measured. The data collected using these two technologies eventually led to the revelation and then confirmation that the younger female rhino was an induced ovulator with a 21-day reproductive cycle. The older female appeared infertile with a large uterine mass and small, inactive ovaries. Eventually, the reproductive data acquired through this effort provided the foundation upon which a breeding program that optimized conditions conducive to safe, successful matings was developed. Animals were paired for breeding only when the female's progesterone levels were basal (< 100 pg/ml) and her ovaries contained a follicle at least 20 mm in diameter. When these criteria were met, mating typically took place on that day or, in some cases, the following day.

A pregnancy was established after the second mating and was monitored closely by ultrasound from the day of detection (14 days after mating) until embryo loss was diagnosed on Day 42. After many subsequent infertile matings, the female became pregnant a second time but lost the pregnancy between days 79 and 90 of gestation. Three additional pregnancies were established but each lasted less than 60 days. When the female became pregnant for the 6th time, she was administered an oral progesterone supplement (Regumate™; 16 ml; 0.044 mg/kg/day) beginning on the day of pregnancy detection (Day 16) and continuing until Day 450. She was weaned off the Regumate™ by slowly reducing the daily dosage (1.0 ml per day) until she was no longer receiving any supplement (Day 465). A healthy male calf was delivered on Day 475 after an uncomplicated labor.

Blood collection, hormone evaluations and ultrasound examinations were conducted throughout gestation for two reasons. First and foremost, the technology was employed to closely monitor the

health and progression of the pregnancy. Second, it was used to generate data on hormonal changes during pregnancy and fetal development. This information is the first of its kind for this species and is of interest from both applied and basic scientific perspectives.

Ultrasound examinations initially conducted every 10 days revealed that embryo development was very similar to that in horses, but after Day 83 of gestation, the fetus descended over the pelvic brim and could no longer be visualized rectally. Monitoring continued on a monthly basis via transabdominal scanning near the mammary gland with a 3.5 MHz convex probe, and the fetus could be observed until Day 223 after which it shifted cranially and no longer could be detected. From Day 223 until parturition, most information acquired through ultrasound exams was limited to allantoic fluid quality and only occasionally could a part of the fetus be seen.

The pregnant rhino's progesterone concentrations rose to luteal levels (1.52 ± 0.55 ng/ml) ten days after breeding and remained there for the first two months of gestation. Progesterone then gradually increased, rising to ≥6.0 ng/ml by seven months. From 7 months to parturition at 16 months, progesterone concentrations averaged 8.54 ± 1.75 ng/ml (range, 6-12 ng/ml). By 24 h post-partum, progesterone concentrations had returned to baseline. Relaxin concentrations were basal (<1 ng/ml) for the first 6 months of gestation then rose to 2.71 ± 1.17 ng/ml were they remained until spiking to ≥800 ng/ml two weeks before parturition. Relaxin has never before been measured in a pregnant rhinoceros, and the sharp increase in relaxin two weeks prior to parturition may prove to be a useful indicator of pending parturition.

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fter producing the first Sumatran rhino calf and raising him through weaning at one year of age, there was yet another challenge ahead. To prove that the scientific captive breeding protocol was valid and that the first calf was not just a "one-time-wonder", the success had to be repeated. Relying this time just on serial ultrasound data, the male and female rhinos were paired when a newly developing follicle reached 19-20 mm in diameter. After six consecutive matings over a period of five months, the female conceived. The pregnancy was first observed 15 days after mating, by the presence of an embryo in the left uterine horn. This time, the female rhino was not supplemented with the synthetic progesterone Regumate™. Instead, she was given a chance to demonstrate that she could carry a pregnancy to term naturally without exogenous hormones. Ultrasound examinations were conducted every 10 days for the first three months of gestation and then monthly throughout the remainder of the pregnancy. The female successfully

carried this pregnancy to term and delivered a healthy, female calf 477 days after mating.

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espite the hopeful results achieved at the Cincinnati Zoo, challenges with this species still abound. During the years of study and effort to produce these two calves, a disease outbreak occurred at the rhino facility on Peninsular Malaysia that killed all five remaining rhinos in that program. The cause of death appeared to be trypanosomiasis, but we can only speculate on the exact etiology of the disease and the reason for its 100% mortality rate. Emerging diseases may become more serious threats to the Sumatran rhinoceros because of increased agriculture along forest boundaries.

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n addition to the threat of disease, the challenge of breeding this species in captivity has not been overcome for all rhino pairs. Despite intensive efforts to breed a pair of rhinos at the reserve on Sumatra, the female has yet to conceive, and the fertility of both animals has come into question. Reproductive pathology has been confirmed in many older, female rhinos that have not reproduced for an extended interval and it is possible that the Sumatran rhinos captured over a decade ago now suffer from reduced fertility.

Finally, a husbandry problem that has plagued all facilities is an unusual ocular syndrome that has not been reported in any of the other rhino species. On occasion, Sumatran rhino eyes become cloudy, impeding the animal's vision and causing irritation. Over a period of days or months, depending on the severity of the case, the eyes gradually clear. However, the corneas eventually become scarred after repeated or severe episodes and the vision becomes permanently impaired. Because this species spends most of its time in dark forests and is not very active during the day, it seems likely that the rhinos' eyes simply have not evolved to tolerate much direct sunlight. Zoos maintaining this species now make every effort to provide shade and to limit exposure to sunlight, but with changing seasons and sun angles, it is very challenging. At the Cincinnati Zoo, a large project was undertaken in 2004 to erect large, angled, fabric, shade structures over the Sumatran rhino yards that eliminate over 95% of the Uvb rays from the enclosure. Although this shade structure has been extremely helpful in protecting the rhinos while they are on exhibit during the peak summer season, the shoulder seasons still are a problem because of the significant change in the angle of the sun allowing it to come under the shade material during much of the day. Furthermore, there is some evidence that there are confounding factors (i.e., dry air) contributing to the occurance of the

ocular episodes. Although we have made some progress in addressing it, this syndrome is still far from understood.

In summary, a substantial amount of knowledge now exists regarding the basic husbandry needs of the Sumatran rhinoceros and the reproductive physiology of the species. The animals are now healthier, largely due to appropriate diets. Their enclosures more closely mimic living conditions in the wild with mud wallows, pools and lots of shade. Although breeding this species still is challenging, we know it can be done, and we have the scientific tools and data base that allow us to do it more safely and effectively. Today, emerging diseases and the possible loss of fertility in rhinos captured over a decade ago may pose the greatest threats to the program, and the lack of genetic diversity represented by the few remaining founders is a significant concern. Clearly, there are still challenges in establishing a vigorous captive breeding program for the Sumatran rhinoceros, but we have made great strides in overcoming some of the greatest hurdles from the past and can now point to some successes the provide hope for the future.

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