captured in Indonesia as part of the effort to establish a captive propagation program for this species. The other 3 surviving Sumatran rhino from Indonesia in captivity are in zoos in the United States.

The IRF provided the initial capital (about $ 500,000) for development of the rhino facilities and is supporting operation of the biological program (about $ 50,000/year)

(2) The Sumatran Rhino Conservation Center - Sungai Dusun (SRCCSD) at Sungai Dusun Wildlife Reserve in Peninsula Malaysia.

This center is currently smaller in size than the SRS in Way Kambas but has more rhino: two males and five females. The original facilities consisted of a barn with seven yards. With funds from and through the IRF, a larger enclosure of four hectares contained by electric fence has been constructed to extend the facilities into the adjacent forest. A project by the Malaysian government has enclosed another 40 hectares of forest by the end of 1999.

The IRF and AsRSG have now an assumed joint financial and managerial responsibility with the Department of Wild Life and National Parks of Peninsula Malaysia for this center. An objective is to manage the two breeding centers at Way Kambas and Sungai Dusun in as integrated and interactive a way as possible. It is likely that there may be some movement of rhino between the Way Kambas SRS and the Sungai Dusun Center to manage the surviving rhino as a single population to maximize propagation.

(3) The Sepilok Sumatran Rhino Breeding Center in Sabah.

This is the smallest of the three centers and has just a pair of Sumatran rhino currently. The centre is currently being upgraded with support of SOS Rhino.

Conclusion

The Conservation Programs for Southeast Asian rhinos are of vital importance for the survival of two species of Rhinoceros. These programs are complementary to the long-term efforts for preservation of wildlife and biodiversity that are ongoing in the Rhino Range States and include protected areas, legislation, law enforcement, public awareness, education, and fund raising by the Range State Governments and National and International Conservation Agencies.

The Rhino Conservation Program has been supported by the International Rhino Foundation(IRF) and its member institutions (including especially the Howard Gilman Foundation and the Walt Disney Company Foundation), World Wide Fund for Nature - Indonesia (WWF-I), the Rhino and Tiger Conservation Fund of the US Fish and Wildlife Service (RTCF). AAZK Bowling for Rhinos, and the Anna Merz Trust.

Anesthesia Management in White Rhinos for Reproductive Evaluation, Semen Collection and AI – a Team Approach

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Extended Abstract

In order to elucidate the problems of poor reproductive performance in captive white rhinoceros *(Ceratotherium simum)*,[8] the EEP committee has encouraged intensive and serial reproductive monitoring in this species. Although the reasons for these problems have not been identified definitively, a multi-disciplinary, multi-institutional research proposal aims to work on possible solutions. The overall objectives of this project are to use an integrated approach to enhance breeding of southern white rhinoceroses in the EEP. Focus is placed on older non-breeding animals (F0 and F1). These older animals are targeted in order to conserve their genetic potential within the breeding program. Our combined approach to enhance breeding and overcome reproductive problems includes endocrine monitoring, transfer of animals to enhance natural breeding, and the development of artificial insemination (AI) techniques (see Schwarzenberger et al. these proceedings).

The transfer of animals between institutions requires only minimal applications of chemical restraint. Although several authors have demonstrated that ultrasonographic evaluation of the genital tract and semen collection are possible on unrestrained animals,[4,6,7,9] this requires the commitment of a minimal training program and zoo management/keeper compliance. Presently with exception of the Salzburg Zoo,[9] no rhino chutes are available within the EEP. Various authors have described anesthetic procedures in white rhinos.[1,2,3]

During the period March 1999 to July 2001 a total of 53 elective anesthetic events were performed on 14 male and 28 female animals. Using the experience gained with the combination of Detomidine–HCL (Domosedan®, Orion Corp. Farmos Finland) and Buthorphanol (Turbugesic®, Fort Dodge Animal Health, Iowa, USA) in the standing sedation of white rhinos, and the experience with this combination and additional Ethorphine-Acepromazine (Large Animal Immobilon® C-Vet Veterinary Products, Lancs, UK) in Przewalski´s Horses (Equus prezwalskii)[10] we elected to apply this combination in the white rhinoceros.

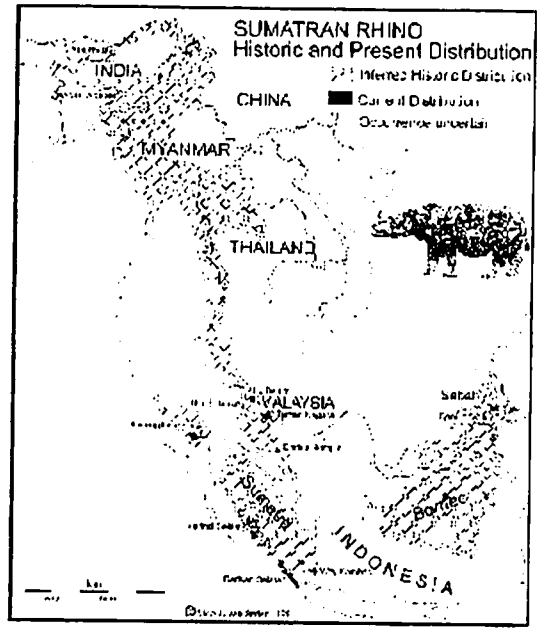
Following a pre-anesthesia evaluation questionnaire (institution veterinarian and Rhino keeper) all animals (estimated weight range 2000 – 3100 kg) were initially sedated with a combination of Detomidine-HCL 10 - 15 mg; and Buthorphanol 10 - 15 mg. This combination was injected into the neck muscles caudo-ventral to the ear using a dart pistol and 3.5ml plastic darts with a 60-mm needle (Dan-inject International Gelsenkirchen, Germany).

After 20 minutes anesthesia was induced with intramuscular Ethorphine 3 ± 0.6 mg and Acepromazine 12 ± 2.5 mg. In safari park settings or when it was deemed difficult to dart an animal twice induction was carried out with an initial combination of all three drugs. In most procedures an additional i.v bolus application of Ketamine 100 – 300mg (Narketan®, Chassot AG, Bern, Switzerland) was used to reduce the time to lateral recumbancy, and thus facilitate the correct placement of the animal within the enclosure. A heavy-duty tire inner tube was placed beneath the shoulder in order to alleviate possible compressive trauma. All animals received supplemental oxygen at a rate of 15 l/min through a nasal tube. The mean duration of anesthesia was 76 ±48 min and a total down time in excess of 50 hours has been accumulated during these procedures. Anesthesia was reversed in all cases with an i.v. combination of Naltrexone 250 mg (Trexonil® Wildlife Laboratories Inc., Fort Collins, Colorado, USA) and Atipamezole 20 mg (Antisedan®, Orion Corp. Farmos Finland). Reversal was smooth and without signs of excitation. All animals were standing and alert approximately 2 min following administration of the antagonists.

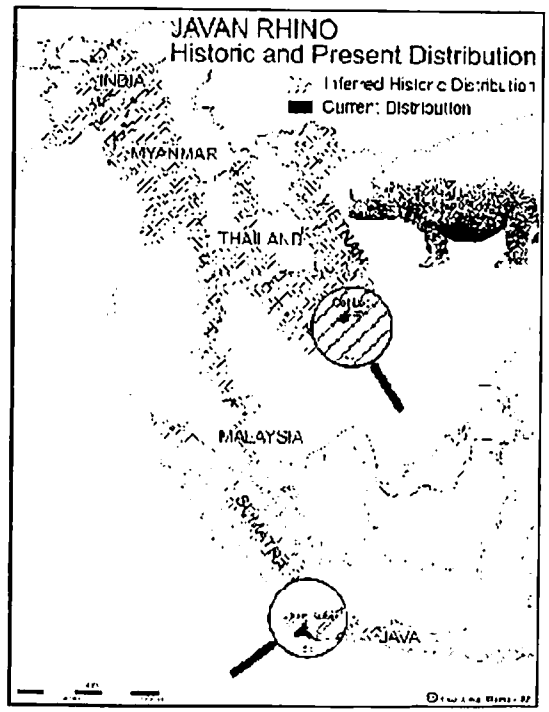
Once in lateral recumbency, rhino monitoring included measurement of the heart rate by direct cardiac auscultation and Doppler; Respiratory rate by direct observation of thoracic excursions. The percent oxygen saturation of hemoglobin (SpO_2) was continuously monitored using a hand-held pulse oximeter (Nellcor NP-20, Hayward, California USA). The ideal placement of the probe varied between individuals. Sites used included, the medio-proximal aspects of the front leg, the mammary gland, and using reflective probes the nasal and oral mucosa. Additionally sequential venous blood samples were drawn from auricular veins. Arterial blood samples for monitoring purposes were drawn from the auricular artery. The arterial blood samples were processed immediately with a portable blood gas analyzer (i-Stat®, SDI Sensor Devices Waukesha, Wisconsin USA).

Mean heart rate was 97 ±47 bpm and in most cases decreased over the duration of the anesthesia. Mean respiratory rate was 6 ±3 breaths per minute, and in most cases remained stable during the procedure after a phase of initial stabilization (mean 20 min). Both the heart rate and the respiratory rate were influenced by the procedures (ultrasound, electroejaculation, etc.) being carried out and must be evaluated in this context. Mean SpO_2 values were 83.5 ± 13 % with supplemental nasal O_2 (measured over the total time frame). SpO_2 gradually increased over the duration of anesthesia in most individuals.

Collection of sequential arterial blood samples from the auricular artery proved difficult under the field conditions but markedly improved with experience. The evaluation of the arterial samples revealed an extremely low mean pH of 7.29 ± 0.08; The arterial carbon dioxide partial pressure (PCO2) revealed a marked hypercapnia 73 ± 13 mmHg which remained relatively constant in each individual over the complete duration of anesthesia. The arterial oxygen partial pressure (PO2) varied greatly between individual animals but on the whole demonstrated a mean tissue oxygenation of 67 ± 23 mmHg. In all animals where sequential samples were obtained, PO2 increased over the duration of the procedure. Oxygen saturation (SO2), the amount of oxyhemoglobin expressed as a fraction of the total hemoglobin able to bind oxygen, is a useful predictor of the amount of oxygen that is available for tissue perfusion. In all measured samples SO2 were elevated when compared to the pulse oximetry derived oxygen saturation values. Low SpO2 values always corresponded to low S02 values and should be acted on accordingly. While this partially validates the use of pulse oximetry, severe pitfalls are possible and the reader is referred to Saint John (1992) for a discussion of the limitations. Elevated mean Base Excess (BE) 10 mmol/l and HCO3 34 mmol/l values demonstrate a primary respiratory acidosis



Map 1



Map 2

with metabolic (compensatory) alkalosis.

Similar to the experiences in Prezwalski´s horses,[10] the combination of ethorphine, buthorphanol, and detomidine provided a safe and reliable method for long term anesthesia in the white rhinoceros. These initial findings correspond in principle to those described by other authors.[1,2,3] In our experience the agonistic / sedative properties of buthorphanol seem to outweigh any possible antagonistic properties in this species, although this is unknown. As we already described in the Przewalski horse,[10] the pacing – a normal side effect with ethorphine – is greatly reduced due to the addition of buthorphanol and enhances the safety of the procedure in many enclosures. The animals suffer from marked hypercapnia and severe hypoxemia. As observed by Heard et al. 1992, this recorded hypoxemia may be adequate for tissue oxygenation due to higher oxygen affinity of hemoglobin and lower tissue metabolic rate in large mammals. It is possible that our incorporation of butorphanol into the initial dart protocol may have helped partially antagonize some of the respiratory depressant effects of etorphine and thus improve SpO_2 values in this study. The average arterial carbon dioxide partial pressure measured in our procedures is markedly elevated when compared to those described by Heard et al. (1992) in one animal.[2]

Prolonged recumbency in white rhinos is associated with hypoventilation resulting in hypercapnia and respiratory acidosis. Through the provision of supplemental oxygen the severity of hypoxemia can be limited. Pulmonary shunting and ventilation/perfusion mismatch also likely play a role in recumbent anesthesia of the white rhino. It is the authors opinion that in order to fulfill the necessary monitoring and therapeutic interventions in long-term rhino anesthesia it is essential to establish an anesthesia team with individually clear defined tasks.

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