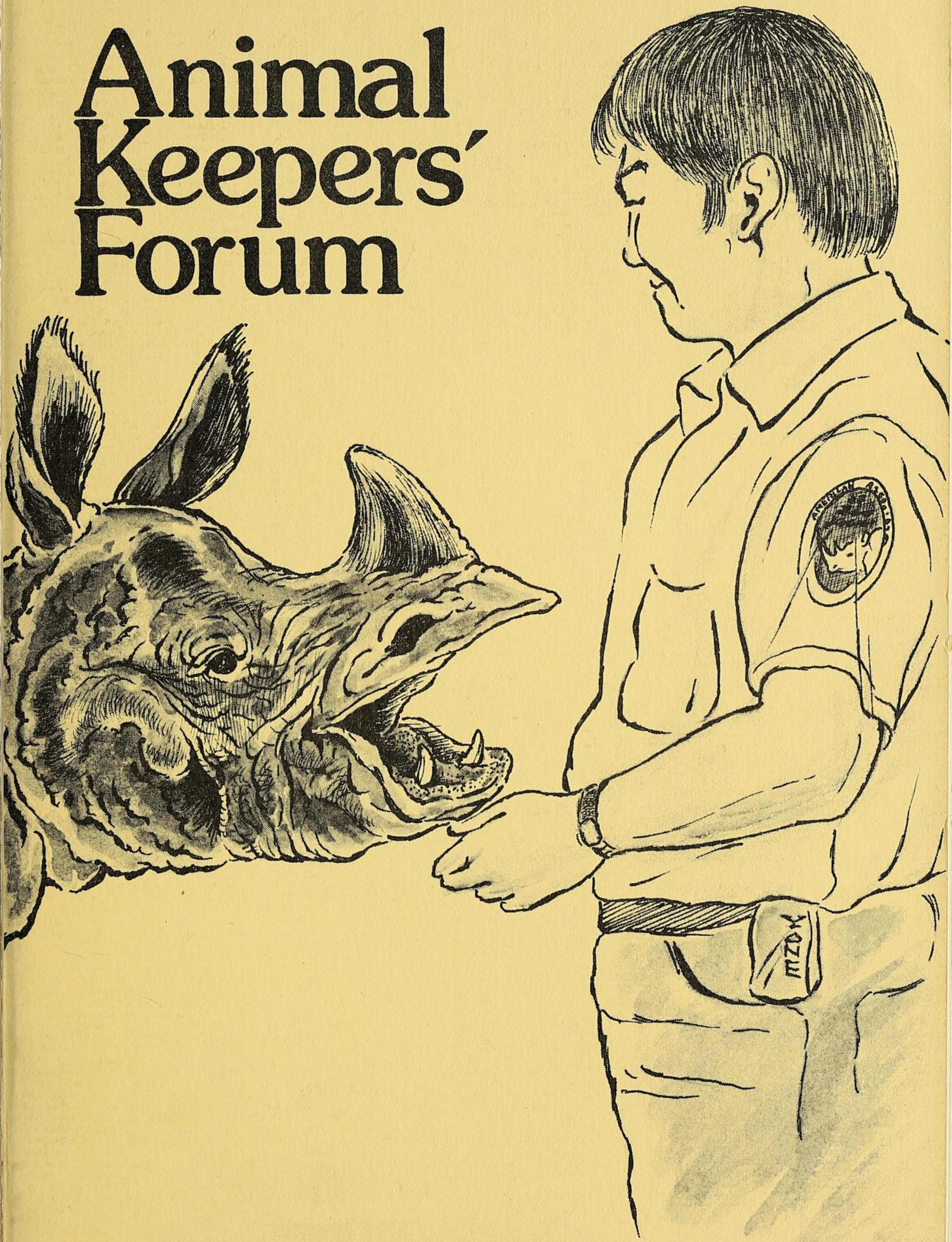


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Dedicated to Professional Animal Care

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ARTIFICIAL BREEDING IN CAPTIVE WILD MAMMALS

by

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To date development of programs for artificial means of semen collection and insemination in the captive wild mammal population has been, for the most part, negligible. These methods have been developed to a high degree of proficiency in many domestic mammals, such as the bovine, ovine, porcine and avian species. In our laboratory, attempts are being made to adapt systems from domestic species, as well as develop new procedures and technical approaches, to provide a means of solving many of the breeding problems associated with the captive wild populations in zoos and game parks.

We have collected semen by electrical and manual stimulation in a number of species. Also, data from our laboratory has shown that artificial induction of estrus and ovulation can be achieved routinely in the domestic feline with the aid of laparoscopy for direct observation of reproductive activity. We have obtained a number of viable progeny from the use of frozen semen in domestic dog, cat and Timber wolf *Canis lupus* (1,2,3).

Semen Collection

Anesthesia is generally required for electroejaculation. This process has been performed successfully in the squirrel monkey *Saimiri sciureus* and rhesus macaque *Macaca mulatta* without anesthetic; however, this may be traumatic to the animal. Drugs used either singularly or in combination for electroejaculation in the various species are Ketaset (Bristol labs), Sernylan (Parke-Davis), Surital (Parke-Davis), C1744 (Parke-Davis), Rompun (Haver-Lockhart), Acepromazine (Ayerst), Sparine (Wyeth), and M-99 (Reckitt and Colman).

A deep surgical plane of anesthesia is desirable for electroejaculation. Successful ejaculates have been collected, however, in animals in light to medium anesthetic planes. A list of the species that have undergone electroejaculation is shown in Table I. Table II illustrates the results of four parameters of semen analysis in some of these species.

The procedure for electroejaculation is similar to that reported in the domestic cat (4,5). A rectal probe is used with either AC or DC power source for the electroejaculation procedure. It is rarely possible to collect semen from any of the captive wild mammals using manual stimulation and an artificial vagina. In a few instances, successful collections have been obtained from Timber wolves, Siberian tigers, ocelots, and cheetah; however, only with great precaution.

After the semen is obtained, it is evaluated both macro and microscopically if freezing is desired. The semen sample is then equilibrated at 5°C, pelleted on dry ice and deposited into liquid nitrogen for storage. It can be inseminated immediately or, if good quality, held for two to three days at 5°C in proper extenders until used for insemination.

Semen stored in liquid nitrogen for more than six years is capable of fertilization in the dog. Cattle have been produced from artificial insemination of semen that had been stored 30 years. Based on this data, we assume that a similar result would be possible in the captive wild mammals.

continued

Artificial Breeding in Captive Wild Mammals, continued

TABLE I

SPECIES ELECTROEJACULATED TO DATE IN OUR PROGRAM

NON-DOMESTIC ANIMALS

| | |
|--------------------------------------|-------------------------------------|
| Golden marmoset | <i>Leontideus rosalia</i> * |
| Lowland gorilla | <i>Gorilla gorilla gorilla</i> * |
| Baboon, Hamadryas | <i>Papio hamadryas</i> * |
| Squirrel monkey | <i>Saimiri sciureus</i> * |
| White-handed gibbon | <i>Hylobates lar</i> |
| Red Uakari monkey | <i>Cacajao rubincundus</i> |
| Grey gibbon | <i>Hylobates moloch</i> |
| Orangutan | <i>Pongo pygmaeus</i> * |
| Spider monkey | <i>Ateles fusciceps</i> * |
| Black and White Colobus monkey | <i>Colobus colobus</i> |
| Black and Red Tamarin | <i>Saguinus nigricollis</i> |
| Hamlyn guenon | <i>Cercopithecus hamlyni</i> |
| Assamese macaque | <i>Macaca assamensis</i> |
| Lion Tailed macaque | <i>Macaca silenus</i> |
| Moor macaque | <i>Macaca maurus</i> |
| Mandrill | <i>Papio sphinx</i> |
| Owl monkey | <i>Aotus trivirgatus</i> * |
| Chimpanzee | <i>Pongo pygmaeus</i> |
| Yellow baboon | <i>Papio cynocephalus</i> |
| Greater kudu | <i>Tragelaphus strepsiceros</i> |
| Fallow deer | <i>Dama dama</i> |
| Black rhinoceros | <i>Diceros bicornis</i> |
| Bactrian camel | <i>Camelus bactrianus</i> * |
| Pere David deer | <i>Elaphurus davidianus</i> |
| Blesbok | <i>Damaliscus albifrons</i> |
| Muntjac | <i>Muntiacus reevesi</i> * |
| South American tapir | <i>Tapirus terrestris</i> |
| Axis deer | <i>Axis axis</i> |
| Sitatunga | <i>Tragelaphys spekei</i> |
| Arabian oryx | <i>Oryx leucoryx</i> * |
| Red sheep | <i>Ovis orientalis</i> |
| Red Lechwe | <i>Kobus leche</i> |
| Slender horned gazelle | <i>Gazella leptoceros</i> |
| Eld's deer | <i>Cervus eldii eldii</i> * |
| Speke's gazelle | <i>Gavella spekei</i> |
| Yellow backed duiker | <i>Cephalophus sylvicola</i> |
| Dik dik | <i>Madoqua kirkii</i> |
| Brocket deer | <i>Mazama americana temama</i> * |
| Pygmy hippopotamus | <i>Choeropsis liberiensis</i> |
| Onager | <i>Equus hemionus onager</i> |
| White or Square lipped rhinoceros | <i>Ceratotherium simum</i> |
| Dorcus gavelle | <i>Gazella dorcas</i> * |
| South American llama | <i>Llama peruana</i> |
| Binturong | <i>Arctictis binturong</i> * |
| Tree kangaroo | <i>Dendrolagus matschiei</i> |
| Meerkat | <i>Suricata suricata</i> * |
| Egyptian mongoose | <i>Herpestes ichneumon</i> * |
| Paím civet | <i>Paradoxurus hermaphroditus</i> * |
| Spotted hyena | <i>Crocuta crocuta</i> * |

Continued

Artificial Breeding in Captive Wild Mammals, continued

TABLE I, continued

SPECIES ELECTROEJACULATED TO DATE IN OUR PROGRAM

NON-DOMESTIC ANIMALS

| | |
|--------------------------|--|
| Lesser panda | <i>Ailurus fulgens</i> |
| Polar bear | <i>Thalarctos maritimus*</i> |
| American black bear | <i>Ursus americanus*</i> |
| Bush dog | <i>Speothos venaticus*</i> |
| North American red fox | <i>Vulpes fulva</i> |
| Canadian timber wolf | <i>Canis lupus canadensis*</i> |
| Kodiak bear | <i>Ursus arctos middendorffii</i> |
| Sloth bear | <i>Melursus ursinus</i> |
| European brown bear | <i>Ursus arctos arctos</i> |
| Spectacled bear | <i>Tremarctos ornatus*</i> |
| African water mongoose | <i>Atilax paludinosus</i> |
| Cougar | <i>Felis concolor*</i> |
| North Chinese leopard | <i>Panthera pardus japonensis</i> |
| Canadian lynx | <i>Felis lynx canadensis*</i> |
| Bobcat | <i>Felis rufa*</i> |
| Temminck's Golden cat | <i>Felis temminckii*</i> |
| Ocelot | <i>Felis pardalis*</i> |
| Geoffroy's cat | <i>Felis geoffroyi*</i> |
| Clouded leopard | <i>Neofelis nebulosa*</i> |
| Lion | <i>Panthera leo*</i> |
| Bengal tiger | <i>Panthera tigris tigris*</i> |
| Siberian tiger | <i>Panthera tigris altaica*</i> |
| Leopard | <i>Panthera pardus</i> |
| Sand cat | <i>Felis margarita</i> |
| Amur leopard cat | <i>Felis bengalensis euptilura</i> |
| Jaguar | <i>Panthera onca*</i> |
| African cheetah | <i>Acinonyx jubatus*</i> |
| Leopard cat | <i>Felis bengalensis</i> |
| Margay | <i>Felis wiedii</i> |
| Crab eating fox | <i>Cerdocyon thous*</i> |
| Bull snake | <i>Pituophis melanoleucus</i> |
| Angolan python | <i>Python anchietae*</i> |
| Green sea turtle | <i>Chelonia mydas*</i> |
| Galapagos tortoise | <i>Testudo elephantopus*</i> |
| Hog nose snake | <i>Heterodon platyrhinus platyrhinus</i> |
| Red eared pond turtle | <i>Pseudemys scripta elegans</i> |
| Degu | <i>Octodon degus*</i> |
| Patagonian cavy | <i>Dolichotis patagona</i> |
| White rat | <i>Mus norvegicus albinus</i> |
| Sugar glider | <i>Petaurus breviceps*</i> |
| Mexican fruit eating bat | <i>Artibeus jamaicensis*</i> |

* denotes more than one ejaculation obtained from the species by electroejaculation

Artificial Breeding in Captive Wild Mammals, *continued*

TABLE II
SEmen Collections and Freezing Results from Selected Zoo Animals

| Date | Species | Volume Collected (ml) | Total Sperm Count (x10 ⁶) | Post Collection | | Post Thaw | |
|---------|--------------------|-----------------------|---------------------------------------|-----------------|------------|----------------|------------|
| | | | | Percent Motile | Prog. Mot. | Percent Motile | Prog. Mot. |
| 9-30-77 | Arabian oryx | 1.85 | 26 | 60 | 5 | 4 | |
| 9-29-77 | Axis Deer | 0.024 | 2192 | 80 | 5 | 5 | |
| 8-26-75 | Baboon | 0.25 | 115 | 30 | 4.5 | 25 | 4 |
| 3-14-77 | Sloth Bear | 0.88 | 156 | 60 | 5 | 40 | 3 |
| 4-23-77 | Cheetah | 1.45 | 14 | 60 | 5 | 55 | 5 |
| 1-6-77 | Degu | 0.078 | 640 | 85 | 5 | 80 | 5 |
| 12-9-78 | Dorcus gazelle | | 143 | 5 | 5 | 65 | 5 |
| 9-29-77 | Sitatunga | 1.69 | 316 | 60 | 5 | 55 | 5 |
| 12-9-78 | Eld's Deer | 3.20 | 2957 | 80 | 5 | 60 | 5 |
| 6-27-78 | Jaguar | 7.30 | 526 | 80 | 5 | 30 | 5 |
| 9-13-76 | Leopard cat | 0.093 | 532 | 90 | 5 | 70 | 5 |
| 1-5-77 | African Lion | 3.05 | 64 | 70 | 5 | 70 | 5 |
| 5-20-73 | Canadian Lynx | 0.40 | 25 | 60 | 4.5 | 20 | 4 |
| 4-23-77 | Margay | 0.35 | 127 | 90 | 5 | 30 | 5 |
| 9-15-76 | Meerkay | 0.03 | 28 | 40 | 5 | 70 | 2.5 |
| 9-13-76 | Mongoose | 0.09 | 192 | 50 | 5 | 30 | 4.5 |
| 4-23-77 | N. Chinese Leopard | 6.30 | 16 | 65 | 5 | 30 | 4.5 |
| 4-1-73 | Ocelot | 0.20 | 5 | 40 | 4.5 | 20 | 4.5 |
| 1-11-78 | Bactrian Camel | 10.3 | 1256 | 80 | 5 | | |
| 6-79 | Black Rhinoceros | 44.6 | 440 | 60 | 20 | | |

Artificial Breeding in Captive Wild Mammals, continued

Laparoscopy

Laparoscopy has been a valuable technique for monitoring reproductive cyclicity in both domestic and wild mammals. It has been used successfully to monitor the effects of exogenous hormones on follicle development and ovulation in the domestic cat. Successful pregnancies have been produced in our laboratory in the domestic cat from the artificial induction of estrus and ovulation followed by artificial insemination with previously frozen semen. Future attempts of obtaining pregnancies in wild animals will be based on these successful procedures developed in the domestic cat and dog (6).

Table III illustrates the species in which laparoscopy has been performed.

Table III

Species in Which Laparoscopy Has Been Utilized

| | | |
|------------|------------------|------------|
| Man | Dog | Lion |
| Mouse | Nonhuman primate | Tiger |
| Rat | Birds | Cheetah |
| Guinea pig | Sheep | Leopard |
| Hamster | Pig | Jaguar |
| Rabbit | Cow | Polar Bear |
| Cat | Horse | Reptiles |
| Fish | | |

Discussion

Our program has been very successful in most species in respect to semen collection and freezing. The artificial insemination, estrus and ovulation induction program is currently being investigated in several of the large species of felines and other captive animal species (8,9).

The eventual goal of this project is to establish a program of artificial breeding in non-domesticated animals. The reasons for establishing such a program are the following:

1. To establish reproductive physiological parameters.
2. To develop and refine methods:
 - a. of physical restraint for artificial insemination and semen collection.
 - b. of electroejaculation, semen freezing and artificial insemination.
 - c. of estrus and ovulation induction, detection, and pregnancy diagnosis.
3. To improve breeding and preservation of common and endangered zoo animals.
4. To preserve valuable cells for future breeding and research study.
5. To establish a national and eventually an international semen bank.

Continued

The advantages of a frozen semen-artificial breeding program are to:

1. Eliminate the risk and expense of shipping captive wild animals for breeding.
2. Inseminate the female without the male being present, or to eliminate the problem of incompatible pairs.
3. Prevent possible disease transmission from outside animals brought in for breeding.
4. Introduce new bloodlines into gene pool from the wild animal game parks and reserves and zoos.
5. Help eliminate complicated legal procedures and animal shipment involved with breeding loans.
6. Improve bloodlines with possible reduction or elimination of undesirable genetic traits.
7. Make available the possibility of progeny testing males.

The authors advocate the use of an artificial breeding program only as a part or an aid in an overall breeding program. We believe that animals given ideal situations and habitat need little help from man to reproduce. It is when man has put such constraints on the 'ideal' situation, whether it be disease, caging, diet or other stress, that we suggest artificial insemination can play a vital role in wild animal reproduction. The success thus far observed leads us to believe that the capability for breeding many captive wild mammals, including some of the endangered species, can be brought about using artificial methods.

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