niche differentiation in colobus populations in Zaire; biology of the New Guinea harpy eagle; ecology, behavior, and conservation of the sloth bear in India, and factors limiting abundance and distribution of the sloth bear in Nepal; langurs in Malaysia; post-release behavior and movements of reintroduced Bali mynahs in Bali Barat National Park; behavior and conservation requirements of the glossy black cockatoo (*Calyptorhynchus lathami*) in South Australia; comparative biology of Australian fairy-wrens (*Malurus* spp.); genetic variation of malleefowl; conservation and evolutionary implications of sex-related habitat segregation in neotropical rainforest birds in southern Mexico; endocrinology of captive male orang-utans; research and conservation of rose-bellied buntings in southern Mexico; dietary analysis of the mountain tapir in Ecuador; diurnal raptor diversity and habitat use in Chile; ecology of the yellow river turtle in Colombia; response of peccaries to seasonal fluctuations in Brazil; and taxonomic status of Central American spider monkeys in the wild and in captivity.

DENVER ZOO, COLORADO, U.S.A.

Extracts from the Annual Report 1992

Conservation, Research and Husbandry

Financial support for the AAZPA's Bali mynah SSP release project continued, with positive results beginning to show at year's end. The wild population of these rare and beautiful birds had doubled during the past year. The zoo was a major financial supporter of a gibbon SSP genetics project designed to examine gibbon mitochondrial DNA to determine population relationships. This research is being conducted at the University of California, San Diego. Another financially supported project involved Grevy's zebra SSP animals in a genetics study to determine individual lineages within a population; the research institution in this case was the University of Illinois at Champagne/Urbana.

Another AAZPA-sanctioned group that has Denver Zoo staff input is the Brazilian Fauna Interest Group. As the name suggests, the purpose of this group is to coordinate and facilitate North American institutional involvement in conservation efforts in Brazil. This will include support for field studies, captive-breeding programs and research. Our zoo is also a major financial supporter of the Madagascar Fauna Interest Group.

Zookeeper Elizabeth Hooton continued video documentation of Asian elephant social relationships and examination of possible behavioral enhancement objects. Our new video equipment was put to good use in other staff projects, such as Susan Haeffner's documentation of greater hornbill and lesser green broadbill (*Calyptomena viridis*) nesting behavior, and Christine Bobko's record of infant-mother relationships in the black rhinoceros.

Our Registrar, Doug Fletcher, has spent much of the year working to get the ARKS (Animal Records Keeping System) data available to staff on our network computer program. This was nearly accomplished by the end of the year. In other words, any of the 50+ computers in the zoo can have access to Animal Department data. Presently, we are the only zoo in the world with a networkable ARKS program, which means that we have accomplished something that the developers of the ARKS program had failed to do. Another interesting item from the records side of our operation is that the Annual Report collection data has been mostly computerized to the point that it now only takes 40 minutes to retrieve data that once took three to five weeks to compile.

Birds, Primates, and Children's Zoo Division

Four new bird species were added to the collection this year – two female shoebills, a trio of white-backed mousebirds (*C. colius*), a pair of golden conures and a pair of Von der Decken's hornbills (*Tockus deckeni*). Other notable bird acquisitions included 0.1 Temminck's tragopan, 0.1 steamer duck, 1.0 African pygmy goose (*Nettapus auritus*), 1.0 beautiful fruit dove and 1.1 Tibetan white eared pheasant (*Crossoptilon c. drouyni*). This was the first year that the zoo successfully raised common piping guan (2), Nicobar pigeon (1), galah (2), Lady Ross's turaco (3) and white-breasted kingfisher (*Halcyon s. smyrnensis*; 1). Our first hatchings of a white-bellied go-away bird (*Corythaixoides leucogaster*) and a crested screamer also occurred this year, but the chicks did not survive. In all, 155 chicks of 36 species hatched in 1992 and we raised 95 chicks of 26 species.

Mammals new to the collection on this side of the zoo included three Kirk's dik-dik (on loan from Cincinnati) and two southern flying squirrels (*Glaucomys volans*). Participation in SSP programs has meant the curtailment of breeding in many of our mammal species, particularly the primates, where all of our female lemurs, many of the tamarins, several Old World monkeys and the gibbons now have contraceptive implants. In spite of this, there were still a number of planned births, including white-faced saki, black howler monkey, silvered leaf monkey, hooded capuchin and slender loris. The non-breeding pair of golden lion tamarins was transferred to St Maarten Zoo, Netherlands Antilles, and the application process was begun to import a breeding pair from the Rio Primate Center in Brazil. Other notable mammal births included two litters of streaked tenrec (*Hemicentetes semispinosus*; DNS) and three Kirk's dik-dik (1 DNS).

Black howler monkey mother and infant at Denver Zoo; in this species females and young are golden brown, adult males are jet black. (Photo: M. Philpott)

Carnivore and Hoofed Animal Division

There were several significant acquisitions during 1992. A male red panda was purchased to pair with one of our breeding females who lost her mate last year. A female Grevy's zebra was acquired to bring our breeding group of this threatened species to 1.5, and a new reindeer bull was brought in to replace our deceased breeding male. Denver holds the most numerous herd of lesser kudu in the New World; in order to optimize genetic diversity in our herd, as well as the rest of the North American population, we traded breeding males with St Louis Zoo. A male yellow-backed duiker came to us on loan from Cincinnati; at year's end, negotiations were underway to procure a female of this species, which is new to the zoo.

A number of significant births occurred, including 1.1 Amur leopards, a male black rhinoceros, 2.1 reticulated giraffe (1.0 DNS), 0.1 river hippopotamus and 0.2 lesser kudu. The red kangaroos continue to thrive and reproduce, thanks to improved husbandry techniques and quick intervention by our medical staff when 'lumpy jaw' is suspected, and the group now numbers 17 animals. Our breeding group of coatis came from Honduras as orphaned youngsters, and thus represent founder animals for the captive North American population. Although some of this year's young did not survive, at least seven did, three of which were hand-reared. Significantly, the mother of the hand-reared cubs gave birth to another litter late in the season, an occasion which, although not unheard of in other collections, was nevertheless unusual. Our young pair of wart hogs reproduced for the first time. First litters are often rejected by mother wart hogs in captive situations, but fortunately our female reared her 1.1 offspring in an exemplary fashion.

Two significant species reproduced, but with unfortunate results. Our Siberian tiger pair produced two litters this year. None of the three cubs survived, and all appeared to be undersized and weak at birth. Although our breeding represents an excellent genetic mix according to the SSP management committee, we are reassessing future attempts to breed these two animals. Two male bongo were born early in the year, neither of which survived. Modifications to the exhibit, holding pens and stalls have made a significant impact on the behavior of our group, seeming to relieve stress in the females of this retiring forest antelope. These modifications also allow us to manage pregnant animals more equitably. This combination of reduced stress and better management facilities will hopefully pay off with the production of viable young in the future.

1992 saw the completion of the second phase of the feline complex renovation, providing indoor habitats for African lions, spotted hyenas, snow leopards and Amur leopards. A large artificial termite hill provides the centerpiece of an exhibit for 2.1 dwarf mongoose; this is the first time the zoo has exhibited these frisky, frolicking little creatures. An off-exhibit, two-stall, heated holding barn/yard complex is near completion. This facility will help alleviate potential herd conflict situations caused by surplus animals (especially males). It will provide a quality space to hold these animals until appropriate homes can be found for them.

Veterinary Medicine

In January 1992 we were awarded $4,000 by the Bay Foundation of New York for unrestricted nutrition research. This money enabled us to have laboratory analyses performed on hay and grain samples, to assay numerous blood samples from our frozen serum bank for Vitamin E and Vitamin A levels on a wide range of species, and to purchase specialized (and expensive) forms of Vitamin E to continue research projects in rhinoceros and elephant. In March a two-year, $40,000 grant was awarded by the Frost Foundation of Denver to conduct pioneering Vitamin E research in hoofstock, macropods and selected birds; this included the establishment and sponsorship by the zoo of a Ph.D. graduate student position in the Animal Sciences Department at Colorado State University. To the best of anyone's knowledge, this is the only program of its kind in North America where a zoo is sponsoring postgraduate education leading to a Ph.D. in zoo animal nutrition. A key element in this project is the design and construction of various devices that will allow blood sampling of fully-awake, non-stressed animals. The nyala (*Tragelaphus angasi*) herd, perhaps the most sensitive zoo species to deficiency of Vitamin E, is the first being studied.

On 30 January the decision was made to euthanize our baby black rhinoceros, Kwanza. At the time of her death she was 16 months old and had lived in the hospital all but three weeks of her life. Her neurologic condition had begun to deteriorate rapidly earlier in the month, and we were no longer capable of offering her a reasonable quality of life. Necropsy confirmed what we had feared all along, that she was the fourth known case of leukoencephalomalacia to be diagnosed in a young female black rhinoceros. The disease destroyed much of the white matter of her brain. We are hopeful that the information gathered during her illness will aid in discovering the as-yet unknown cause of this condition.

In November Malayan tapir Moe developed signs of severe abdominal pain. For a period of 45 minutes he was constantly vocalizing and frantically running around his holding stall, pawing at his belly with his hind legs. In the horse these are considered signs of severe colic and exploratory surgery is mandated. We anesthetized Moe and proceeded through three hours of exploratory abdominal surgery, searching for evidence of a life-threatening problem such as a torsion or rupture of stomach or intestine. Nothing abnormal was found, and the animal made an uneventful recovery until 23 November, when he required a second surgery to remove nearly a liter of clotted blood that had collected at the incision site. He has gone on to make a full recovery. This case is noteworthy in that abdominal surgery is rarely attempted and highly risky in herbivorous animals as large as the 675-pound Moe.

When botulism arrived in June to make its eighth annual attack on wild waterfowl and zoo birds, a surprise was waiting. With a few unfortunate exceptions, all of the zoo's ducks, geese, swans, cranes, pheasants and other susceptible species had been inoculated with a botulism vaccine marketed for use in farmed mink. No zoo had ever used this product on such a wide array of bird species, so this was very much an experimental study. Even with wild birds dying in the same ponds and pens, zoo birds were protected and did not succumb to the deadly botulinum toxin. The only exceptions were five ducks that had not been vaccinated for fear of disturbing their nesting. Meanwhile, 80 migratory waterfowl died in Duck Lake, City Park Lake, or within the zoo, while 14 that were caught early enough were treated in the hospital and released. Although many questions remain to be answered about the use of this product, vaccination will now become an annual spring ritual for the bird collection.

Animals in zoos occasionally (but infrequently) develop aberrant behaviors that involve some degree of self-mutilation. Steroids are traditionally used in an effort to control these behaviors, but there can be negative side effects from their long-term use. We have successfully substituted a narcotic, naltrexone, to control this problem in an Amur leopard, a clouded leopard and a Prévost's squirrel. There have been no behavioral side effects and two of the animals have sired offspring. Several other institutions have expressed interest in using this treatment protocol. The mechanism by which the drug works in this condition is not known.

ZOOLOGICAL SOCIETY OF SAN DIEGO, U.S.A.

Extracts from the Annual Report 1990

In 1992 the administration continued to enlarge its innovative 'team approach' to exhibit management: bioclimatic areas were assigned for complete care to selected employees, who see to the plants, animals and maintenance, working as teams to manage and solve problems. This innovation brought about greater efficiency, stimulated 'pride in work', and produced many favorable comments from leaders in the zoological and business worlds.

The Society supported basic research and field conservation in the amount of $3.9 million. Further, 1992 saw the initiation of plans for a new veterinary hospital and CRES facility to be located at the Wild Animal Park. This complex, when completed, will be without a world peer and will ensure that the Society remains in the forefront of animal-related conservation and research. To our already prestigious CRES organization will be added a division of microbiology, which will be invaluable in the study of the many obscure diseases afflicting exotic animals.

The year saw the opening of the temperature-controlled greenhouse at the Park: this facility, constructed to house hummingbirds and butterflies, was an enormous success and attracted many visitors. In the coming year, the size of the exhibit will double, as well as the variety of species housed in it.

Caring for elephants has been a part of Zoo activities since the days of founder Dr Harry Wegeforth. Nevertheless, providing adequate husbandry for these huge animals has been shown to be one of the world's most dangerous occupations, and the Society is actively seeking ways to minimize risk to our personnel and to improve the well-being of the pachyderms. During 1992 at the Park, the elephant staff embarked on an innovative program of 'protected contact': with this method, elephants are trained to respond to a food reward. Implementing this program has required that elephant barns and demonstration areas be completely rebuilt. This program has attracted great interest from the zoo world, and we plan to introduce the new technique to the general public in 1993.

The Society's botanical collection was also a major focus. During 1992, a complete inventory of our plant collections at both campuses was concluded. This was a monumental job, to say the least, with the objective of having the animal, plant, library, photo lab, Frozen Zoo, and herbarium collections (the latter maintained at the San Diego Natural History Museum) accredited by the American Association of Museums. The Society has now, indeed, been notified of such accreditation, which places us among a few select zoos that have received status as museums.

Among notable animal events in 1992, two pygmy chimps were born at the Wild Animal Park, as was a male Indian rhino. A male black rhinoceros, Werikhe, was born at the Zoo, the first Zoo rhino birth ever. (The Wild Animal Park has had 100 rhino births: five black, 17 Indian, and 78 southern white.) A female sun bear, Elvira, was born in February at Sun Bear Forest. Three cheetahs were born at the Park, bringing to 104 those that have been born at the Park's CRES facility over the years. Two rare milky storks (*Mycteria cinerea*) hatched at the Zoo, and three painted storks (*M. leucocephala*) at the Park, a Society first. Other births and hatchings included, at the Zoo, a female Sumatran orang-utan and a northern koala, and at the Park, a Persian onager, a Somali wild ass, an okapi, and four San Clemente Island loggerhead shrikes (*Lanius ludovicianus mearnsi*), destined to be introduced into their native habitat [see *I.Z.N.* No. 242, pp. 62–63].

Three red-fronted gazelles (*Gazella rufifrons*) were received, the first to be exhibited in the United States. A male Komodo dragon came to the Zoo on loan from Cincinnati, and a male Sumatran rhino arrived to pair with the Zoo's female.

The Center for Reproduction of Endangered Species (CRES) enjoyed a banner year in 1992 with regard to external funding and scientific achievement. More than $1.5 million was obtained from various federal or state agencies, as well as private foundations and gifts, and more than 88 scientific articles and several dozen technical reports were written by the CRES staff. These numbers alone, however, do not tell the complete story. Important and often unique successes were achieved by each division.

Many of these accomplishments resulted from the ever-increasing involvement of CRES personnel in overseas projects. Many staff members are also involved at various levels with national and international conservation agencies. We are now members of no less than a dozen SSPs, special task forces, and advisory groups. Expert scientific input has benefited species as diverse as cheetahs, gorillas, condors, macaques, iguanid and varanid lizards, turtles, wild horses and dikdiks.

Dr Michael Worley and the virology/immunology division continued their examination of free-ranging koalas from parks in Australia to determine the prevalence of retrovirus infection. Because the majority of deaths in adult koalas are the results of cancer or opportunistic infections, there is a likely link between these causes and the presence of retrovirus.

The genetics division, under the direction of Dr Oliver Ryder, furthered their study of the genetic viability of the Przewalski's horse and its eventual restoration to its former habitats. During 1992, discussions with officials of the Mongolian government led to an agreement for future studies of endangered species of the Gobi Desert region. Arlene Kumamoto and her associates accessioned almost 300 samples into the Frozen Zoo, and the entire cell line collection now has samples from more than