

(*Eudromia elegans*) on the Pampas, it was decided that they had to go until we are able to give them an enclosure of their own.

Apart from the crested screamers (*Chauna torquata*) on the Pampas, other animals new to the collection include a group of Defassa waterbucks (*Kobus defassa*) on the East African Savanna, a couple of grey seals (*Halichoerus grypus*) in the Nordic Area and a pair of ravens (*Corvus corax*) donated by the Alpenzoo in Innsbruck in connection with the opening of a new tourist route between Austria and Denmark. Among smaller animals, the colourful fire salamanders (*S. salamandra*) and leopard frogs (*Rana utricularia*) have attracted especial attention.

Our long connection with the Swedish reintroduction project for European eagle owls (*Bubo b. bubo*) continued in 1989, although at the beginning of the year we sent our breeding pair on loan to Jesperhus Blomsterpark in northern Jutland. Three chicks were hatched, and were all reintroduced early in October; any future chicks will also be reintroduced.

As part of an overall sex determination project on the birds in the Zoo, our Caribbean flamingos (*Phoenicopterus r. ruber*), scarlet ibis (*Eudocimus ruber*), Inca terns (*Larosterna inca*), and some of the birds in the Tropical House were surgically sexed in December.

Research

As in previous years, research was carried out in the Zoo in co-operation with the University of Copenhagen. Projects completed during 1989 included the following:

Claus Damsgaard Sorensen: 'Red Pandas in Copenhagen Zoo - Activity Patterns, Distribution Patterns and Social Behavior'. This study was based on a similar one made in 1986. In the autumn of 1987 the Zoo received a new female, and the pair had been together for slightly more than a year when the

study began; its aim was to establish whether replacing the female had any effect, especially with regard to future breeding possibilities. The study showed that activity patterns had not changed significantly. There was, however, considerably more social interaction: the pair were in physical contact for over half the observation time, either playing or lying together in the nesting boxes. The latter behaviour was hardly ever recorded in the previous study, and seems to suggest a more harmonious relationship between the present pair.

Tina Jeanne Moller: 'The Chimpanzees' Exploitation of Behavioural Enrichment Devices'. The aim of this project was to establish the extent to which the chimps used the various devices available to them, and whether there were individual differences between the apes in this respect. Generally the young chimps turned out to be more active than the older ones (83% of the daytime compared with 37%). It was also mainly the young who used the enrichment devices. The most popular was the termite mound, which was on average in use for almost 10% of the observation time. An artificial trunk from which the apes could 'fish' for fruit using branches was also used a lot, but mainly by the younger animals. The other activities, such as the raisin blocks and a sunflower seed castor, were in general equally popular with young and old. Spreading of food pellets and raisins in the straw was found to increase foraging activity considerably, and availability of wheat sprouts increased the activity rate 5 to 6 times. Enrichment activities are being improved as a result of the study - though it should be added that the existing ones are generally seen as highly effective.

Frands Hjordt-Carlson: 'The Savanna in Copenhagen Zoo - Introduction of 1.2 Defassa Waterbuck'. This project is a continuation of last year's study of the interaction between the Savanna animals. The introduction of the

waterbuck was recorded daily from day one until relations seemed to have stabilised a fortnight later. The report describes the course of the introduction in detail, the social standing of the waterbuck in relation to the other species, and their use of the enclosure. The waterbuck hold their own against the other animals, and defend themselves in case of confrontations. They use the entire enclosure, and do not seem to have had problems establishing themselves. Their introduction caused no change in the relationships between the other animals, neither did their general behaviour change noticeably. The study concluded that the present stock (zebra, eland, waterbuck, ostrich and cattle egret) co-exist peacefully, and that they use the enclosure in the

DENVER ZOO, COLORADO, U.S.A. Extracts from the Annual Report 1989

Attendance in 1989 reached 1,231,510, a 2% increase over the previous year, despite one of the wettest Junes on record and a prolonged period of near-100°F heat during July. When attendance of 64,426 at our various special events is included, total zoo usage was just under 1.3 million, an all-time record.

The historic Bear Mountain exhibit has been remodeled and renovated, and now houses grizzly bears, Asiatic black bears and coatis. The Condor/Eagle Aviary was completely renovated to provide proper facilities for captive breeding of Andean condors and bald eagles: the work included restriction of visitor viewing to only one side of the exhibit, by constructing a cliff of artificial rock and providing proper shelter and nesting caves. The first phase of remodeled indoor feline exhibits was completed and opened just in time for Christmas. The rockwork and murals are outstanding, and our visitors have been very impressed with the new homes for our clouded leopards, jaguars and servals. Work is now under way to

best possible way. During the introduction of the waterbuck, the daily results of the study determined the next steps to be taken - each day was evaluated and changes were only introduced when the situation was stable.

Inventory and Attendance

On 31st December 1989 the stock of animals amounted to 653 mammals of 76 species, 504 birds of 127 species, 213 reptiles of 58 species, 153 amphibians of 18 species, 9 fish of 1 species, and approximately 400 invertebrates of 13 species, a total of nearly 2,000 animals of 293 species.

Attendance in 1989 totalled 1,048,407 compared with 1,027,298 the previous year.

renovate remaining interior areas in both wings of the Feline House.

Work has started on the cleaning of Duck Lake, using a floating dredge to remove silt and sludge which had accumulated on the lake bottom. This operation should remove many of the disease problems with our waterfowl population (see veterinary report), and a clean lake will certainly provide opportunities for further bird-related projects.

Carnivore-Hoofed Animal Division

A group of 2.4 young coatis (*Nasua n. narica*), a species absent from Denver Zoo for many years, was acquired to make use of the old sea lion area in the newly-restored Bear Mountain: they have provided an active and attractive display. Two young female servals were purchased to inhabit one of our newly renovated feline exhibits. A pair of Solomon Island prehensile-tailed skinks (*Corucia zebrata*), an interesting and unusual arboreal lizard, was obtained for display in one of the small vignette exhibits in the Feline House.

Two young female red pandas were obtained from the National Zoo to form

a breeding trio with our older male. Four female scimitar-horned oryx arrived as new stock for our successfully breeding herd. A female lesser kudu (*Tragelaphus imberbis*) was brought in from San Diego Zoo to add to our breeding herd as part of a consortium effort with three other zoos: this species is quite rare in North American zoos, with a total of less than 30 individuals. A new young dromedary camel came to us on exchange from Metro Miami Zoo, and a pair of East African bongo (*Tragelaphus eurycerus isaaci*) was purchased. A young female puma was donated by the Colorado Division of Wildlife after her mother was killed in a suburb north of Denver, and is now living with our sibling pair in the North American Predator exhibit. We acquired 3.2 Barrow's goldeneye (*Bucephala islandica*) from the Wyoming Wildfowl Trust to replenish our group at the Northern Shores Ponds.

A male black rhinoceros, born in late October, was probably the most significant birth this year. A pair of baby red pandas unfortunately did not survive,

but two healthy snow leopard cubs were raised in the Feline House by their mother. For the first time in over 30 years a wolf puppy, a female, was whelped and reared at the zoo: she now runs and howls with the pack. All four breeding female reticulated giraffes gave birth to healthy youngsters, two males and two females. Other significant births included two male Grevy's zebras, a pair of lesser kudu, a male California sea lion, a female spotted hyena, a female hippopotamus and two female rock hyrax (*Procavia capensis*).

Regrettably, this division experienced some tragic losses during the year. Most notable among these was the death of our African elephant, Vicky, an account of which appears in the veterinary report. A very upsetting event happened as a result of several dogs getting into the zoo one night; they found their way into the pronghorn (*Antilocapra americana*) yard and chased them, resulting in the deaths of nine of the ten animals in our herd.

Several animals were transferred from Denver to other collections. Two



Jasper, Denver Zoo's black rhinoceros calf.

female lesser kudu were sent to San Antonio Zoo, Texas; our baby hippopotamus, Bridget, went to the Ruhr Zoo, Gelsenkirchen, Germany; three savannah monitor lizards (*Varanus xanthematicus*), which were rapidly outgrowing their display, were placed at Washington Park Zoo, Portland, Oregon; a yearling red panda was sent on breeding loan to Lincoln Children's Zoo, Lincoln, Nebraska; and our snow leopard cub from two years ago, Kangji, went to Baton Rouge Zoo in Louisiana.

One of our young male Przewalski's horses, Bogart, now resides at the Gansu Endangered Wildlife Center in central China, and will become part of, and perhaps the herd stallion for, a herd that will soon be reintroduced into the steppes of northern China. We are extremely pleased that one of our Denver-bred animals will be participating in this major reintroduction project.

Birds - Primates - Children's Zoo Division

A pair of golden-headed quetzals (*Pharomachrus auriceps*), on loan from Houston Zoo, tops the list of significant bird acquisitions. Bird species returning to the collection after an absence of several years included northern pintails (*Anas a. acuta*), violaceous euphonias (*Euphonia violacea*) and bay-headed tanagers (*Tangara gyrola*). Males were acquired to pair up a number of single birds including Cabot's tragopan (*Tragopan caboti*), Bornean crested fireback (*Lophura ignita*), lesser green broadbill (*Calyptomena viridis*), gold-fronted leafbird (*Chloropsis aurifrons*), red-billed toucan (*Ramphastos tucanus*) and white-breasted kingfisher (*Halcyon s. smyrnensis*).

Significant breedings included double-wattled cassowary (*C. casuarius*: Denver has raised 77 chicks since 1977), canvasback (*Aythya valisineria*: our first successful breeding of this duck), sunbittern (*Eurypyga helias*), hooded pitta (*Pitta sordida*), short-tailed green

magpie (*Cissa thalassina*), black-headed gonolek (*Laniarius barbarus*), buff-throated sunbird (*Nectarinia adelberti*), Formosan yuhina (*Yuhina brunneiceps*), snowy-headed robin chat (*Cossypha niveicapilla*), and toucan barbet (*Semnornis ramphastinus*). The toucan barbets were especially significant as we are the only North American zoo to exhibit this species and only the second zoo ever to have bred them. In all, 45 species of birds laid 320 fertile eggs, of which we raised 134 chicks of 29 species.

There were two major acquisitions of primates during the year. One was the purchase of Ernie, a six-year-old lowland gorilla born at Oklahoma City Zoo: at the end of the year he was being introduced to Bibi, one of our females, with the hope that all four of our gorillas would be on display together early in 1990. The other was two male golden-headed lion tamarins (*Leontopithecus rosalia chrysomelas*) on loan to us from Riverbanks Zoo, Columbia, South Carolina: mates for them should become available in 1990.

Species reproduced for the first time at Denver included silvered leaf monkey (*Presbytis cristatus ultimus*), tri-colored squirrel (*Callosciurus prevosti*), and degu (*Octodon degus*). A spotted paca (*Cuniculus paca*) was born here but conceived at Lincoln Park Zoo, Chicago. Other significant births included Bennett's wallaby, two-toed sloth, pale-headed saki (*P. pithecia*), Celebes macaque (*Macaca nigra*), colobus monkey, white-handed gibbon, Dall's sheep and bighorn sheep.

Husbandry, Conservation and Research

Denver participated in 21 of the AAZPA's Species Survival Plan programs during 1989, and zoo staff are represented on eight SSP Management Committees. With the assistance of Robert Wiese of Colorado State University, and various AAZPA biologists, a new format for an

SSP husbandry questionnaire was developed: originally designed for scimitar-horned oryx, it will lend itself readily to statistical analysis, and a similar format is now being utilized by another SSP committee for a better understanding of captive husbandry problems known to occur with addax. Mr Wiese is also contributing time and effort to a program to establish a 'Photo Identification File' for the Grevy's zebra SSP group.

For the second year running, behavioral observations of the maned wolves (*Chrysocyon brachyurus*) were made throughout the breeding season (from September through January), and this year the Animal Health Division monitored hormonal changes that were also occurring. Colorado State University graduate student, Jackie Joshua, began work on developing an ethogram for clouded leopards (*Neofelis nebulosa*), which in time will help in the understanding of the behavior of this species as it relates to propagation. Other research projects in the zoo include a behavioral enrichment study with the lowland gorillas, a study of photoperiod influence on harbor seals, a program of behavioral observations on Arctic wolves, and an investigation into the possible relationship between inbreeding and a bacterial jaw infection ('lumpy jaw') in bighorn and Dall's sheep.

Examination of statistics on the animal collection over the past decade seems to indicate a lowering of the mortality rate in both mammals and birds, and the figures for birds also show a trend towards an increased percentage of hatchings of fertile eggs, and an increased proportion of hatchlings successfully raised. A major cause of this improvement is the fact that our total collection numbers are smaller, so that we are now able to concentrate more time and effort on fewer animals. During this decade we have slowly converted to a rarer, more intensively managed collection. This means that, in

general, we are working with more animal species that need captive sanctuary, and we are better able to plan births so that ever-increasing numbers of offspring are kept within known and approved facilities. Much of the success during the decade with programs dealing with rare animals has come through tremendous breakthroughs in computer technology. But certainly improvements have occurred on all fronts, such as animal health, nutrition, improved facilities, better understanding of behavior, and better educated or trained personnel.

Veterinary Medicine

There were several notable cases during 1989. Rena, matriarch of our roan antelope herd, became acutely ill with what was correctly diagnosed as displacement of the cecum, a portion of the large intestine. Abdominal surgery, though extremely rare and risky in exotic ruminants, was considered the only option to save the 615-lb animal. The compromised organ was successfully exteriorized and impacted food material removed. Rena recovered completely from the three-hour procedure, without which she would almost certainly have suffered a painful death.

Our Bengal tiger, Apollo, was euthanized in May following recurrence of his oral tumor. There had been several months of remission after complicated and stressful treatment in 1988, which may have been the first-ever attempt at radiation implant therapy in a tiger: but post-surgical management of such a dangerous patient proved difficult and impractical. A report will be published in the scientific literature in the hope that this procedure can be adapted to other (perhaps more accessible) zoo animal cancer patients.

Bibi, a female gorilla, received successful repair to an abdominal hernia. Following surgery in 1986 to remove diseased portions of her large intestine and appendix, which had

caused the hernia, Bibi had been left with a grapefruit-sized swelling on her lower abdomen; treatment of this was postponed until it was safe to assume that all traces of infection were eliminated. The surgical closure of the abdominal wall defect was strengthened with a patch of Gore-Tex, a costly high-tech material, donated by the manufacturers, W.L. Gore and Associates, Inc. Bibi recovered quickly, and seemed more energetic and playful than before. She has since had a relapse of her previous intestinal illness, the future course of which cannot be predicted; but the hernia repair remains intact.

This summer brought on our fifth consecutive outbreak of avian botulism on Duck Lake. Migratory waterfowl suffered most of the casualties; 35 ducks and 16 geese died, but most startling were the deaths of 297 black-crowned night herons (*N. nycticorax*) on the island. Perplexingly, laboratory tests for botulism in the herons were negative; they manifested only signs of starvation. But their decomposing carcasses represented a source of botulism toxin for other birds, and they therefore remained an integral part of the disease cycle. Attempts to eliminate this long-standing problem involve removing the herons' nests and discouraging their return to the island for the 1990 breeding season, as well as the dredging of the lake.

A tragic event with important consequences for veterinary research was the death of our African elephant, Vicky, who was euthanized on 11th February after suffering severe generalized muscle degeneration. She first collapsed on 17th January during a routine standing sedation for follow-up treatment of fractured tusks. After eight hours of abortive attempts to raise her, she was coaxed into standing by Mimi, one of her Asian elephant companions. But blood samples showed an unmeasurably low level of Vitamin E, a known cause of muscle disease in numerous species; despite attempts at

supplementation, she collapsed again on 10th February, and the next morning, her condition being obviously hopeless, she was put to sleep by lethal injection. Her death led to a major research project into Vitamin E absorption in elephants. From February through September, the zoo's two Asian elephants, together with four owned by Allen Campbell of Elephantastic, Inc., were the subjects of a study to determine which of the oral forms of Vitamin E currently available for animal use was best absorbed by this species. It was discovered that the acetate form of the vitamin most commonly used in animal feed supplements was absorbed most poorly of all; the more natural alcohol form, expected to give the best results, also showed very poor absorption in elephants. By contrast, a form little known to the animal feeds industry, tocopheryl polyethylene glycol succinate or TPGS, gave dramatically increased Vitamin E levels in the blood in a short time. This work has bearing on several zoo species that suffer from known or suspected Vitamin E deficiency syndromes, most notably the black rhinoceros. These findings were presented in December at the 8th Annual Dr Scholl Conference on the Nutrition of Zoo Animals, and generated a great amount of interest in the zoo community.

JAPANESE ASSOCIATION OF ZOOLOGICAL GARDENS AND AQUARIUMS

Some notes on the 1989 Annual Report

Headquartered in Tokyo, the Japanese Association of Zoological Gardens and Aquaria (JAZGA), with three full-time staff members, is engaged in a variety of work. However, its presence is little known outside the small circle of zoos and aquariums in Japan. JAZGA's activities may be divided into three major categories:

(1) Conferences. Annual conference is