

Research Reports

ZOOLOGY

At Zoo, orangutans use symbols, labels to communicate with humans

By Brenda Kean Tabor
Special to Research Reports

Even though 22-year-old Azy and his 19-year-old sister, Indah, spend five days a week working with computers, and seem to enjoy doing so, they wouldn't be considered "techies." They are orangutans learning communications skills by means of a computer. Their rapt attention to the screen is part of the ongoing Orangutan Language Project that has been under way at the Smithsonian's National Zoological Park since 1995.

The project is a component of the National Zoo's "Think Tank" exhibition, where displays, videotapes and live demonstrations are used to share with visitors the latest research on animal intelligence. Some of the orangs who participate in the project live at "Think Tank," while others can voluntarily "commute" from their living quarters at the Great Ape House via a system of steel cables and 45-foot towers known as the "orang transit system."

"When we began to redesign the old monkey house in 1993," says Rob Shumaker, a biologist at the National Zoo and director of the Orangutan Language Project, "our goal was to improve not only the

animals' physical environment but also their mental environment. We feel a tremendous ethical commitment toward these individual animals, all of whom were born here at the National Zoo."

"The cognitive capabilities of the great apes illuminate the evolution and functioning of human cognition and bear directly on the ethics of our relationships with these wonderful creatures," Ben Beck, associate director for biological programs at the National Zoo, says.

Testing orangutan skills

Using abstract symbols that are viewed on the animals' computer screens, Shumaker is currently trying to determine how accurately orangutans can label objects, the rate at which they acquire competency in using symbols and their ability to understand and use numbers, specifically Arabic numerals.

Shumaker chose Arabic rather than Roman numerals because Roman numerals provide visual cues to their value, whereas Arabic numerals are totally abstract. "The orangs have to learn and

remember the meaning of symbols if they are going to use them productively," Shumaker explains. "I consider numbers to be another category of symbols in the overall vocabulary of the orang."

Both Azy and Indah "work" five days a week. Though rewarded for correct answers with treats, neither is forced to participate and both do so readily.

They clearly enjoy their tasks, ambling up to the computer when Shumaker appears with his materials and sitting patiently while he prepares to start a session. They do not seem to be frustrated by their mistakes, and Shumaker is careful not to push them beyond their limits.

Azy weighs 270 pounds, and Indah weighs approximately 125 pounds. Gentle by nature, the orangutans' sheer sizes make them dangerous, and Shumaker cannot risk entering their cage lest he be inadvertently injured by their innocent play. Instead, he conducts his research from the other side of a cage divide,

while also passing objects and rewards to the animals through a narrow opening.

When the research first began in the fall of 1995, Shumaker says, he started with flash cards. The orangs were coached to associate a symbol with an object, such as an apple or a grape. After showing one of the animals the object,

Shumaker repeatedly placed the animal's index finger on the appropriate flash card until the animal began to associate the object with the cards and to point to the appropriate card when shown an object.

The animals now use a computer with a touch-sensitive screen on which the symbols appear, instead of flash cards.

It is easy for the animals to point because "they have good manual dexterity," Shumaker says. "The females frequently use their hands for detailed work, although the males have larger hands and often manipulate things with their lips. Both males and females tend to be ambidextrous in the wild, but are predominantly right-handed in captivity."

Once a number of objects and their corresponding symbols have been introduced, a larger choice of labeling symbols is put up on the screen. By increasing the number of possible choices, Shumaker has been able to test the animals' memory, their abilities to distinguish between symbols from up to 30 possibilities and their rate of accuracy.

New symbols are never introduced until an accuracy rate of about 90 percent has been achieved for symbols that have already been introduced. To avoid confusion, when

a new symbol is first introduced, the choice of symbols on the screen is reduced.

Shumaker goes to great lengths to avoid helping the animals choose the correct answers and points out that their mistakes confirm the objectivity of their selections. After the animals make a correct selection, a bell rings, and they receive positive reinforcement in the form of food and Shumaker's praise.

Yielding results

Shumaker's results, so far, indicate that the speed with which the orangs learn a new symbol increases with the number of symbols to which they are exposed. "Azy initially needed 600 exposures before achieving 90 percent accuracy, while Indah needed 540 exposures. There is no overall drop in

Orangutans can use the "orang transit system" to voluntarily participate in cognitive research at the National Zoological Park. (Photo by Jessie Cohen)

'Orangutans,' continued on Page 6

Smithsonian marine research ■ The Smithsonian operates a network of coastal laboratories and long-term marine research sites in the western Atlantic Ocean that extends along the East Coast of North and Central America, bridging the Panamanian isthmus, from the Caribbean Sea to the Pacific Ocean. In addition to infrastructure and staff expertise in marine sciences, the Smithsonian Marine Science Network provides unparalleled access to, and research support for, Atlantic Ocean and Atlantic shore ecosystems.

These marine ecosystems provide valuable environmental services for human populations centered in the coastal zone. Understanding human interactions with the marine environment is critical: 70 percent of Earth's human population lives in coastal cities supported by these marine resources. The Smithsonian Environmental Research Center in Edgewater, Md., emphasizes multidisciplinary, multiscale ecological analysis of the nation's largest estuary, the Chesapeake Bay, and its watershed. The center also is designated as the national center for the study of biological invasions of coastal ecosystems.

The Smithsonian Marine Station at Fort Pierce in Florida focuses on the Indian River Lagoon, a 156-mile-long ecosystem with the highest estuarine biodiversity in North America. Researchers have access to mangroves, coral reefs, the continental shelf, and Gulf Stream plankton and open sea communities. The Caribbean Coral Reef Ecosystems Program at Carrie Bow Cay in Belize is perched atop the world's second largest barrier reef. This undisturbed environment of mangroves, sea grasses and coral is removed from immediate coastal influences. Ongoing investigations there include analyzing mangrove ecosystems and the rich biodiversity of the Caribbean coral reef.

The Smithsonian Tropical Research Institute in Panama bridges the Central American isthmus, allowing biological and geological comparison of two oceans. The institute is the nation's only long-term research location focusing on tropical biology and evolutionary change in response to fluctuations in sea level and the formation of land barriers.

The National Museum of Natural History in Washington, D.C., has the world's largest collection of marine plant and animal specimens and geological samples. The museum's staff of marine systematists analyze marine biodiversity and have documented major first discoveries and formal descriptions of several marine phyla, classes and orders.

Research by Smithsonian staff and their collaborators has resulted in some interesting observations. For example, recently, three species of snapping shrimps with a social structure—the first such finding in a marine crustacean—were discovered by researchers at the Carrie Bow Cay Marine Field Station. Behavioral observations confirmed that large male shrimp of these species care for broods and defend their sponge-dwelling colony against intruders, while a single queen reproduces. This provides an entirely new biological system in which to address the origin and maintenance of advanced cooperative animal societies, such as those of honeybees, ants and naked mole-rats.

Researchers in San Blas, Panama, have observed gamete release by green algae on coral reefs and documented synchronized early morning mass spawning of 18 species from five genera. These observations establish an unexpectedly prominent role for sexual reproduction in the ecology of green algae and raise new questions regarding the fertilization dynamics, hybridization potentials, population biology and life history of these important members of the coral reef community.

As we consider that the Marine Science Network is greater than the sum of its parts, an increased coordination of activities and resource allocation will further this notion. Some Smithsonian scholars feel that research is best advanced by curiosity and individually prioritized objectives. At the same time, large-scale environmental research often requires team approaches to gather big data sets over enormous regions to address problems in the coastal zone. The Marine Science Network supports both approaches.

—Dennis O'Connor, *Under Secretary for Science, Smithsonian Institution*



Jess Parker measures the girth of a tree in a forest study plot. (Photo by Richard Strauss)

ECOLOGY

A view from the top gives ecologist insight into what is happening below

By Elizabeth Tait
Smithsonian Office of Public Affairs

Geoffrey “Jess” Parker never outgrew climbing trees, he just got more sophisticated in his methods and more purposeful in his objectives. A forest ecologist at the Smithsonian Environmental Research Center in Edgewater, Md., he studies the nature and function of forests, from the top down, focusing on the treetop environment, the forest canopy.

Canopy revelations

“Once you’ve seen a forest from the canopy, where the leaves are, it changes how you think about the world,” Parker notes. “Most people see trees and think about wood; they think ‘slow, constant, inactive.’ In fact, forests are dynamic, 3-D and constantly changing.”

The key, Parker says, is understanding that our view of the forest captures a moment frozen in time. But time in a forest operates on a scale different from that to which we are accustomed. “The life span of a forest is equivalent to three or four human lifetimes,” he points out.

The canopy, according to Parker, is the “machinery of production” for the forest. “It tells the story of the current state of the forest and its capacity for growth,” he says. “The organization of the forest canopy has a big effect on everything the forest does.”

What a forest does—provides habitat for plants and animals, absorbs carbon dioxide from the atmosphere, and controls wind speed and water flow, for example—changes as a forest ages.

SERC’s forest canopy studies utilize 50 forest plots at or near the Edgewater site. The plots, with an average area of 65 by 164 feet, are comprised largely of upland, mixed hardwood forests that are characteristic of the mid-Atlantic region. These forests are indicative of rich soil and are typically very diverse in terms of tree sizes

and plant species, with the tulip poplar—growing to heights upwards of 130 feet—often the most dominant.

Measuring and analyzing

Numerous measurements are made by Parker at ground level in each plot—trees are counted, measured and identified, and their ages are determined by using a special trunk-coring device. The acidity of the soil is measured to determine if it is becoming more or less acidic over time.

‘Trees,’ continued on Page 5

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From de' Medici to Liberace: Celebrating 300 years of the piano and its music

By Angela Cervetti
Smithsonian Office of Public Affairs

The wooden crate stands alone in the middle of the room. A small group of people—among them National Museum of American History Curators Cynthia Adams Hoover, Patrick Rucker and Edwin Good—silently looks on. The item inside has come a long way, and they have waited three years for it.

During these years of waiting, the three curators, responsible for putting together the museum's exhibition "Piano 300," have spent a great deal of time negotiating, building relationships, seeking financial support, and planning and replanning—all to make this moment a reality.

Carefully, the group takes the contents out of the crate and assembles them. Under the glow of soft light stands a piano built in 1722 by Bartolomeo Cristofori, the inventor of the instrument.

"There wasn't a dry eye in the room," Rucker says. "Not only was this a very important

piece in the history of the piano, but it had taken so much to get it here. For me, it was an emotional moment."

Getting a real jewel

"Piano 300," an exhibition on view in the Smithsonian's International Gallery in Washington, D.C., until June 3, 2001, celebrates the 300th anniversary of the invention of the piano. The Cristofori masterpiece introduces visitors to a diverse and dazzling group of additional pianos and related objects that tell the social, cultural and technological story of the instrument.

"From the very beginning, we knew we wanted to include a Cristofori in the exhibition," Good says. "Beyond its historical significance, it was in itself an important object of curatorial study."

For the exhibition, Good focused on understanding the technology of the

piano. "The instruments themselves," he says, "are the real primary documents, the laboratories, in which we find the knowledge we need. To read [about the technology of] a piano is as laborious, as technically demanding and as exhilarating as it is to read a historical document, such as a letter or a diary or a manuscript by Homer or Mozart."

But getting an original Cristofori would be a challenge. "Only three exist, one in New York; one in Leipzig, Germany; and one in Rome," Hoover explains. "The one at the National Museum of Musical Instruments in Rome had been the least modified through the ages. So we decided to approach them."

Hoover and Good contacted Antonio Latanza, director of the museum, and requested to meet with him and to see the Cristofori. A trip to Italy also would mean that Hoover and Good could conduct research at the Archivio di Stato, the state's archives, in Florence. This location was significant because it was there that Cristofori, under the patronage of Ferdinando Maria de' Medici, maintained harpsichords for the court and experimented with his new creation.

For a long time, Hoover says, it was believed that the piano was invented in 1709. "But that was because Cristofori was interviewed by Scipione Maffei, a Venetian writer, in 1709, and the article was not published until 1711," she explains. "So the first time people widely heard about the piano was then, and they assumed it had just been invented at the time of the interview, in 1709, two years earlier."

The curators, however, knew Cristofori had invented the piano in 1700. "Several scholars had already done research on the origin of the piano and the work of Cristofori," Hoover adds. "Some felt that the piano was built earlier than 1700, but we and many others had not seen that evidence. To confirm the date, we needed to see the Medici inventory."

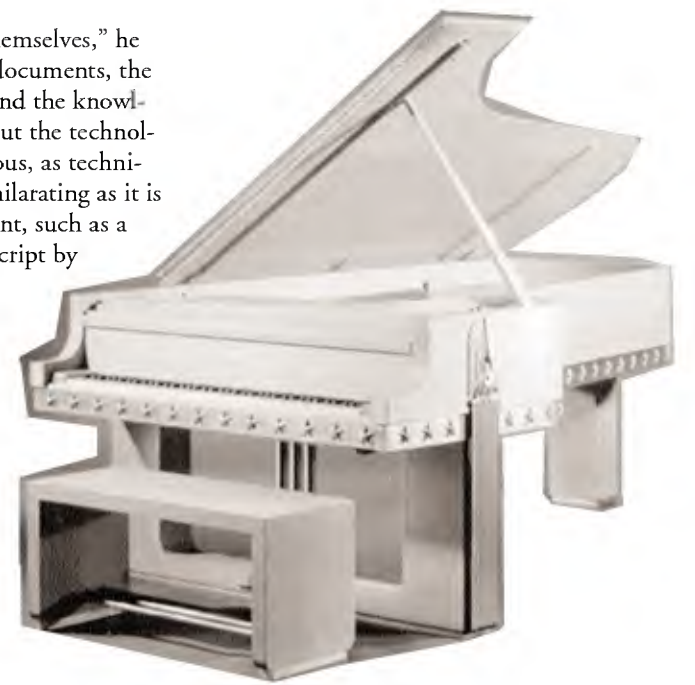
A trip to Italy

At the archives in Florence, Hoover and Good examined the important document. "It was a court inventory done in 1700. It included a description of 'a keyboard, of new invention with hammers, that plays soft (piano) and forte (loud)' and mentions Cristofori as its creator," Hoover says. "This could only be the piano."

The pianoforte, as it came to be known for its dynamic effects, was different from its predecessor, the harpsichord, in the internal action Cristofori designed for it. "The harpsichord plucks the strings," Good explains. "The pianoforte had little wooden hammers covered with soft leather that hit the strings. This allowed the player to have control over the volume of the sound by applying more or less force on the keys."

Negotiating for an original

With one mission accomplished, Hoover and Good headed to Rome's National Museum of Musical Instruments to meet



This Steinway & Sons piano, featured in the exhibition and part of the museum's permanent collection, was commissioned to represent American industrial progress in the American pavilion at the 1939 World's Fair in New York. (Robert Lautman photo)

with Latanza. "We talked to him about the show, and when we thought it was appropriate, we asked if they could loan the Cristofori to us," Hoover remembers. The answer: "A big 'no.' But he was very courteous and polite. We then knew we had to approach this in a different way."

In the meantime, Rucker, through his work with the Smithsonian Chamber Music Society, knew Italy's ambassador to the United States, H.E. Ferdinando Salteo, and the first secretary, Giuseppe Perrone, both of whom had been guests at Smithsonian concerts using Stradivarius instruments.

After repeated requests directed to the museum in Rome yielded nothing, the curators decided to approach the Italian Embassy in Washington, D.C. "Our collaboration [with the embassy] culminated in my visiting Rome in September 1999," Rucker says. "Once there, I met with Latanza and Marissa Zaccagnini, who had supervisory responsibilities over the National Museum of Musical Instruments. At this point, the exhibition was developed enough that I could share detailed plans of its design and explain the setting and interpretation planned for the Cristofori. Their response was largely positive."

Five months later, the Cristofori, accompanied by Zaccagnini, arrived at the Smithsonian's International Gallery, located inside the S. Dillon Ripley Center on the National Mall. "It was the culmination of a lot of effort and patience," Hoover says. "But it was well worth it."

Selecting other gems

Most of the pianos in the exhibition are part of the National Museum of American History's collection. "Choosing which pianos to present was a difficult process," Good says. "After taking into account all the factors—space, condition of the instrument, availability and, most importantly, which ones were crucial to tell our story—we narrowed the selection down to the 25 you see today."

'Pianos,' continued on Page 6



Museum staff and contractors unpack the long-awaited Cristofori. From left are Stacey Kluck, assistant chair of the National Museum of American History's Division of Cultural History; Edward Ryan, the museum's assistant registrar; Barbara Wolf, a contracted harpsichord and piano builder and former museum employee; Cynthia Adams Hoover; and Thomas Wolf, also a contracted harpsichord and piano builder and former museum employee. (Hugh Talman photo)

Lost Revolutions shows 1950s South as an era of conflict and turbulence

By Vicki Moeser
Smithsonian Office of Public Affairs

The years between World War II and 1964's Freedom Summer were not tranquil and placid in the South, says Pete Daniel, author of *Lost Revolutions: The South in the 1950s*, a new book published by the University of North Carolina Press. Instead, it was a time of displacement, conflict and creativity.

"I had finished a book in the mid-1980s on agriculture, followed by a survey book on the 20th-century South," says Daniel, a curator in the National Museum of American History's Division of the History of Technology, "and I was interested in looking into questions that came out of those books. I was intrigued with how the South had changed in the middle of the century. What happened between the 1940s, when many Southerners anticipated a tranquil and prosperous future, and the 1960s, a time of great social change?"

Subsequent research resulted in *Lost Revolutions*, which explores such subjects as the civil rights movement, segregation and school integration. The book also examines the breakdown of traditional agriculture and the ensuing rural-urban migration, gay and lesbian life, the emergence of rock 'n' roll and stock-car racing, and the triumph of working-class culture.

Daniel was able to begin his research in October 1994 as a result of a Smithsonian Regents Fellowship Award for independent study. The fellowship relieved him of his day-to-day curatorial duties in order to do research for this book.

In addition, the fellowship provided money for travel and other research expenses. Daniel, a native of Spring Hope, N.C. (population 1,000), visited libraries and archives in North Carolina, South Carolina, Georgia, Louisiana, Tennessee, Arkansas, Alabama, Mississippi and Wis-

consin. "I spent that year going on the road for a while, coming back and organizing my materials, writing some and then going back out on the road."

Digging for the truth

In remarks at a book-signing at a bookstore in Washington, D.C., Daniel told of meeting with a former professor in 1994 and telling him that what he was learning in his research was not what he recalled from growing up in the South in the '50s. "Nor did it support most of the scholarship that portrayed the 1950s as a calm, dull, apathetic decade that was simply a prelude to the glorious 1960s," he says.

Daniel says that, when he first started research for the book, "I had only a few pieces of a puzzle with no picture to guide me. The other pieces were hidden in libraries and archives. The picture would only emerge after I found and put together the pieces."

He built on research he had done as one of the curators of two museum exhibitions, "Science in American Life" and "Rock 'n' Soul: Social Crossroads," an exhibition that opened in Memphis in April.

In driving across the South, Daniel says he would arrive at a particular archives when it opened and leave when it closed. "Archivists and librarians were invariably helpful, many going beyond the call of duty. I accumulated enough of the puzzle pieces to start putting it together."

Indeed, Daniel inspected almost 70 manuscript and archival collections, ranging from the Agricultural Extension Papers at Louisiana State University in Baton Rouge to the "Beale Street Black and Blue" oral history transcripts at the Memphis Public Library.

"I did a lot of traditional research," Daniel says. "I'd get a hunch and follow

leads. When I was on the right track, I'd add another piece to the puzzle. In some cases, I found collections of papers that I had no idea existed that led me to new information."

Daniel's research in law libraries uncovered significant legal changes ushered in by the New Deal and the use of synthetic chemicals after World War II. He also interviewed many people who lived during that time. "That's how farmers, bureaucrats, fire ants, pesticide residues, stock-car drivers, rock 'n' roll artists, segregationists, integrationists, heroes and villains ended up in the book," he adds.

Three books in one

After completing the research, Daniel realized that the material was so comprehen-



Louise Smith, a race-car driver from Greenville, S.C., during the 1950s, was among the few women racing cars at that time, but she was one of the most well-known. (Photo courtesy of the International Speedway Corp./NASCAR)

sive that he would need to divide *Lost Revolutions* into three major sections. In Book I, "The Postwar Landscape," he writes that prosperity created a new sense of hope, at least for whites. Segregation, however, remained a dominant issue. "There were so many possibilities for change," Daniel says, "yet the old guard held on, creating a solid wall of opposition to integration that punished anyone who opposed them."

There was a lot of pressure from relatively few people to support segregation, Daniel says, and he investigates the question of why no group of whites formed an opposition party to the hard-liners.

Daniel expects some readers will take offense at the term "lowdown" in Book II, titled "Low Culture." But, he says, "working-class culture is not an adequate term for what I was discussing. I wanted to find a term that had not been used in this context. I wanted it to have an edge and to encompass both blacks and whites. Many of the people who appear in this section were wild, talented and fearless."

In those chapters, Daniel writes about such people as NASCAR founder Bill France; bootlegger and stock-car racer Junior Johnson; wrestler Sputnik Monroe; Sun Studio founder Sam Phillips; and a number of black and white performers, including Elvis Presley, Little Richard, Jerry Lee Lewis, Charlie Rich and B.B. King.

"These folks had national, indeed, international reputations," Daniel says, "and they changed the way culture was regarded throughout the world."

Book III, "Fatal Divisions," is about the South and civil rights in the post-Brown vs. the Board of Education era. During the summer of 1954, Daniel says, there was the opportunity for Southern leaders to

form a plan for integration of schools. "Instead," he says, "there was silence, until some political leaders decided to revert to antebellum political theories."

"The deeper question," he adds, "is why were racists and segregationists so intimidating to 'nice' people? The answer, I think, is that most people were reluctant to confront them. They feared retaliation. And no one came forward to lead."

Impact of the Great Migration

Central to all the sections of the book is the theme that a great exodus took place during this time. Half of the South's rural population—some 11 million sharecroppers, tenants and small farm owners—moved to towns and cities between 1940 and 1965. "The breakup of rural life had

profound implications," Daniel writes, "for Southern exiles transplanted rural culture wherever they settled."

A satisfying product

Lost Revolutions went through 10 drafts, at one point growing to more than 1,000 pages. "These things have to work themselves out," Daniel says. "I would write something, think about it, clarify it, then rewrite and write some more."

Ultimately, he says, "entire chapters disappeared, others were salvaged and what little I had written on politicians vanished. There was no use in discussing major events covered so well by other authors. It was not apparent until the ninth of 10 drafts that this was a three-dimensional puzzle, thus three books within the book."

Redefining the South

It has been typical of historical scholarship to see civil rights as separate from the rural transformation that sent millions of people into towns and cities across the country, Daniel says. But he included aspects of civil rights in the chapter on agriculture, and rural life in the civil-rights chapters.

"In the middle decades of the 20th century," Daniel writes in *Lost Revolutions*, "brave Southerners opposed repression and united in the fight for equal rights. At the same time, stock-car drivers and musicians embodied the hard gem of working-class spontaneity and genius. Before they were divided or tamed, these people redefined the South and established enduring cultural monuments."

Lost Revolutions: The South in the 1950s (\$45 cloth; \$19.95 paper) is available from the University of North Carolina Press by calling 1 (800) 848-6224.



Newspaper boys preparing to deliver an issue of *The Afro-American* with the lead story "Boycott Spreads" (Photo courtesy of South Caroliniana Library, University of South Carolina)

Mother has to wait nearly two years for the arrival of her 'bundle of joy'

By Jennifer Buff

Conservation and Research Center, National Zoo

Animal keepers, scientists and staff at the Smithsonian's National Zoological Park gathered with anticipation. Veterinary scientists Thomas Hildebrandt and Frank Goeritz of the Institute for Zoo Biology and Wildlife Research in Germany were performing an ultrasound-aided pregnancy check on Shanthi, the National Zoo's 24-year-old Asian elephant. And the results were all good news. The late May ultrasound showed that Shanthi was pregnant, following two artificial inseminations performed in February.

Shanthi's pregnancy follows several years of research on elephant reproductive biology, much of it conducted at the National Zoo's Conservation and Research Center in Front Royal, Va. Project leader and Reproductive Biologist Janine Brown and her staff have developed hormone assay techniques for monitoring reproductive cycles in elephants.

"The artificial insemination was successful," Brown says, "in part, because of the recent progress we have made in monitoring reproductive hormones. This information ensured that Hildebrandt and Goeritz could artificially inseminate Shanthi at the precise time of her ovulation."

In 1995, Shanthi was the first elephant ever inseminated by the German team. Despite the fact that she did not conceive, and three African elephants in other zoos did, Shanthi has remained one of their special favorites. So special that Hildebrandt and Goeritz have returned five times to Washington, D.C., for a total of six insemination attempts.

Impregnating Shanthi

The procedure is complex: A 6-foot-long endoscope-guided semen catheter, developed by Hildebrandt and Goeritz, is used in conjunction with transrectal ultrasound. The techniques allow the scientists to

deposit viable sperm deep within an elephant's reproductive tract, virtually guaranteeing sperm access to the ovulated egg.

Artificial insemination has been attempted in elephants without success for more than two decades. However, a unique international partnership, which combined this novel insemination technique with the advances in hormone-monitoring techniques, made the successful insemination possible.

This is Shanthi's second pregnancy. Her first calf, Kumari, born Dec. 16, 1993, was produced by natural mating. Sadly, Kumari died in 1995 from a mysterious infection that was later identified by National Zoo Pathologist Richard Montali and then pathology resident Laura Richman as an unknown herpes virus. Thanks to the identification of the virus, methods have been developed to diagnose and treat this deadly infection.

"Ever since Kumari died of the herpes virus, we have focused our research efforts



Shanthi, pictured here, was impregnated through artificial insemination and is expected to deliver her calf in mid-December 2001. (Photo by Jessie Cohen)



The image on the ultrasound monitor confirms Shanthi's pregnancy for Smithsonian staff and visiting researchers. (Photo by Jessie Cohen)

on improving artificial insemination techniques in elephants and in getting Shanthi pregnant again," Brown says. "This pregnancy is a dream come true."

Unlike her first conception, the new artificial insemination technique allowed Shanthi to remain in Washington, D.C., with the security of her elephant "family" and keepers. Viable semen, shipped by commercial airline from Canada, was collected from a 13-year-old bull elephant, who lives at African Lion Safari in Toronto.

Elephant reproduction

Shanthi's pregnancy becomes even more significant in light of recent findings from the National Zoo Conservation and Research Center's hormone laboratory, which has confirmed serious problems with elephant reproduction in zoos. Fewer than five elephant calves are being born in U.S. zoos each year. At this rate, in 15 years, there will not be enough calves born to ensure the continued existence of elephants in zoos in the United States.

Natural breeding of zoo elephants is exceedingly complicated. Bull elephants are too difficult to house at most zoos, so females must be transported to zoos with

bulls, a stressful and expensive undertaking. In addition, recent reproductive studies done at the Conservation and Research Center have shown that an increasing number of captive female elephants do not have normal reproductive cycles.

A normal female elephant has a 16-week reproductive cycle, making her fertile three times a year. New research shows that one in five zoo elephants have irregular cycles that prohibit ovulation and conception.

To prevent a population crash, the American Zoo and Aquarium Association Elephant Species Survival Plan has recommended breeding all reproductively healthy females, preferably before age 20. Both natural breeding and artificial insemination have been endorsed, and although artificial insemination is still considered experimental, its success to date suggests it could become an important tool for aiding the captive management of this species.

Awaiting the results

Shanthi's pregnancy will last 22 months, with her due date in mid-December 2001. The birth of her calf will point to the future success this technology may bring to captive management and preservation of elephants and other endangered species.

'Trees,' continued from Page 2

Fallen leaves are collected in buckets, sorted by species, dried and weighed. This is one way, Parker says, "we figure out which tree species are in each plot and how that mix is changing."

Getting to the top

The primary logistical hurdle for a scientist studying the forest canopy is to gain access to it. Parker and his colleagues climb ropes, ladders and scaffolding and use hoists and cranes—both hydraulic and tower—for direct access to the canopy.

One prominent landmark at the research center is a 164-foot-high walk-up tower that rises 33 feet above the canopy of trees surrounding it. At various levels and at the

top, it is equipped with instruments to measure light, wind speed, relative humidity, temperature and carbon-dioxide fluctuations in the atmosphere surrounding the forest canopy.

The 12-year-old program of forest monitoring is known as the Deciduous Canopy Observatory. "Much as conventional observatories use a variety of instruments to study stars," Parker points out, "we use many approaches to understand forest canopies." He has launched sensors mounted on balloons, as well as a camera equipped with a telephoto lens.

The internal organization of the canopy, the top-to-bottom 3-D arrangement of leaves, branches and trunks, is the best indicator of the forest's age, growth rate and habitability for animals. These evalua-

tions are best made from above, where a technique called remote sensing works best.

A bird's-eye view

Seeking a fast and accurate means to obtain a bird's-eye assessment of the forest's vertical structure, Parker is now using data from a remote-sensing tool developed by the National Aeronautics and Space Administration. It is called a Scanning Lidar Imager of Canopies by Echo Recovery, or SLICER. Lidar works like radar but uses pulsed laser light rather than radio waves. The SLICER instrument was flown on an airplane five miles above the research center forest plots.

Parker likens the ability of the SLICER to look inside forest canopies to that of a CAT scan examination of the human body,

a major advancement over former "skin deep" remote-sensing methods. Using SLICER, "the information on canopy structure can be used to show how a whole region may be performing," Parker says.

Parker has applied for a grant from the National Science Foundation to continue working on a portable version he calls SPLICER, which can be carried on a researcher's back.

SERC is coordinating its Deciduous Canopy Observatory research with similar programs elsewhere in the United States and around the world. This collaboration promotes greater understanding of forest dynamics on a global basis and allows for comparisons between forests.

Patricia Acton contributed to this article.

Determining which pianos would be in the exhibition did not automatically mean that the ones selected were ready to be exhibited. One of the pianos that needed restoration was the art deco grand piano designed by Walter Teague and made by Steinway & Sons. The piano was commissioned to represent American industrial progress in the American pavilion at the 1939 World's Fair in New York.

"Unfortunately, the limited budget with which we operated did not allow for the type of restoration the piano needed," Hoover says. "If it hadn't been for the generosity and expertise of many people at Steinway & Sons, the restoration would not have happened."

The firm also helped in the restoration of a piano owned by Duke Ellington, one of the few pianos in the exhibition that does not belong to the Smithsonian. The curators found the white grand in New York City at the Cathedral Church of St. John the Divine. Ellington had it in his

New York apartment and used it to compose his special "sacred" concerts. The cathedral agreed to loan it to the Smithsonian. "Ellington is an important part of the story we wanted to tell," Hoover adds.

The exhibition also presents a piano owned by Irving Berlin and other pianos typical at the time of Mozart, Beethoven and Liszt. Liberace's piano also is there, on loan from the Baldwin Co. The makers used 125 pounds of rhinestones to create its dazzling casing. In addition, there are original manuscripts of such masters as Mozart, Chopin and Gershwin, and tools, photographs, playbills and sheet music.

A link to old and new

"In a sense, I have been preparing for this exhibition my whole Smithsonian career, a career that began in 1961," Hoover says. "Through the years, I have studied keyboard collections here and at other museums to learn about their technical characteristics, to admire their beauty as musical instruments and their place in decorative arts, and to discern their cultural history.

"The piano," she continues, "may take different shapes, be made of new materials, but it will continue to link us with past repertoires and to inspire new types of music. It seems most likely that the piano will be with us for years to come."

Related programs

Special events related to the exhibition take place weekly. A popular series has been the performance tours in which museum staff and professional pianists give tours of the exhibition and perform classical, jazz, gospel and traditional music. Performance tours take place in the gallery at noon, every Thursday and Saturday.

The exhibition was organized by the National Museum of American History and sponsored by the National Association of Music Merchants-International Music Products Association, with additional support from the Piano Manufacturers Association International, the Music Educators National Conference, the Irving Caesar Lifetime Trust, Alitalia Airlines and U.S. Airways.



In the early 19th century, Europeans preferred vertical pianos in the home, such as this Giraffe piano, made between 1809 and 1811. (Photo by Hugh Talman)



Because of the sizes of the orangutans, Rob Shumaker conducts his research from the other side of a cage divide. A narrow opening in the divide allows him to pass objects and rewards to the orangutans. (Photo by Jessie Cohen)

comprehension when more objects are added," he explains.

Both animals have now progressed from using symbols to identify objects to using symbols to identify actions and using Arabic numerals to identify quantities. So far, Azy has been able to correctly point to the numbers one and two when shown the corresponding number of objects.

A matter of choice

As a biologist with a special interest in perception and cognition, Shumaker was interested in studying the animals' abilities to communicate using abstract symbols. He chose orangs for this work "because they were clearly the least studied and understood of the great apes in terms of their mental abilities," he explains. "I had also been working with these individual animals, Azy and his little sister, Indah,

since I started working at the National Zoo in 1984."

"Chimpanzee and bonobo cognition, including their capacity for language-like behavior, is relatively well-studied, but less is known about gorillas and orangutans," Beck says.

Shumaker's colleague, Smithsonian post-doctoral fellow Mindy Babitz, focuses on the orangutans' tool use, while Karyl Swartz, a professor of psychology at Lehman College in New York City who spent a year on sabbatical at the National Zoo, returns every couple of weeks to conduct research on the animals' memory.

All the projects may be regularly observed by the public in "Think Tank." The various projects provide a rare opportunity to watch a real scientific observation as it takes place.

Of all the species of apes, which include gorillas, orangutans, chimpanzees and bonobos, "the orangutan is the farthest

from us in terms of the social system and behavior," Shumaker says.

Living exclusively in the forests of Borneo and Sumatra, orangutans are a critically endangered species and will likely be extinct in the wild by the year 2020, scientists predict, as a result of deforestation, poaching and hunting. With an average life span of between 30 and 60 years, they are solitary animals, forsaking hierarchical groups or families.

Surviving on a diet of fruit, adult males spend their time alone, except when they are briefly in the company of a single female for the purpose of mating. Females can be found alone or together, with their most recent offspring. By contrast, chimpanzees live in male-dominated societies, and gorillas in families consisting of a dominant male and a handful of females.

As Azy sits, his hands under his chin, scrutinizing the audience of adults and children that have assembled beyond his cage to watch the day's session, it is easy to recognize that this huge, hairy ape has behavior patterns that are characteristic of

humans. It is these patterns that interest Shumaker and drive him to discover more about Azy and his little sister's communications abilities.

Junior's great escape

National Zoological Park primate keeper Doug Donald reports that the 34-year-old orangutan Atjeh, also known as Junior, is "back to normal" following a short jaunt through the National Zoo on Aug. 29. The 250-pound male orangutan had never, before the day of his brief escape, ventured out on the system of steel cables and 45-foot towers known as the "orang transit system" that links the National Zoo's Great Ape House to the "Think Tank" exhibition.

Atjeh, who was named by former Smithsonian Secretary S. Dillon Ripley and is the father of the National Zoo orangs Indah, Iris, Kiko and Azy, was somewhat lethargic and likely nursing sore muscles and joints following his physical exertion on the cables and immobilization by veterinarians with a dart gun, who returned him to the Great Ape House, keepers say.

Smaller orangs have routinely demonstrated their arboreal locomotion skills without incident on the orang transit system, but this very hairy and very long-armed older male was able to overcome the barriers and climb to the ground from one of the towers.

Once on the ground, Junior was extremely docile. He visited a flower bed, then traveled about 100 yards to the National Zoo police station, where he tried, without success, to open the locked door.

"Our animal escape procedure worked as planned, and Junior was brought home safely," Curator Lisa Stevens says. No one was injured during the escape.



Orangutans are shown here using the "orang transit system." (Jessie Cohen photo)

Research Highlights

Largest donation ever. Kenneth Behring, a California philanthropist, developer and former owner of the Seattle Seahawks, has increased his support of the Smithsonian to \$100 million by making an \$80 million donation to the National Museum of American History. It is the largest single gift ever to the Institution. In 1997, Behring gave \$20 million to the National Museum of Natural History. The latest contribution will allow the Smithsonian to begin a complete transformation and modernization of the National Museum of American History. Initial plans, according to Museum Director Spencer Crew, call for the creation of thematic exhibition halls highlighting the history and contributions of the American people in preserving and protecting freedom and democracy. In recognition of the gift, the



Kenneth Behring holds the sword of Civil War Gen. Ulysses S. Grant from the National Museum of American History's collections. (Photo by Hugh Talman)

building that houses the National Museum of American History will be inscribed with the designation "Behring Center" beneath the museum's name.

New moon discovered. Using data taken by the University of Arizona's Spacewatch program, a team from the Minor Planet Center at the Smithsonian Astrophysical Observatory in Cambridge, Mass., determined that Jupiter has 17 satellites, one more than previously thought. After poring over data with a new software program, the Smithsonian team first thought the object might be a comet. However, upon further examination, the researchers noted that its trajectory put it right around our solar system's biggest planet. This is the first Jovian moon discovered since 1979, when the Voyager spacecraft orbited Jupiter and spied three new satellites.

Carbon dioxide and animal behavior. Mary Beth Voltura, a Smithsonian fellow, hopes to utilize the resources and staff of a couple of Smithsonian research centers to find out if elevated levels of carbon dioxide in the atmosphere impair reproduction

of certain animals through induced protein deficiency. Working closely with Olav Oftedal, a nutritionist at the National Zoological Park, and Bert Drake, a plant physiologist at the Smithsonian Environmental Research Center, Voltura is investigating how the foraging behavior and reproductive performance of the common vole, *Microtus pennsylvanicus*, can serve as an early indicator of nutrient shortages for animals that graze on plants.

Domestication of goats. Smithsonian scientist Melinda Zeder has devised a method for detecting animal domestication. Working with museum skeletal collections of modern wild goats, she has developed a way to distinguish the selective slaughter of managed domestic herd animals from prey animals killed by hunters. She detected this domestic profile in the goat remains from two archaeological sites in modern-day Iran. Using a new technique for precisely dating small fragments of bone (atomic mass spectrometry radiocarbon dating), Zeder determined that goat domestication first took place 10,000 years ago in the highlands of Iran and then expanded some 500 to 1,000 years later to arid lowland regions well outside the natural homeland of wild goats. The research resolves a long-standing controversy over the environmental and social context of initial domestication and highlights the importance that museum collections play in ongoing scientific exploration. These findings were published in the March 2000 issue of *Science* magazine in an article co-authored with former Smithsonian Fellow Brian Hesse.

Prehistoric dwelling found. A prehistoric dwelling at the edge of the Great Sand Dunes National Monument in Colorado was found in mid-August by Pegi Jodry, an archaeologist at the National Museum of Natural History, and her research team. It is the first Archaic-age dwelling found in sand dunes in Colorado. The house floor and charcoaled hearth of a primitive dwelling, dug in a hillside near Indian Spring on the Nature Conservancy's Medano-Zapata Ranch, was inhabited some 4,000 to 6,000 years ago, Jodry says. The research team recovered a probable basket-making tool made on a deer metapodial, a small stone pendant, grinding stones and a stone tool.

Astronomical research priorities. The National Research Council of the National Academies in Washington, D.C., has cited four proposed initiatives based, or originating, at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., as priorities in astronomical research for the new millennium. Among the proposed projects selected by a national panel of astronomers are Constellation-X, a linked array of several orbiting X-ray telescopes, which would be the successor to the Chandra X-ray Observatory; the Very Energetic Radiation Imaging Telescope Array System, or VERITAS, a ground-based array of seven 10-meter-diameter telescopes designed to study the very-high-energy gamma rays that permeate space; the Energetic X-ray Imaging Survey Telescope, known as

EXIST, an X-ray telescope operated from the international Space Station; and the South Pole Submillimeter Telescope, a complement to existing Smithsonian facilities in Hawaii and Antarctica devoted to submillimeter astronomy.

Series Publications

The following publications on research in various fields were issued during the period May 1 through July 31, 2000, by Smithsonian Institution Press in the regular Smithsonian series. Diane Tyler is managing editor. Requests for series publications should be addressed to Smithsonian Institution Press, Series Division, 470 L'Enfant Plaza, Suite 7100, Washington, D.C. 20560-0950.

Smithsonian Contributions to Paleobiology

- 91 Myodocopid Ostracoda from the Late Permian of Greece and a Basic Classification for Paleozoic and Mesozoic Myodocopida, by Louis S. Kornicker and I.G. Sohn, 33 pages, 22 figures, 1 table.

Smithsonian Contributions to Zoology

- 607 Zoogeography and Systematics of the Lanternfishes of the Genus *Nannobranchium* (Myctophidae: Lampanyctini), by Bernard J. Zahuranec, 69 pages, 25 figures, 34 tables.

Books & Recordings

Witness in Our Time: Working Lives of Documentary Photographers

by Ken Light (Smithsonian Institution Press, 2000, \$45 cloth; \$17.95 paper). This book traces the recent history of social documentary photography through 22 of the genre's best photographers, editors and curators.

Deep Ocean, by Tony Rice (Smithsonian Institution Press, 2000, \$14.95). This lively, informative book tells how oceanography developed as a science and summarizes what is known about the organisms that live in the deep ocean.

Lichens, by William Purvis (Smithsonian Institution Press, 2000, \$14.95). In this generously illustrated book, the author, a lichenologist, contends that understanding and maintaining lichen biodiversity may lead to the discovery of new medicines and increasingly precise monitoring of the environment's health.

Snakes, by Petter Stafford (Smithsonian Institution Press, 2000, \$14.95). The author charts the biology and natural history of these creatures, highlighting the variety and complexity of a group that includes almost 300 living species.

Asteroids: A History, by Curtis Peebles (Smithsonian Institution Press, 2000, \$29.95). The author covers asteroid investigation, showing how ideas about the orbiting boulders have evolved and discussing the ebb and flow of scientific debate.

Bananas: An American History, by Virginia Scott Jenkins (Smithsonian Institution Press, 2000, \$16.95). Covering every



Front cover of *The Food Value of the Banana*, which was published in 1928 by the Food Co. of Boston (Courtesy of Ann Lovell's Banana Museum)

aspect of the banana in American culture, the book provides an insightful look at a fruit with appeal.

China Pilot: Flying for Chennault During the Cold War, by Felix Smith (Smithsonian Institution Press, 2000, \$17.95). Smith shares a fascinating view of the events that shaped modern Asia as he saw them while flying throughout the region for Civil Air Transport in the tumultuous years following World War II.

Angels Zero: P-47 Close Air Support in Europe, by Robert V. Brulle (Smithsonian Institution Press, 2000, \$29.95). Combining anecdotes from his diary, research in U.S. and German records, and interviews with participants from both sides, the author links his daily experiences as a fighter pilot with events in wider Europe.

Beyond the Moon: A Golden Age of Planetary Exploration, 1971-1978, by Robert S. Kraemer (Smithsonian Institution Press, 2000, \$34.95). Providing an insider's view of what has been called a golden era in space pioneering, the author describes the financial, political and technical hurdles facing each space mission during this time.

The Museum in Transition, by Hilde S. Hein (Smithsonian Institution Press, 2000, \$40 cloth; \$17.95 paper). Suggesting that the current emphasis on experience and multiple perspectives may be replacing an old monolithic value with a new one, Hein urges museums to amplify and sharpen their distinctions from one another.

America's Public Holidays, 1865-1920, by Ellen M. Litwicky (Smithsonian Institution Press, 2000, \$39.95). The author argues that the invention of more than 25 holidays between the close of the Civil War and the end of World War I provided various

'Books,' continued on Page 8

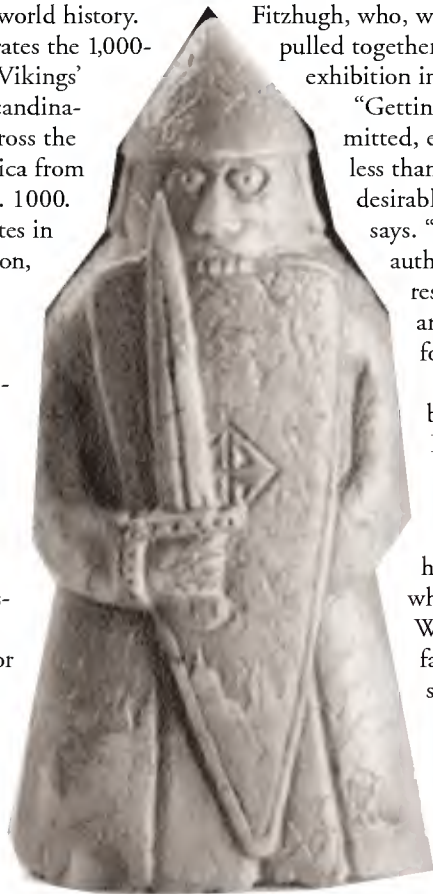
Vikings: The North Atlantic Saga

Edited by William W. Fitzhugh and Elisabeth I. Ward (Published by Smithsonian Institution Press, 2000, \$60 cloth; \$34.95 paper)

The Vikings, not Columbus, reached America first, according to a newly released Smithsonian Institution Press book titled *Vikings: The North Atlantic Saga*. The book not only corrects misconceptions, it uses the history of the Vikings as a framework for a range of events in world history.

The book commemorates the 1,000-year anniversary of the Vikings' expansion from their Scandinavian homelands west across the Atlantic to North America from about A.D. 800 to A.D. 1000. The expansion culminates in the voyage of Leif Eriksson, who brought his ship to shore in what is today northeastern Canada, becoming the first European to set foot in the New World, around the year 1000.

Vikings was edited by William Fitzhugh, a curator in the National Museum of Natural History's Anthropology Department and director of the museum's Arctic Studies Center, and Elisabeth Ward, a museum specialist in the department and assistant curator for the Vikings project. It was published to accompany a traveling exhibition of the same name, which closed at the museum Aug. 13.



In 1831, a spectacular cache of 93 chessmen carved from walrus ivory, such as this one, was found on the Isle of Lewis in the Outer Hebrides. These islands were connected to a trade network controlled from Norway.

The book, divided into more than 30 chapters, is replete with color photographs, drawings and maps of Viking sites, artifacts and landscapes. It first leads readers through Scandinavian culture, art, religion and daily life and then into Europe. It traces the expansion of farmers and explorers throughout the North Atlantic and into the New World.

Vikings also reveals that contacts with Native American groups were far more extensive than has previously been believed and that the outnumbered Norsemen never established more than temporary settlements in North America.

"Topics were determined by need—to cover the subject fully—and by expertise, because there was a body of scholarly information already available," says Fitzhugh, who, with the help of Ward, pulled together both the book and the exhibition in 18 months.

"Getting 38 manuscripts submitted, edited and illustrated in less than a year is not a typical or desirable publication plan," he says. "Fortunately, many of the authors had already done research on these topics and could write quickly for us."

By putting together the book and the exhibition, Fitzhugh wanted to dispel stereotypes of Vikings as raiding and pillaging people in horned helmets. "The Vikings who came to the New World were explorers, farmers, fishermen and settlers, home folks interested in their families and ancestral deeds," he says.

The book's goal, Fitzhugh adds, was not to provide a primary source but to gather primary sources into a single, readable and highly illustrated volume that could be produced at a modest

cost. "We wanted to reach as many people as possible with the new and unfamiliar information that it was the Vikings, not Columbus, who reached America first."

The Vikings exhibition, which opens Oct. 20 at the American Museum of Natural History in New York City, was produced as part of a large international exhibition on Vikings. It was organized by the National Museum of Natural History and received primary funding from the Nordic

Council of Ministers and Volvo. The show also will travel to Los Angeles; Houston; Denver; and Ottawa, Canada. It is presented in partnership with the White House Millennium Council.

—Jo Ann Webb

This fall, Donor Level and above Contributing Members will receive the book *Vikings: The North Atlantic Saga* as a benefit of membership.

'Books,' continued from Page 7

American groups with the opportunity to recast the story of the United States with themselves in the pivotal roles.

The Flowering of Man: A Tzotzil Botany of Zinacantán, by Dennis E. Breedlove and Robert M. Laughlin (Smithsonian Institution Press, 2000, \$24.95). Considered to be one of the most comprehensive studies of Mesoamerican ethnobotany, the book looks at this Mayan culture and its intensive use of the botanical landscape.

Rain Forest Exchanges: Industry and Community on an Amazonian Frontier, by William H. Fisher (Smithsonian Institution Press, 2000, \$45 cloth; \$19.95 paper). Drawing on both historical sources and indigenous informants, Fisher argues that decisions to cooperate with frontier industries are best understood by taking into account the power of native social systems to shape the acquisition of trade goods.

The Politics of Ritual in an Aboriginal Settlement: Kinship, Gender and the Currency of Knowledge, by Françoise Dussart (Smithsonian Institution Press, 2000, \$45). The author looks at how female ritual leaders transcend the rigid physical divisions that separate them from their male counterparts and how they function simultaneously in various roles within their culture.

The Best of Broadside: 1962-1988 (Smithsonian Folkways Recordings, 2000, \$69.95 CD). This collector's set contains

more than five hours of music first published in the historic Broadside magazine, which promoted social change and made available the underground music that fueled the innocent-sounding folk revival and the explosions of angry rock and rap.

Lord Invader: Calypso in New York (Smithsonian Folkways Recordings, 2000, \$15 CD). This compact disc features 26 songs, 13 of which have never before been released, by the composer of the song "Rum and Coca-Cola," which popularized calypso in the United States.

Calypso Awakening (Smithsonian Folkways Recordings, 2000, \$15 CD). A flourishing of calypso creativity, a dramatic period in Trinidad's history and an audio engineer named Emory Cook inspired these tracks, originally released on Cook Records between 1956 and 1962.

Books published by Smithsonian Institution Press can be ordered from P.O. Box 960, Herndon, Va. 20172-0960. To order by phone or for more information, call 1 (800) 782-4612. There is a \$3.50 postage and handling fee for the first book ordered and \$1 for each additional book.

Smithsonian Folkways Recordings can be ordered by writing to Smithsonian Folkways Mail Order, 955 L'Enfant Plaza, Suite 7300, Washington, D.C. 20560-0953. To order by phone or for more information, call (202) 287-7297 or 1 (800) 410-9815. There is a \$5.50 fee for shipping and handling of the first 15 recordings ordered; call for other shipping prices.

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