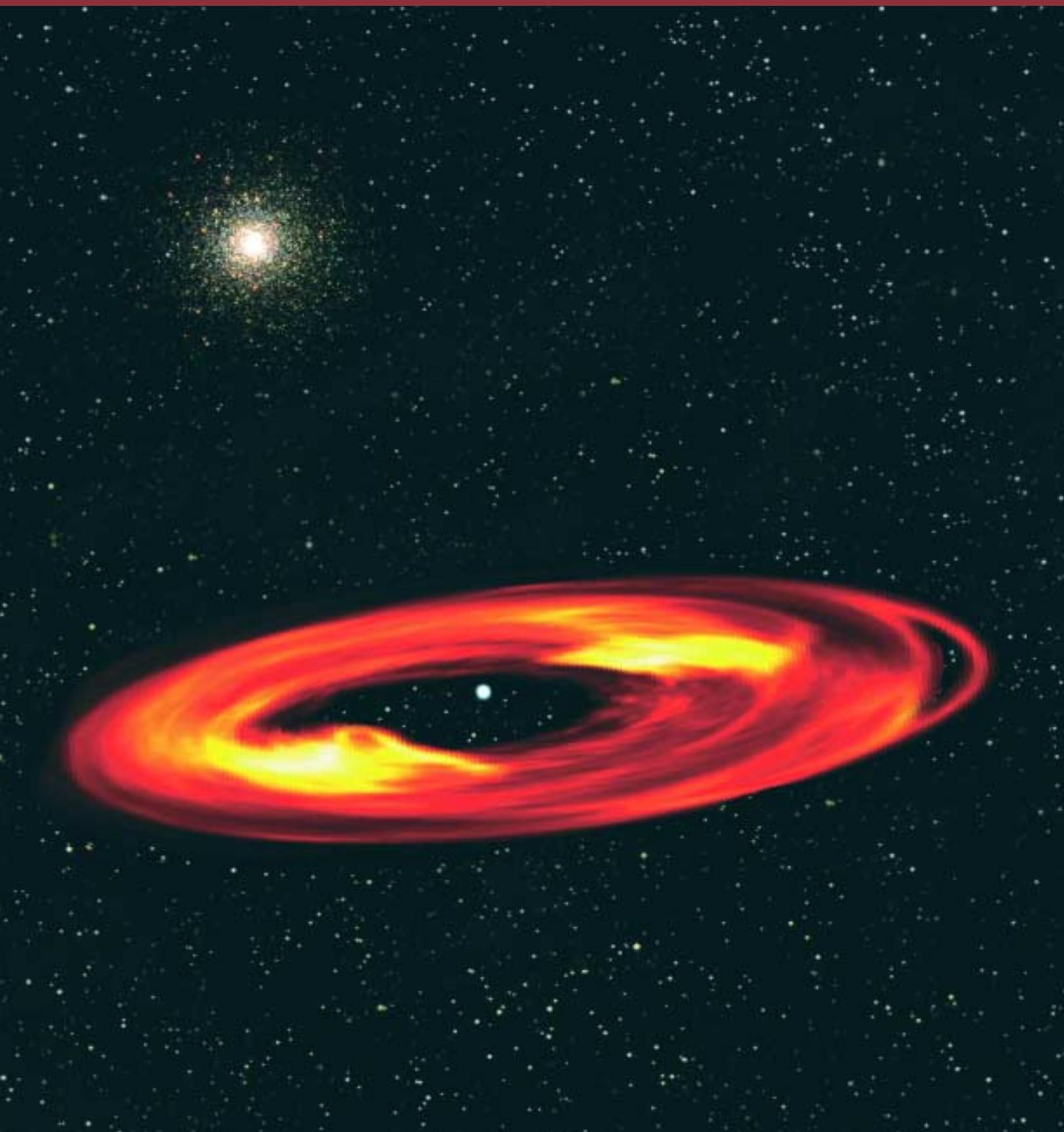


Since its founding, the Smithsonian Institution has pursued
the quest for understanding through scientific endeavors that have
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Searching for New Understanding Research Programs

Since the dawn of time, we have sought to understand our place in the cosmos. The quest for new understanding can take many forms—from scientific examination of our world and worlds beyond our own fragile planet to the collection of artifacts that can help us interpret human events.

Since its founding, the Smithsonian Institution has pursued the quest for understanding through scientific endeavors that have made it one of the world's foremost research institutions. Smithsonian research, which underpins the Institution's collections, exhibitions, and education programs, is increasingly being disseminated to wider audiences through the Affiliations Program, traveling exhibitions, and the World Wide Web.

This section describes the results of some Smithsonian research activities in fiscal year 2002 that have yielded new knowledge about coffee production, endangered giant pandas, and the spread of West Nile virus; contributed to planning for the Mars orbiter mission; and led to the discovery of dinosaur remains in Montana and unseen planets in the constellation Lyra.

Planets in the Dust

Using an innovative technique, astronomers at the Smithsonian Astrophysical Observatory reported that observations of features in the dust swirling around the nearby star Vega may be the signatures of an unseen planet. David Wilner, Matt Holman, Paul Ho, and Marc Kuchner formed the team that made this discovery.

Vega, located 25 light-years away in the constellation Lyra, is the brightest star in the summer sky. Observations of Vega with the Infrared Astronomical Satellite in 1983 provided the first evidence for large dusty particles around another star, probably debris related to the formation of planets. In our solar system, dust particles created by asteroid collisions and the evaporation of comets spiral in toward the sun. The gravity of the planets affects the distribution of these dust particles. With their large surface area, these dust clouds are much

easier to detect than the planets themselves. It is akin to seeing the wake of a boat from an airplane when the boat itself is too small to be visible.

This discovery was made possible by using a telescope array that had high sensitivity in the shorter wavelengths of the electromagnetic spectrum approaching the submillimeter range. SAO's new Submillimeter Array on Mauna Kea in Hawaii is scheduled for completion in 2003. This innovative telescope array, which will provide an even more detailed look at Vega and other star systems where new planets are forming, helps scientists better understand how our own solar system formed 4.5 billion years ago.

Studying the Giant Panda

Research based at the National Zoo is yielding new knowledge about giant pandas. One year after Tian Tian and Mei

Research by scientists from the Smithsonian Astrophysical Observatory suggests the presence of an unseen planet near Vega, the brightest star in the summer sky.



National Zoo biologist William McShea's discovery of Eld's deer in the wild was significant news about this endangered species.

Continuing research on the giant panda focuses on the Zoo's popular panda pair Tian Tian and Mei Xiang.

Xiang greeted the public in January 2001, the Zoo held a free, two-day public symposium, "Giant Pandas at the National Zoo: From the First Year into the Future." At the symposium, scientists from the Zoo and other organizations at the forefront of wildlife conservation explored national and international policies that may affect the species; the Zoo's contribution to understanding panda reproduction, nutrition, and behavior; and how the Zoo, through financial support and professional training programs, is helping wild panda populations. These initiatives are a collaborative effort of the Zoo, scientists in the giant panda's native China, and other colleagues from around the world.

Two research-based education programs, both funded by Fujifilm, were developed for launch in fall 2002. A distance-learning video program—a cooperative venture of the Zoo, Friends of the National Zoo, and the public schools of

Fairfax County, Virginia—features Zoo research that illustrates the components of the scientific method. The program has the potential to reach 13 million students nationwide. Highlighting Zoo research, an online curriculum for schools and families focuses on temperate forest habitats in central China and the eastern United States. Fujifilm also supports the Zoo's giant panda Web site, which provides up-to-the-minute research news at natzoo.si.edu.

Better Coffee Harvests with Bees

Coffee harvests improve dramatically when plants are grown under shade trees near tropical forests where natural insect pollinators are plentiful. Entomologist David Roubik of the Smithsonian Tropical Research Institute reports that coffee plants pollinated by bees yield over 50 percent more beans than plants that are protected from insects. His findings, reported in the June 13, 2002, issue of



Nature, could affect approaches to coffee production at a time when some coffee yields are declining.

The coffee plant produces flowers capable of pollinating themselves, so insect pollinators were thought to be unnecessary. But Roubik found that yields increased when natural insect pollinators “helped” the plants pollinate by dusting the female parts with pollen from the male parts. He concluded that shade-grown coffee trees near natural forests will produce more beans than coffee grown on homogeneous plantations in regions where there are few pollinating insects.

Roubik, the “bee man” featured in a *National Geographic Explorer* documentary, has studied aggressive Africanized bees since 1976 as they moved northward from Brazil, where they were accidentally introduced. His latest research shows an intriguing example of the influence of science on the marketplace.

Montana Dinosaur Discoveries

During summer 2002, a team of dinosaur experts from the National Museum of Natural History excavated recently discovered fossil dinosaur specimens in the Hell Creek Badlands of Montana. One specimen, the partial skeleton of a *Tyrannosaurus rex*, will provide important clues to the legendary dinosaur’s way of life. Now on long-term loan to the museum, the skeleton is nicknamed “N. rex” in honor of its discoverer, Nathan Myhrvold, former chief technology officer of Microsoft and sponsor of the digs.

Armchair paleontologists tracking the field team’s daily progress in an online journal at www.nmnh.si.edu/paleo/summer2002_fieldjournal_calendar.html found that torrential rain, hail, high winds, and extreme temperature fluctuations challenged the annual summer expedition. By late August, the team had prepared plaster jackets for the specimens so that they could

An international meeting at the Smithsonian Tropical Research Institute highlighted the resurgence of research on the *Heliconius* butterfly.

Below, right, archaeologist Laurie Burgess uses a zoom microscope to analyze 19th-century glass trade beads from the National Museum of Natural History Sullivan's Island Bead Collection, which may hold clues to interactions between European Americans and Native Americans.

Anthropologist Rick Potts, leader of a National Museum of Natural History Human Origins team, excavates a 6 million-year-old elephant tooth from a paleontological site in western Kenya. At this and neighboring sites, the team investigates early human activity and environmental change.

be safely airlifted by helicopter from the remote site to a base camp.

The expedition was a collaborative effort with the Museum of the Rockies, through Jack Horner, that museum's curator of paleontology and recently appointed senior scholar in paleobiology at the National Museum of Natural History.

One of the world's leading centers for paleontological research, the museum's Paleobiology Department has also received support from the Smithsonian Women's Committee to restore a deteriorating Stegosaurus skeleton that has been on exhibition since 1917.

Marine Biodiversity and Ecology

Several research programs at the Smithsonian Marine Station at Fort Pierce, in Florida, focus on the biodiversity and ecosystem health of the Indian River

Lagoon, which occupies more than 30 percent of Florida's east coast and is one of the most biologically diverse estuarine systems in the continental United States.

During 2002, a resident research biologist was hired to establish a monitoring program of the Indian River Lagoon with an emphasis on studying biological response to natural and human-induced environmental change. The Indian River Lagoon Species Inventory Web site (www.sms.si.edu/IRLSpec), a major educational and public outreach venture, was expanded to list more than 3,000 species, along with many photographs and scientific references. Other new features enhance the inventory's educational and administrative value, including an interactive glossary, improved indexing and searching capabilities, and links to other relevant Web sites.



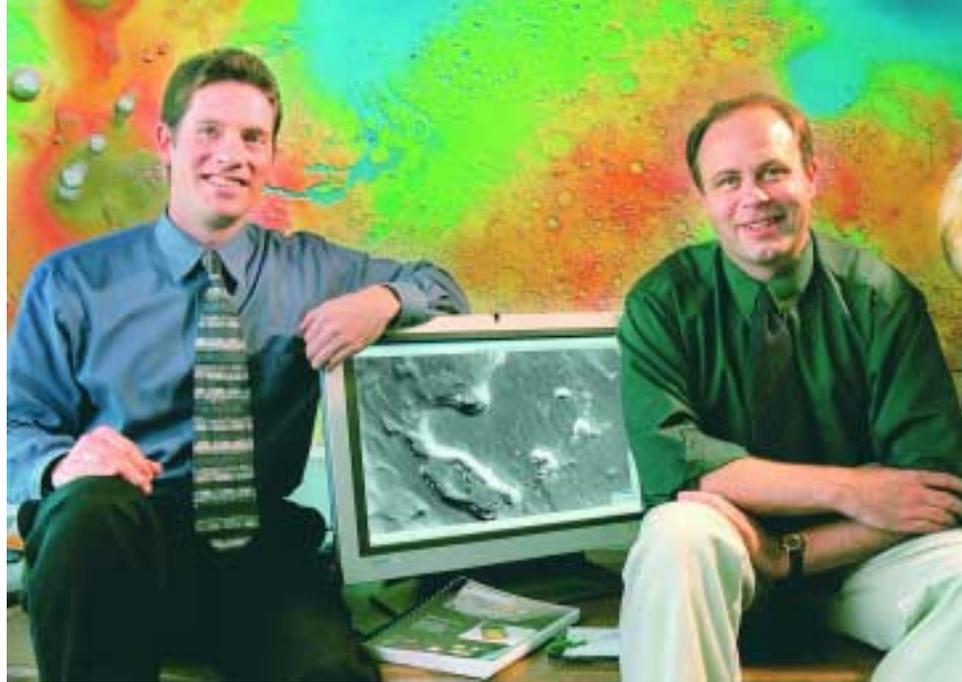
Migratory Birds and West Nile Virus

The alarming spread of West Nile virus since 1999 is a major concern for public health and wildlife officials. Scientists at the Smithsonian Environmental Research Center are responding to the need for immediate information about the potentially fatal virus. With funding from the Centers for Disease Control, animal ecologist Peter P. Marra and his avian ecology laboratory at SERC have begun an important collaboration with the New York State Department of Health–Wadsworth Laboratory to monitor the transmission of West Nile virus through migratory songbirds. This avian ecology research explores how birds' behavior and habitat interact to influence and regulate their population dynamics.

West Nile virus is passed through the bite of infected mosquito species that feed on both birds and mammals. First thought to be limited to crows, the virus is now known to infect as many as 120 bird species, as well as people, horses, and free-living mammals, such as raccoons and Eastern chipmunks. The migratory patterns of songbirds make them excellent candidates for transmitting the virus. Many of the songbirds that breed in the northeastern United States during the spring and summer migrate to spend the winter in warmer regions, such as Mexico and the Caribbean, where there are year-round mosquito populations.

Mars Reconnaissance Orbiter Research

Two scientists from the National Air and Space Museum's Center for Earth and Planetary Studies have been selected for the international team that is planning the scientific investigations to be conducted on



the Mars Reconnaissance Orbiter Mission in 2005.

As a coinvestigator for the HiRISE (High-Resolution Imaging Science Experiment), John Grant is studying the evolution of the Martian landscape to determine the role of surface water, the safety of potential landing sites, and the presence of active dunes and other geological features. After the mission reaches Mars in 2006, museum visitors will be able to see near real-time images from HiRISE projected on flat screens in the Exploring the Planets gallery. Grant also serves on the

Top, Bruce Campbell and John Grant of the National Air and Space Museum are members of the international team planning scientific investigations for the 2005 Mars Reconnaissance Orbiter Mission.

High school students conducted watershed studies with Smithsonian Environmental Research Center scientists during the National Youth Watershed Summit.



Artifacts collected by the National Museum of American History document the complex and emotional stories of September 11 and its aftermath. Shown here are pieces of the World Trade Center structure and the door of a fire truck crushed in the buildings' collapse; a squeegee handle used by Jan Demczur to escape with five others from an elevator; an apron from Nino's Restaurant near ground zero with rescue workers' patches; and the helmet worn by Joseph W. Pfeifer, the first fire chief to arrive at the World Trade Center on September 11.



science team for the 2003 Mars Exploration Rovers and chairs its Science Operations Working Group.

Bruce Campbell is part of the U.S. team affiliated with the Italian Space Agency's SHARAD (Shallow Subsurface Sounding Radar) project. He is working on design aspects of the instrument, which uses radio waves to penetrate the upper kilometer of the Martian crust. Data from SHARAD will provide detailed profiles of the subsurface, which are important to future missions that will drill beneath the surface seeking evidence of ancient life and climate.

The 2005 mission is just one facet of Mars-related research and activities at CEPS, where scientists conduct original research and outreach on planetary science, terrestrial geophysics, and the remote sensing of environmental change.

Bearing Witness to History

The day after the terrorist attacks of September 11, 2001, curators at the National Museum of American History confronted a most challenging collecting decision. How should the museum document these unprecedented events and their aftermath? What kinds of artifacts should be collected and how? How should the collection honor the victims and survivors, their families, and rescue workers?

A public law signed by President Bush gave the Smithsonian the authority to collect September 11 artifacts. In intensive discussions over the following weeks, a staff committee shaped collecting guidelines. They decided to gather material from all three sites—the World Trade Center, the Pentagon, and the Shanksville, Pennsylvania,

crash site—and determined that it was important to document the rescue and recovery efforts, as well as the attacks.

In addition to acquiring significant objects, such as building fragments and airplane parts, curators faced a more difficult and emotional challenge in deciding how to represent the victims who died and those who survived. The collection began to grow, as curators visited the sites, talked with survivors and rescue personnel, and researched media accounts. About 50 objects were on view in the museum's exhibition *September 11: Bearing Witness to History*, which opened on the first anniversary of the attacks. A multilayered Web site, americanhistory.si.edu/september11, presents still more.

The September 11 collection is a work in progress for the museum. As the full impact and meaning of the attacks unfold, these objects will document and preserve the complex and emotional stories of that tragic day in American history.

New Preservation Challenges

Security responses to the terrorist attacks and anthrax-contaminated mailings of 2001 have consequences for the preservation of our cultural heritage. Experts from the Smithsonian Center for Materials Research and Education consulted with the



Researchers studying Frida Kahlo can consult the Florence Arquin papers in the Archives of American Art, which document Arquin's friendship with the artist. The Archives has the largest collection of documents on the history of the visual arts in the United States.





An unsigned drawing by Michelangelo was discovered this year in the collections of the Cooper-Hewitt, National Design Museum by Sir Timothy Clifford, director of the National Galleries of Scotland, during a research visit to the museum.



staff of the Hart Senate Office Building and the Environmental Protection Agency on the potential damage that the proposed anthrax decontamination process might cause to sensitive artistic and historic objects in that building and what measures could be taken to protect them. This question led to a new SCMRE research project that will evaluate the dangers that several proposed decontamination agents might pose to objects in museum collections.

Because sensitive scientific specimens and archival records often are sent by mail, the sterilization of mail by electron beam irradiation also affects the museum com-

munity. SCMRE scientists measured the degradation of various irradiated materials, summarized on the laboratory's Web site the possible effects of irradiation on collection materials, and answered many inquiries on the subject.

In New York City, art objects in public and private collections that were contaminated with dust from the collapsed World Trade Center posed a health and safety concern for workers involved in their cleanup. SCMRE provided technical information on those dangers and the necessary protection measures.

Johanvi Desai, a volunteer in the Smithsonian Institution Libraries book conservation laboratory, uses her knowledge of chemistry to assess the condition of a book in the collection.

Opposite: David Holbert uses sophisticated scanning equipment to digitize rare and out-of-print books from the Smithsonian Institution Libraries for inclusion in the online library *Galaxy of Knowledge*.