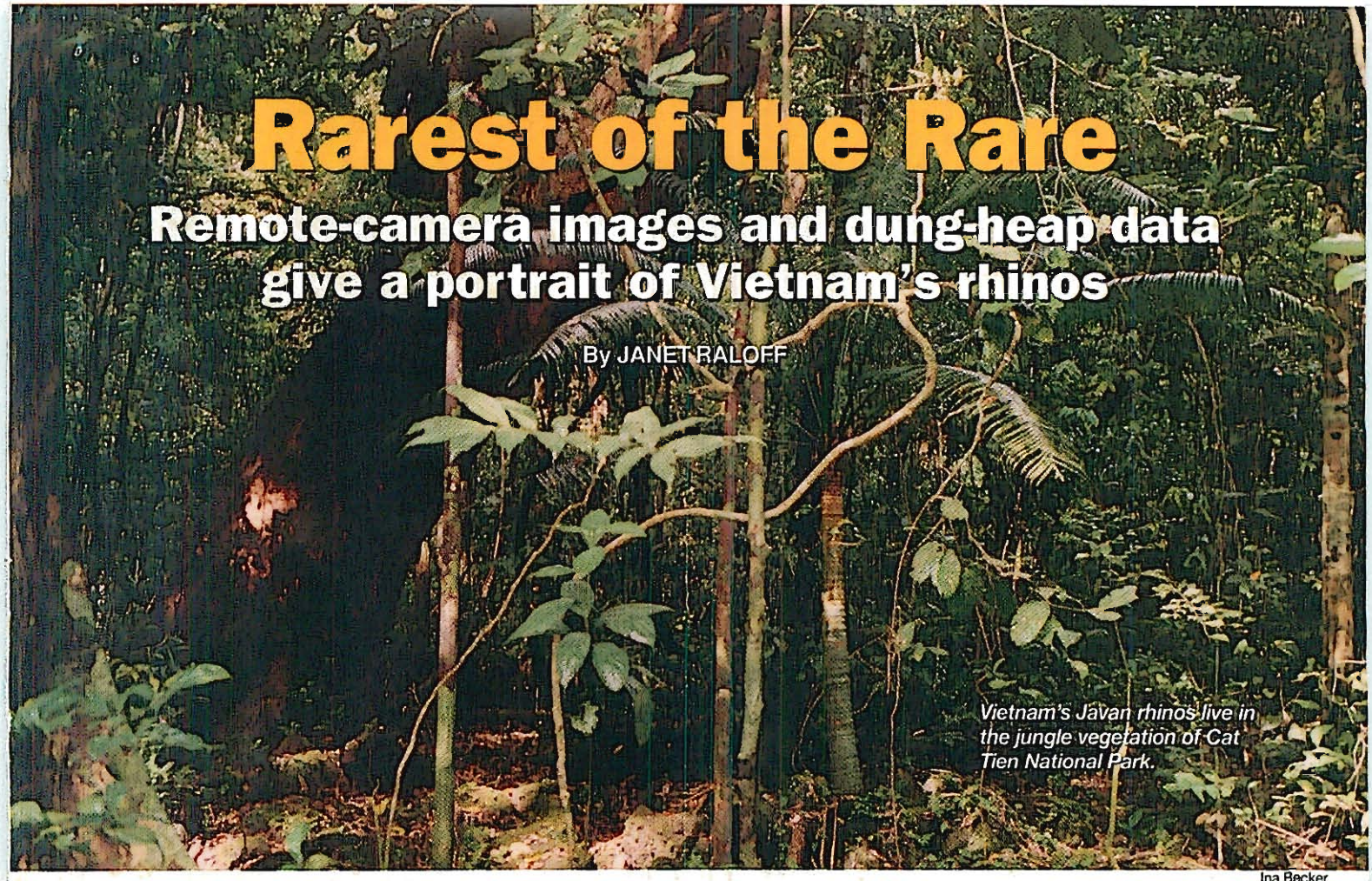
Rarest of the Rare

Remote-camera images and dung-heap data give a portrait of Vietnam's rhinos

By JANET RALOFF



Vietnam's Javan rhinos live in the jungle vegetation of Cat Tien National Park.

Ina Becker

Dense stands of bamboo commingle with spiny rattan and an occasional small tree to form a low, prickly jungle. This is an area almost devoid of trails, much less anything so accommodating as a road.

In the dry season, the land is parched. During the other 9 months of the year, the heavens dump rain continually, creating swamps in the lowlands and steamy, slick hillsides elsewhere. And oh, those hills—not high so much as endlessly undulating. Traversing them puts a constant strain on leg muscles.

Mosquitoes ply their blood-sucking trade, in the process often infecting trekkers with the infectious agents responsible for dengue fever, malaria, or Japanese encephalitis. Huge leeches stealthily attach themselves to passersby, hoping to crawl up to a warm meal on someone's leg or perhaps neck. At bedtime, as rare travelers string their hammocks in this jungle, a snarl might pierce the dark, signaling that a tiger is on the prowl.

Surveying this area on foot is not most people's idea of a walk in the park. Yet that's exactly what conservation biologists and park guards sign up for when they come to Cat Loc, a portion of Cat Tien National Park in southern Vietnam.

Those who patrol this formidable terrain are protecting what is arguably the most endangered mammal on earth. In this 6,200-hectare portion of the park resides the last surviving remnant of Javan rhinos outside Indonesia.

Following the Vietnam War, scientists assumed that this subspecies was extinct—until the carcass of a poached animal turned up in a local market stall in 1989. Since then, scientists have been trying to protect Vietnam's elusive pocket of survivors.

WWF/Cat Tien Natl. Park Conserv. Proj.

On patrol: Forest guards climb a hill covered with bamboo stands and jungle vegetation in Vietnam's protected rhino area.

There aren't many Javan rhinos in the park, and in fact, none of the intrepid conservationists has ever seen one here in the flesh. Last year, an indirect census based on hoofprints pegged Vietnam's population at only five to eight rhinos. Still, that may constitute almost 15 percent of the species' global population—and a sizable share of its biodiversity.

Several conservation groups and government agencies, including the U.S. Fish and Wildlife Service, argue that there's an urgent need to safeguard this rhino from further threats. All acknowledge that the effort will be an uphill battle. At a minimum, government officials and biologists must weigh some politically charged tradeoffs if they hope to spare this creature from extinction.

The Javan, or lesser one-horned, rhino (*Rhinoceros sondaicus*) once thundered throughout Vietnam, Laos, Cambodia, Thailand, Burma, and Indonesia. Primarily a lowland dweller, populations even extended into India. In the mid-19th century, "this rhino could be found 20 kilometers from where Calcutta is now," notes Java-based conservation biologist Nico van Strien of the International Rhino Foundation (IRF), with headquarters in Cumberland, Ohio. He and other biologists were invited by the Vietnamese government to develop a rhino-conservation plan.

Today, all rhinos are endangered owing to centuries of hunting—both to fill trophy cases and to supply folk medicine's demand for rhino horns, which traditional Oriental healers still prescribe as an aphrodisiac (SN: 11/17/79, p. 346). In the most dire condition are the Javans, barely holding on with some 60 animals, and the Sumatran rhino (*Dicerorhinus sumatrensis*), with perhaps 300 individuals, all in Indonesia.

Poaching of both rhinos is now largely under control, so human encroachment and poor habitat are emerging as lead-

ing constraints on each species' recovery. Nowhere is this more evident than in Vietnam.

At about the same time the Vietnamese government made Cat Loc a rhino refuge in 1992, it designated this and the surrounding forested region a "new economic zone." In essence, the authorities invited citizens, especially ethnic minorities from crowded regions in northern Vietnam, to farm the area. People responded in droves, notes IRF program director Tom Foose.

Some immigrants took up rice farming; many others cut down forest to establish cashew plantations. Though illegal, rattan harvesting in the park also developed into a thriving trade.

Villagers' migration and activities have reduced the rhino's habitat to about 15 percent of its area in 1990, Foose reports. Some 16,000 people now live right outside Cat Loc's forest—which, he notes, is the only area of Vietnam where rhinos remain. Another 200 people have actually moved inside the park's rhino territory, reports Gert Polet of the World Wildlife Fund–Vietnam, speaking by phone from Cat Tien, 150 kilometers north of Ho Chi Minh City.

These local farmers tend to be very proud of the rhinos, says Polet, who heads the Cat Tien Conservation Project. Unfortunately, he adds, "the farmers are also very poor, and their making a living these days involves cutting down forest."

What remains of the forest is no picnic for the animals, he adds. Javan rhinos prefer to eat shrubs, small trees, and the occasional mouthful of grass. Defoliants sprayed by U.S. planes during the Vietnam War, however, largely eradicated what had been the rhino's dietary staples. The bamboo and rattan, which quickly filled in the forest, remain.

On the basis of hoofprint measurements, Vietnam's rhinos are only about two-thirds as big as members of their species in Java's Ujung Kulon National Park. While this difference might be genetic, Polet notes that the diminutive stature of Vietnam's rhinos may also reflect their poor diet.

Mike Baltzer/WWF

Infrared-triggered cameras recently provided a few images of live Javan rhinos in Vietnam.

Though Polet would love the opportunity to measure a Vietnamese rhino, he'd settle for just laying eyes on one. To date, he and others working at Cat Loc have had to content themselves with poring over low-contrast, mostly nighttime flash photos of the animals captured by cameras set up last May.

Polet's team identified 10 places in the park where rhinos were likely to wander, based on habitat and dung sightings. On strategically placed trees at each site, they mounted cameras and infrared sensors that trigger the shutters.

Every 2 weeks, park guards laboriously trek to each camera to exchange film. The first rolls from four of the cameras yielded a total of seven portraits—the first-ever photos of live Vietnamese rhinos. In the intervening months, however, none of the cameras has caught another rhino on film. It almost appears, Polet says, as if the cagey critters are out to sabotage the system. Where hoofprints appear, they're now behind the trees bearing cameras. Several infrared sensors have also been roughed up and shoved out of alignment, presumably by the rhinos.

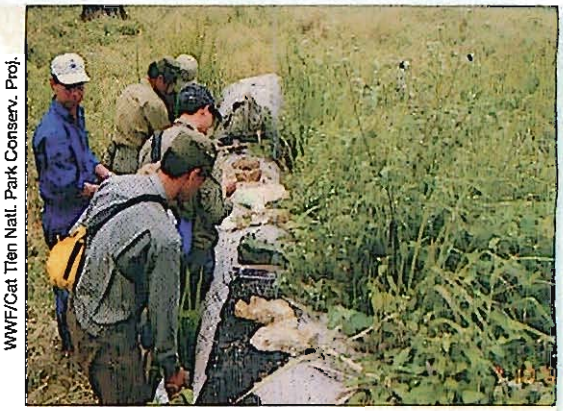
Polet's hope is that photos from cameras placed in varying locations eventually will provide a noninvasive means of surveying the population over time, offering not only portraits of individuals, but also information on size, gender, and reproduction.

In the next few months, dung should also emerge as a rich source of information on these elusive populations, according to Don J. Melnick of Columbia University in New York City.

For the past several years, Melnick has been fingerprinting DNA from the dung of rhinos and other endangered species. Not only do these data identify an animal's gender, but they also permit analyses of the degree to which individuals' genetic blueprints diverge.

Conservation biologists have begun using such analyses to help them manage disappearing pockets of various endangered animals. Under a U.S. Fish & Wildlife Service grant, researchers in Melnick's lab are working out methods to analyze dung from Javan rhinos. They are working with dung from Indonesia and have arranged for specimens to be sent from Vietnam within the next few months.

"There are two measures of a population," Melnick explains. A census tallies how many individuals



WWF/Cat Tien Natl. Park Conserv. Proj.

Forest guards place plaster casts of rhino hoofprints on a fallen tree.

exist. As important to species conservators managing recovery of populations is the effective population size—how many animals have relatively dissimilar sets of genes. If the same individual fathered many of the animals in a group, the effective population size would be significantly smaller than the census indicates.

Melnick notes that conservators often are tempted to move animals between groups to maximize their reproduction. If almost all of the seven or so Vietnamese rhinos prove to be male, for instance, biologists might consider airlifting in a few females from Java's Ujung Kulon reserve.

Yet, important adaptations to endemic diseases or other aspects of each population's local environments may underlie any genetic distinctions between the two populations—already considered separate subspecies *of R. sondaicus*. Introducing genes from one group to the other might therefore render future generations of this beleaguered species even less fit, Melnick worries.

His data already show that geographic distances between populations offer a poor gauge of genetic divergence. Black rhinos in Kenya and South Africa possess roughly the same genes, he found, indicating there would be no genetic problems in moving animals between the populations to enhance breeding.

DNA analyses of Sumatran rhinos on two Indonesian islands, however, suggest that their populations diverged some half million years ago (SN: 2/8/97, p. 92). As a result, Melnick says, "we argued very strongly that these animals not be translocated."

If the Javan rhino populations in Indonesia and Vietnam also exhibit unique genetic adaptations to their local environments, Melnick told SCIENCE NEWS, "only in the most dire circumstances would you consider interbreeding them."

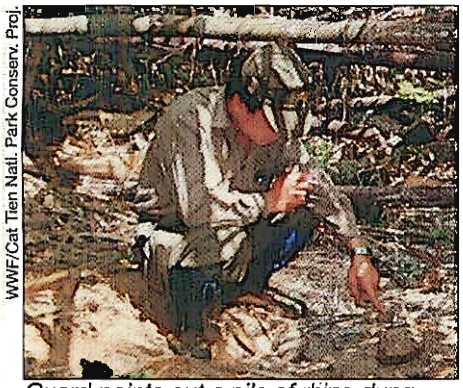
Experience with Indonesia's Javan rhinos suggests that protecting this species in Vietnam won't prove easy.

A few decades back, Java's Ujung Kulon contained far more than the 50 or so animals it has now, observes van Strien. Yet despite "no [human] encroachment, and no confirmed poaching here for years," the

rhino population refuses to climb, he says. This suggests, he worries, that the area can no longer support a larger population, or in other words, "the carrying capacity for Ujung Kulon may be going down."

One concern, he notes, is that the reserve's protected trees have grown too tall for rhinos to nibble on and too dense to support shrubs that might serve as an alternate source of nutrition. For rhino managers, notes van Strien, this sets up a conflict.

"Some argue that as a national park, you shouldn't interfere but let the natural course of events proceed," he explains. "Others counter that Ujung Kulon is specifically meant for rhinos, so we should manipulate it," such as by regularly burning forest to create the clearings needed for new trees and shrubs.



WWF/Cat Tien Natl. Park Conserv. Proj.

Guard points out a pile of rhino dung.

An alternative approach would be to establish one or more new populations away from the reserve. "I would personally prefer . . . captive breeding of some animals," he says. Once researchers stabilize such captive groups, they could move some animals to safe habitats, he says—probably on Indonesia's island of Sumatra.

The idea is neither simple nor sure to succeed. Rhinos have remained elusive even in Ujung Kulon, so finding any to capture wouldn't be easy. If the animals prove vulnerable to stress, forced exile might compromise their health. Finally, as experience with Sumatran rhinos shows, some species simply fail to reproduce in captivity.

Indeed, these concerns fuel a reluctance on the part of Vietnam's rhino conservators to advocate moving its population out of Cat Loc and into potentially better habitat elsewhere in the park. So, a basic dilemma results: "Either the rhinos have to go somewhere else or the people must leave," van Strien told SCIENCE NEWS by phone from Ujung Kulon.

In a new report prepared for the Vietnam government and slated to be published soon by the Centre of Environmental Sciences at Leiden University in the Netherlands, Polet concedes there are no easy or inexpensive solutions. He favors relocating the people and leaving the rhinos be.

New settlers "should be moved out of the park as a matter of urgency," he says, and the government should ban farming immediately outside this area to create a "buffer zone" around the rhinos' domain.

Philip Wells, an Indonesia-based law-enforcement consultant with IRF, was recently invited to Cat Tien to evaluate its species-protection efforts and to train guards. Having spoken with local immigrant villagers, Wells notes that most seem sympathetic to the rhino's plight "and don't seem that unhappy about leaving—provided they got adequate compensation." Indeed, he notes, money seems available for this.

Recognizing the importance of building support in local communities for Vietnam's rhino, the U.S. government has just funded a new program to produce fact sheets for local adults and posters and storybooks for village children. It also will fund town meetings and government seminars to stress everyone's need to cooperate in this animal's protection.

At the beginning of this century, the Indian rhino had been hunted down to an estimated 20 animals. Today, Foose notes, "there are close to 2,000." Africa's southern white rhino, also down to perhaps 20 or 40 animals at the turn of the century, has bounced back even more spectacularly—to at least 8,500 animals.

These successes fuel Foose's hope that even Vietnam's tiny population may recover. Admittedly, he says, "it will take a bit of luck—and strict protection."

With the Javan rhino being confined to Cat Tien and Ujung Kulon, "we've got all our eggs in two very fragile baskets," says veterinarian Steve Osofsky, senior program officer for species conservation with the World Wildlife Fund in Washington, D.C. "Though it's not much solace," he says, "it's also not hopeless." □

© Alain Compost/ Bogor, Java, Indonesia

Javan rhino photographed in an Indonesian wallow.

On the Origin of Circuits

In software and silicon, machines guided by Darwinism seize the reins of design

By PETER WEISS

Imagine this: A wee spacecraft no bigger than a can of soda zips out to an asteroid. There, it grabs on like a leech, sucks minerals out of the surface, and fashions them into parts and supplies it needs to make itself into something bigger and better, with more ambitious travel plans.

By the time the renovated craft blasts off again, it will have morphed into NASA's first interstellar explorer, on its way to seek clues of life on planets circling alien suns.

It's still only a science fiction scenario, but NASA Administrator Daniel S. Goldin predicts that something like this might transpire in only 30 years.

If he's right, the building of future space vehicles will involve a radical departure from tradition. Instead of engineers painstakingly crafting every detail of their systems, they will depend increasingly on machines that design and build themselves.

This trend has already begun, and in its first successes, NASA officials find encouragement that the approach will eventually lead to far more reliable, versatile, and long-lived spacecraft than those being built today.

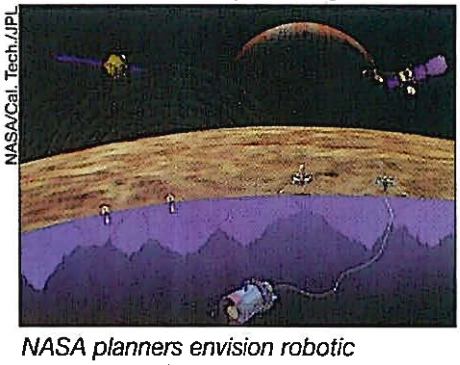
"These evolvable space systems would revolutionize NASA's space exploration," says Moustafa Chahine, chief scientist for NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif.

Initially, NASA scientists and engineers are investigating how machines might revamp their own electronics. In doing so, they join a growing research area that has been dubbed evolvable hardware.

Specialists in the fledgling field investigate techniques for machine-executed design both in software and integrated circuits. The techniques rely on guided trial-and-error strategies inspired by Charles Darwin's theory of evolution by natural selection and known as evolutionary algorithms or artificial evolution (SN: 7/23/94, p. 63).

Although still largely in a research realm, evolvable hardware has started to appear in prototypes of practical devices ranging from cell phones and printers to robots, prosthetic limbs, and even an artificial brain (SN: 7/22/95, p. 62).

Last July, about 100 scientists and engineers from more than 70 universities, companies, and government labs worldwide met in Pasadena, Calif., to discuss the latest in both research and practical developments. Although the field has spurred workshops and conferences since 1995, the 3-day meeting—the First NASA/Defense Department Workshop on Evolvable Hardware—was the first in the United States.



NASA/Cal. Tech./JPL

NASA planners envision robotic outposts, such as this proposed cluster of instruments on a moon of Jupiter, that will independently repair themselves and adapt to changing conditions.

Computers might already rival people as circuit designers. John R. Koza of Stanford University, who has pioneered ways of making computer programs evolve, predicts that his group or another will be filing patents "in the next year or two" on circuit designs created by their machines.

Like idiots savants, Koza's computers work their wizardry without any expert knowledge of circuits. The resulting designs, however, are at least as good as those that top-notch human designers were coming up with pre-1950, Koza suggests. Some of the designs would "squarely infringe" on patents issued to outstanding circuits of that era, he says.

He strutted out a parade of such designs at the meeting, describing how he and his colleagues simply specified a set of commands that told the computer how to place and wire circuit parts. Then, they let artificial evolution take over.

Evolutionary, or genetic, algorithms perform a fast shuffle of pieces of computer programs or digital codes, which the developers think of as genes. A complete set of genes—that is, either the commands making up an entire program or a sequence of digital codes containing all the instructions to build a particular circuit—make up one individual. To start the evolutionary process, a computer randomly jumbles large numbers of genes to create hundreds or thousands of such individuals.

The algorithm then tests these individuals by trying out the circuits they represent, either via simulation or by wiring the devices. It finds out how well, if at all, each circuit performs a desired function. From the tests, individuals earn fitness scores that help determine whether they will be permitted to breed. If so, they swap some of their genes with those of other high performers to create individuals with new combinations of commands or codes. The rest of the individuals die, erased from memory.

As the breeders mate with many partners to rebuild the population, the algorithm occasionally alters, or mutates, an offspring by changing a command or a bit. This adds another element of chance. Ideally, after hundreds or thousands of generations of breeding, testing, and culling, an exceptionally fit individual emerges and the design is done.

Three years ago, Adrian Thompson of the University of Sussex in Brighton, England, created a sensation when he made an actual circuit go through the evolutionary process. It wasn't that the final circuit—a device that could be used to discriminate between frequencies of 1 kilohertz (kHz) and 10 kHz—was so special. Rather, his experiment demonstrated that with artificial-evolution algorithms, a machine could alter itself on the fly.

Thompson performed his feat on a type of commercially available integrated circuit that had been around for 10 years. Called field programmable gate arrays, such microchips contain a grid of minuscule tiles filled with identical collections of components. In response to a string of digital codes, each tile's components can alter the functions that they perform and the routing of signals among the tiles can change.

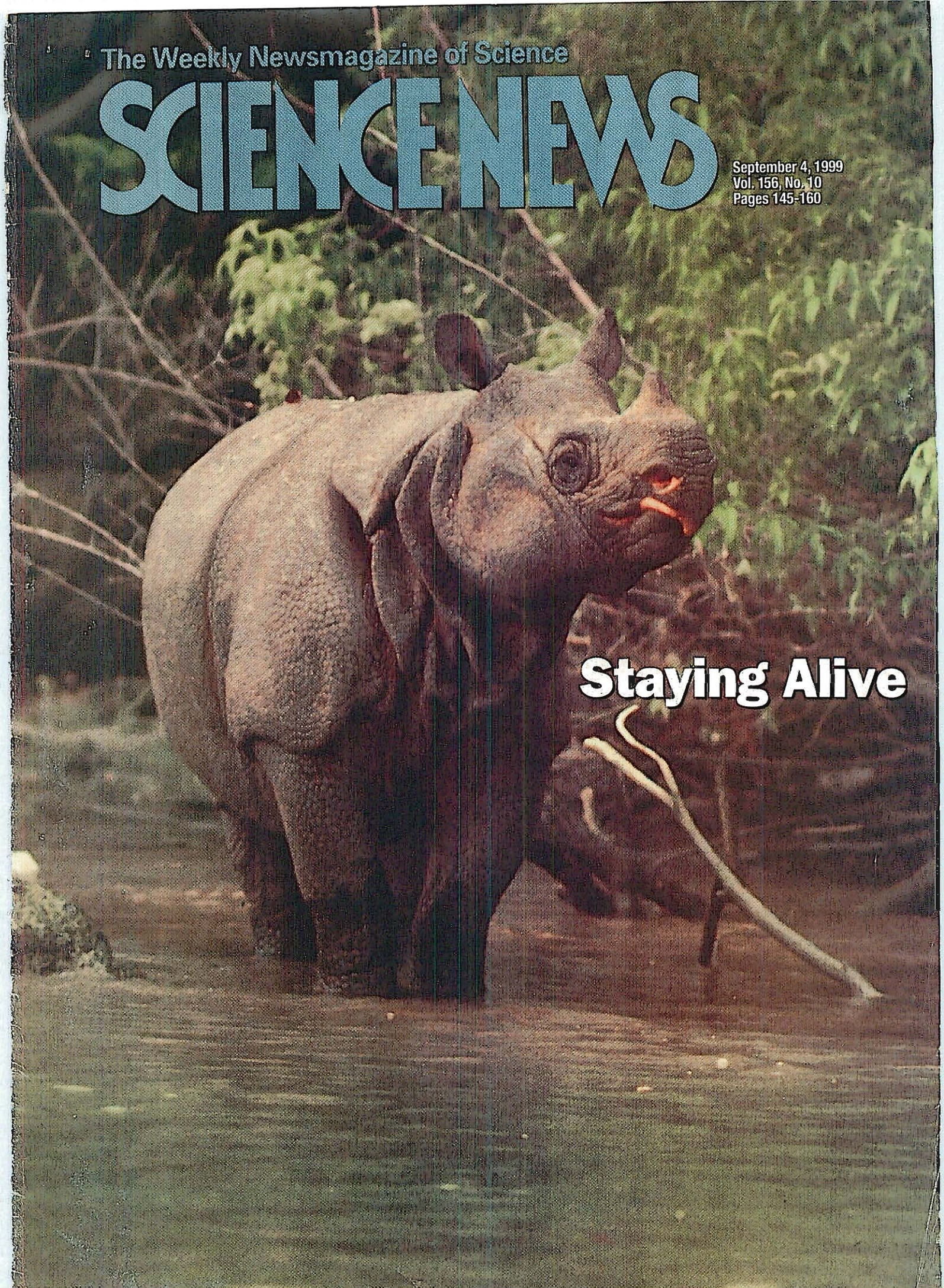
One can think of the grid as a miniature New York City. All the streets and buildings are in place. In response to new codes, each establishment changes its type of business. A small army of traffic cops barricades certain streets but opens others, rerouting traffic in a way that can be changed again later.

Such reconfigurable circuits lend them-

The Weekly Newsmagazine of Science

SCIENCE NEWS

September 4, 1999
Vol. 156, No. 10
Pages 145-160



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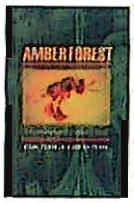
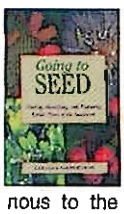


The Amber Forest: A Reconstruction of a Vanished World—George Poinar and Roberta Poinar. The algarrobo tree, a canopy tree prevalent in ancient tropical forests, leached a sticky resin that often captured critters and flora in its flow. Once this resin hardened into translucent amber, it perfectly preserved its captors. Highly regarded for their work with such amber-preserved fossils, the Poinars sketch an ecosystem likely to have existed on the island of Hispaniola between 15 million and 45 million years ago. On the basis of their research and some spectacular specimens, they portray an amazing view of this largely extinct kingdom. Princeton U Pr, 1999, 239 p., color plates/b&w photos/illus., hardcover, $29.95.

Faster: The Acceleration of Just About Everything—James Gleick. Even linguists must maintain a furious pace in order to keep up with the vernacular that people use in their ever-faster lives. Terminology such as *multitasking, channel surfing, real-time, gridlock,* and *instant gratification* signify the impetus to move faster and do more. Gleick (author of *Genius,* the lauded biography of Richard Feynman) assesses the momentum of this trend. He considers whether people drive the technology or the technology drives people in this quest for speed. In doing so, he considers a host of people, places, and things dominated by the clock, including the U.S. government's time keeper, the door-close button in elevators, and fast food. Pantheon, 1999, 324 p., hardcover, $24.00.

The Fuzzy Future: From Society and Science to Heaven in a Chip—Bart Kosko. For decades, the binary, on-off, black-white world of the computer chip dominated technology. Whether or not consumers know it, the gray applications of artificial intelligence are beginning to permeate society. For instance, the automatic transmission in the new Volkswagen Beetle adapts to the driver's style. Some railway switching systems can determine how to prioritize trains. However, Kosko feels that these examples are mere novelties compared with devices and systems to come. In three sections, he considers the potential impact of fuzzy logic on politics, science, and culture and how our view of each field will be substantially altered. Harmony, 1999, 353 p., hardcover, $25.00.

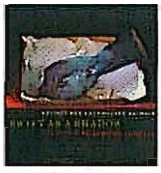


Going to Seed: Finding, Identifying, and Preparing Edible Plants of the Southwest—Kahanah Farnsworth. Buttercups may appear to be a sweet wildflower, but in their raw form they contain a volatile toxic agent. Such warnings accompany profiles of nearly 90 plants indigenous to the southwestern United States. Each description includes the plant's physical attributes, types of flowers, facts about its blooms, and how it can be used as medicine or food—including recipes. Anc City Pr, 1999, 236 p., color plates/b&w illus., paperback, $15.95.

Phantoms in the Brain: Probing the Mysteries of the Human Mind—V.S. Ramachandran and Sandra Blakeslee. As director of the Center for Brain and Cognition at the University of California, San Diego, Ramachandran sees patients whose symptoms baffle other physicians. The authors describe the "phantom" experiences of some of these patients: having feeling in missing limbs, being convinced (and even having symptoms) of pregnancy when a woman is not, and seeing cartoon characters cavorting in one's field of vision. In this book, the authors link brain mechanisms to facets of self, such as body image and belief systems. They propose that the brain is constantly updating its model of reality. Originally published in hardcover in 1998. Quill, 1999, 328 p., paperback, $16.00.

A Skywatcher's Year—Jeff Kanipe. Each season provides a different vantage point for viewing the heavens. For the benefit of stargazers in both the Northern and Southern Hemispheres, *A Skywatcher's Year* highlights celestial events for each week. Readers learn how to determine the location of constellations, stars, nebulae, and meteors. The book also recommends how to determine the best times to view celestial events using the naked eye, binoculars, or a telescope. Appendices list solar and lunar eclipses for the next 25 years and general planet locations for the next decade. Cambridge U Pr, 1999, 189 p., b&w illus., paperback, $19.95.

Slicing Pizzas, Racing Turtles, and Further Adventures in Applied Mathematics—Robert B. Banks. In a follow-up to *Towing Icebergs, Falling Dominoes, and Other Adventures in Applied Mathematics,* Banks presents a new collection of puzzles and the mathematical wherewithal to solve them. Clever readers can discern how many people have inhabited Earth, what blastoff velocity is needed to escape Earth's gravitational pull, why snowflakes have six sides, and whether it's better to walk or run through a downpour. With a healthy dose of algebra and geometry and a little calculus and trigonometry, Banks works through the problems. Princeton U Pr, 1999, 286 p., b&w photos/illus., hardcover, $24.95.



Swift as a Shadow: Extinct and Endangered Animals—Rosamind Purcell. The National Museum of Natural History in The Netherlands has a grim reputation as the keeper of one of the largest collections of specimens of extinct and endangered wildlife. This collection of photographs features roughly 100 of the most visually arresting and important creatures at the museum. In two sections—continental animals and island and marine animals—the book features some familiar stories, such as those of the California condor and the rhinoceros, both of which are battling for survival. Some less famous creatures pictured include the quagga and the Cape Verde giant skink. Mariner, 1999, 159 p., color photos, paperback, $20.00.

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SCIENCE NEWS®
The Weekly Newsmagazine of Science
Volume 156, No. 10, September 4, 1999

This Week

Articles

Research Notes

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Cover: This Javan rhino, one of the last 60 or so of its species on Earth, was photographed in an Indonesian wallow. In Vietnam, scientists haven't seen any of the fewer than 10 rhinos thought to remain there. However, remote cameras, hoofprints, and dung are providing information about the beleaguered animals. **Page 153** (Photo: © Alain Compost/ Bogor, Java, Indonesia)

Letters

Help for arthritis?

I carry a gene that turns on various arthritic nightmares. Could this immune research ("Malaria disrupts the immune system," SN: 7/3/99, p. 4) carry through to find ways to disrupt the immune system beneficially?

John C. Stires III
Escondido, Calif.

The cause of arthritis is unknown, and research on dendritic cells is still in its early stages. However, David J. Roberts of John Radcliffe Hospital in Oxford, England, suggests that finding a mechanism for disabling dendritic cells might prove useful against autoimmune diseases, could help in suppressing transplant rejection, or may aid in combating graft-versus-host disease—in which immune cells in transplanted tissue attack the recipient's cells. —N. Seppa

Monkeys are individuals, too

It surprises me that Sue Bolnski is facing so much opposition to her observations that different squirrel monkey populations evolve different social behavior patterns ("The secret lives of squirrel monkeys," SN: 7/3/99, p. 14). It is common for isolated subpopulations to evolve mating behaviors that effectively prevent crossbreeding with partners from a different group. Only researchers' strong desire to generalize the behaviors they observe can explain the reluctance to acknowledge that a community's present social norms are profoundly affected by the historical and current interactions of the individuals that are a part of the community.

James Larkin
Granger, Ind.

Bt is as Bt does

"Bt-treated crops may induce allergies" (SN: 7/3/99, p. 6) concerns human allergic response to Bt toxin in people who work with crops that have been sprayed with the material. What the article did not say is that many, many more people will be exposed to the Bt toxin and will likely be sensitized by eating crops engineered with the gene for the toxin. If, as the article stated, 70 percent of the farm workers directly exposed to the Bt toxin developed an allergic response within 3 months, what can this mean for a whole human population exposed through their food? The human population is involuntarily participating in a laboratory test on a grand scale.

Mary-Howell Martens
Penn Yan, N.Y.

Dad as decoy

The article "If Mom chooses Dad, more ducklings survive" (SN: 7/3/99, p. 6) noted that it's far from obvious why mallards form pair bonds. I can offer a suggestion. This spring, I observed pairs of both mallard ducks and Canada geese throughout the breeding season. In both species, females on their nests of brownish grass were almost invisible. The males, which normally swam on the nearby pond or conspicuously walked about, were often strikingly visible.

Many scientists have hypothesized that the male's ornaments are indications of genetic fitness. It is also possible that the ornaments are used by the female in the selection of mates because they make the male a decoy.

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Obscure Drugs Cure Malaria in Mice

The high-tech drudge work of sequencing genes is starting to pay dividends. Using newly discovered genetic clues about a parasite that causes malaria, scientists in Germany have cured the disease in mice with two drugs previously used to combat bacterial infections in people. The finding suggests these drugs might successfully treat people who have malaria.

The most severe cases of the disease stem from *Plasmodium falciparum*, the single-cell parasite that has been on scientists' hit list since they first discovered malaria was carried by mosquitoes. For the past century, *P. falciparum* has withstood the best scientific weaponry, ranging from quinine to synthetic vaccines.

The new approach exploits a molecular chainreaction that ultimately produces isoprenoid compounds, which organisms need to survive. This construction process, or pathway, relies on specific enzymes that facilitate each step in the synthesis of isoprenoids.

Scientists have been looking for an isoprenoid pathway in malaria parasites. However, it has become clear in recent years that the pathway used by animals and plants is missing in *P. falciparum*. Some algae, bacteria, and plants, however, make isoprenoids by employing another set of enzymes.

The researchers in Germany sought such a pathway in *P. falciparum* by plowing through its genome. There, they found genes that encode two components in the isoprenoid pathway used by algae, bacteria, and plants, says study coauthor Jochen Wiesner, a physician and biologist at Justus Liebig University in Giessen, Germany. These enzymes are DOXP synthase and DOXP reductoisomerase.

Meanwhile, other research has shown that a little-known antibiotic destroys DOXP reductoisomerase. The drug, called fosmidomycin, was first synthesized by Fujisawa Pharmaceuticals of Japan. For Wiesner and his colleagues, the drug and its derivative, FR900098, became obvious candidates for weapons against the parasite's pathway.

Tests against *P. falciparum* in laboratory dishes showed that shutting down the pathway with the antibiotics kills the parasite, the researchers report in the Sept. 3 SCIENCE.

Because *P. falciparum* grows only in primates, the team infected several groups of mice with the parasite *Plasmodium vinckei*, which causes lethal malaria in mice. The mice were then given FR900098 or fosmidomycin. Moderate doses of either drug cured the mice outright in 8 days, whereas untreated mice died of malaria within that time.

Mice receiving the drugs orally needed greater doses to achieve the same effect that an injection provided. Nevertheless, "these were still safe amounts," Wiesner says.

Whether fosmidomycin or its derivative will kill *P. falciparum* in a person remains unproved. The researchers don't know if the parasite, once it has infected a red blood cell, relies exclusively on the DOXP pathway to manufacture isoprenoid compounds.

There's no evidence that the alternative pathway in animals and plants exists in *P. falciparum*, says study coauthor Hassan Jomaa, a physician at Justus Liebig University. "Whether these isoprenoids are synthesized de novo by the parasite or taken from the [host] medium is not yet definitively proven," Jomaa notes. "However, our data suggest that at least some essential isoprenoids are synthesized de novo."

"Sole dependence on the DOXP pathway would probably raise the value of this pathway's enzymes as drug targets," says Robert G. Ridley of the World Health Organization in Geneva, writing in the same issue of SCIENCE.

This mouse study "shows that the malaria genome project is bearing fruit," says Stephen L. Hoffman of the Naval Medical Research Center in Bethesda, Md. He is a participant in the international consortium that has been sequencing the *P. falciparum* genome and posting completed portions on the Internet for researchers, such as the German team, to use.

"We hoped to promote this exact type of finding," Hoffman says.

Wiesner says that the scientists are prepared to test the drugs on malaria patients because the toxicological data on fosmidomycin already indicate that it's safe to use. In fact, the data suggest that effective doses would be less than the amounts that physicians would prescribe to fight bacterial infections. —*N. Seppa*

Keen-sighted X-ray telescope debuts

Astronomers have started peering through a newly launched X-ray telescope with spectacular results. The $1.5 billion Chandra X-Ray Observatory, formerly known as the Advanced X-Ray Astrophysics Facility (SN: 1/3/98, p. 8), resolves details approximately 10 times finer and detects sources 20 to 50 times fainter than its predecessors could.

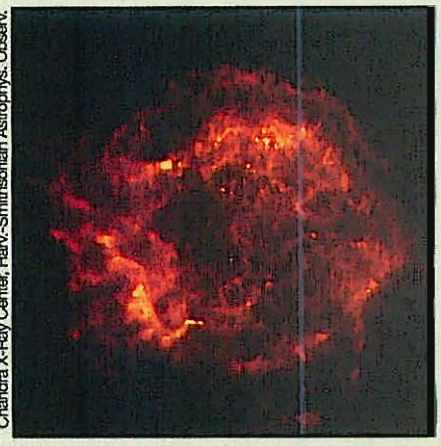
In tests of one of its X-ray cameras, the 14-meter-long, 4.6-ton satellite made brief exposures that boast extraordinary detail. The pictures unveil previously hidden features of a supernova remnant near the constellation Cassiopeia and a jet of radiation 6 billion light years away from Earth.

On Aug. 28, scientists first tested one of Chandra's gratings, similar to prisms, for spreading radiation into a spectrum of lines. The telescope was focused on Capella, a binary star some 40 light years away. The trial revealed a forest of distinct marks where previous X-ray spectra showed only a blur.

The instrument, named after the late Nobel laureate Subrahmanyan Chandrasekhar (SN: 1/18/97, p. 39), will have a tremendous impact on astronomy, predicts Harvey D. Tananbaum, who directs the Chandra X-Ray Center in Cambridge, Mass. "You will be able to pick out things you haven't seen before," he says, such as stars forming in central galaxies of galactic clusters.

Astronomers have been waiting for Chandra for a long time: Tananbaum and others proposed the project in 1976. "When you've been waiting 15 years for Christmas, it had better be very good," says Richard F. Mushotzky of NASA's Goddard Space Flight Center in Greenbelt, Md., who joined the project's science oversight board in 1984.

"I think we're going to have a very good Christmas," he predicts. —*P. Weiss*



Chandra X-Ray Center, Harv.-Smithsonian Astrophys. Observ.

Fiery gas, spewing X-rays, hurtles outward from the suspected explosion, or supernova, of a massive star. The unprecedented visual acuity of NASA's Chandra X-Ray Observatory may have allowed it to spot a long-sought neutron star or black hole (center yellow-orange dot) at the heart of this 28-million-kelvin gas bubble known as Cassiopeia A.