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VOL. 16 NO. 10 JULY 1994

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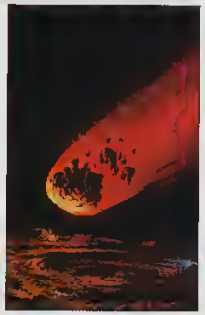
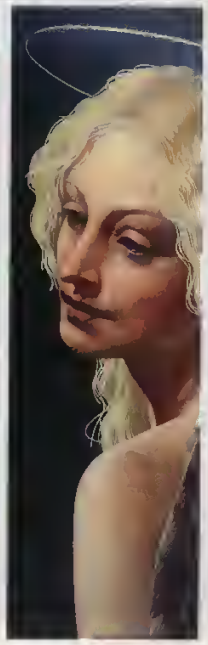




The impending crash of a comet into Jupiter later this month offers us a glimpse into the forces of the cosmos and a reminder of the brevity of our own explorations into space. Cover art by Kim Poor. (Additional art and photo credits, page 84)

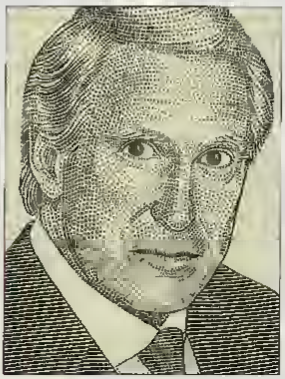
FEATURES

OMNI (ISSN 0149-6711) is published monthly in the United States and Canada by Omni Publications International Ltd. 1965 Broadway, New York, NY 10023-5965. Second-class postage paid at New York, NY and at additional mailing offices. POSTMASTER: Send address changes to Omni, Magazine Post Office Box 3041, Harlan, IA 51537-3041. Volume 16, Number 10. Copyright © 1994 by Omni Publications International Ltd. All rights reserved. Tel: 1-800-289-6664, (212) 496-6100. OMNI is a registered trademark of Omni Publications International Ltd. Printed in the USA by R. R. Donnelley & Sons Inc. and distributed in the USA, Canada, United States territorial possessions, and the world (except Australia and the UK) by Curtis Circulation Company, 433 Hackensack Avenue, Hackensack, NJ 07601. Distributed in Australia by The Horowitz Group, P.O. Box 300, Cammeray, NSW 2062, Australia; and in the UK by Seymour International Press Distributors Ltd., Windsor House, 1270 London Rd., Norbury, London SW16 4DH. Entire contents copyrighted. Nothing may be reproduced in whole or in part without written permission from the publisher. Any similarity between places or persons mentioned in the fiction or semifiction and real places or persons, living or dead, is coincidental. Subscriptions: U.S., AFO—$24 one year; Canada and elsewhere—$36.38 one year. Single copies: $3.50 in U.S., AFO, and Canada. Telephone: 1-800-289-6664. The publisher disclaims all responsibility to return unsolicited matter, and all rights in portions thereof remain the sole property of Omni Publications International Ltd. Letters sent to Omni or its editors become the property of the magazine.
Printed in U.S.A.
Canadian GST Registration #R126607589

FIRST WORD

LIGHTS! CAMERA! ACTION!
It's time to script a new show for NASA

By Jon Cypher



Although his TV character is a marine on the show *Major Dad*, Jon Cypher wants to pitch an idea to the crew over at NASA.

From an actor's viewpoint, the space program is a bad script. It has no plot, no continuity, no theme, and no drama. If it were a play, I'd say it has no "through line of action." That term refers to a play's driving idea. Each scene, character, and dramatic component must serve this thread of meaning if the play is to involve the audience, make them understand it, feel it.

The citizens of the world are the audience, the lights dim, the curtain flies, and the play is the U.S. Space Program. Does it run—or fold on Saturday?

In April 1993, when I was the welcoming speaker at a large, very impressive space conference, I felt the space program had no through line of action. Day after day, I listened to expert, intelligent presentations on every conceivable aspect of space. Never once did I feel I was in a script going someplace. It had no direction, no drive toward anything magnificent, heroic, awesome, or inspiring.

Ah, but in Apollo days! High drama, real danger, technological wizardry, heroes racing a formidable opponent. That was the stuff of Shakespeare, Euripides—a race to the moon!

Today I heard the news of the shuttle launch—it was meaningless, even boring. But launches aren't the space program. They're sets and props, not plot. Take it from an old actor. When they're talking about sets, hold on to your day job.

We seem to have forgotten that space is the greatest play ever mounted. Space is epic. Epics are not about markets, or commercialization, or contracts. Epics are about love and death... and derring-do.

Space has it all, including passion, beauty, and real benefits for humankind and our environment. And these must underlie every single thing the space program undertakes. Somehow, the people in charge don't seem to understand that. Contractors, NASA, politicians, and the Pentagon alike all seem focused on their own narrow agendas: jobs or contracts or bureaucratic turf.

Nobody has raised an oriflamme—the scarlet banner to which scattered troops may repair—to rally all people to a great cause... saying, "This is an epic in which we all have a role. This is something we will be proud to bequeath to our children."

The last three years, I played a marine general on the series *Major Dad*. I met and made friends with many marines, and it was clear immediately that they understand the mythic nature of their corps. They know they are part of an heroic tradition. The space program could learn much from that band of brothers and sisters.

So what would I do if I were called to Washington to doctor this play? I'd say, let's sound some trumpets, fly some banners, and call the world to rally round and truly explore space—especially embracing those who were once our bitterest adversaries. I'd say, let's dream big, let's all chip in and go out there together. After all, space belongs to all of us. Let's go back to the moon (this time to stay), ah, what the hell, let's go to Mars. Let's live and work in space in laboratories, hotels, in hospitals... factories and schools. Let's make this play only about benefiting "the home planet."

That's what I'd say, and I'd pitch the idea with all the passion I had. But that's not the script they're getting ready to mount. Their through line of action is about weaponizing space. Billions are still being spent to bring that show into town... It's an old turkey, and they'll tell you they closed it, but don't believe it. I say the peaceful, cooperative development of space without the contaminating intention to weaponize it is a new plot and really the only show that will take home the Tonys. And come on, when your local terrorist may soon be able to slip an irksome little nuclear or chemical device into his Samsonite (it's called the Satchel Charge Strategy, and believe me, the Big Boys are scared of it) and detonate it in the heart of the urban area of his choice, it renders the whole concept of space-based weapons ludicrous. Expensive production, shaky plot.

Considering the fact this is the only time in history, just before space weapons are emplaced, to change this storyline, one could hardly stage a greater drama than one in which former enemies link arms, undaunted (remember Apollo-Soyuz?) by the physical perils and technological challenges of every space journey. The possibilities are astounding. A show like that could run forever.

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COMMUNICATIONS

READERS' WRITES:
God goes green, putting Earth first, and what about Bob?

Recyclable Souls
I always scoffed at the thought of reincarnation [Interview, April 1994] until the laws of conservation of energy and matter gave me some (albeit not much) reason to think that it might be possible. I thought of a statement in the Bible, John 14:2 ("In my Father's house are many mansions") that could be interpreted as "Old Souls Home." I thought about the earth's population and wondered if God might "recycle" souls. If so, then there is a better chance for a belief in reincarnation. I don't know what kind of energy requirements there are for God to make a soul, but I suspect that it would be more cost effective to recycle, just building new souls for the additional population as necessary. (Of course, we do not know how many other populations God may have to build souls for.) I take exception to Dr. Weiss's statement that new souls are not created, since the population does keep growing (and the Universe does keep expanding).

Rodney G. Williams
Lakehills, TX

Is It Real or Is It Lazar?
I've just finished reading your latest issue on UFOs and an alleged government cover-up. I found the articles on the three individuals interesting, however, Mr. Lazar was hard to believe. The names he quoted were a little unbelievable, and his story degenerated the more I read it. I find it hard to place the Zeta Reticuli star system—is there such a place? The other two stories were a bit more credible.

Thomas A. Froburg
Andover, MA
AOL: TomFro

Down to Earth
What a lark! If the wealthiest nation in the world can't design, build, and maintain a decent mass-transit system for its cities ["Getting Gravity," Continuum, March 1994], how in the universe do space scientists/planners expect to get fancy monorails on the moon and Mars? I hope our scientific and technical priorities will be to solve more important problems before we put fancy elitist gadgets elsewhere.

Rev. C. Arthur Hover
Corinth, VT

Kudos to Us
Initially my interest in *Omni* was your Games section by Scot Morris. One day my finger happened to catch the Interview page and I was introduced to another dimension of *Omni*. I was very excited about the March 1994 interview with George Smoot. The idea of the Big Bang has always intrigued me, and it was wonderful to get information from such a reliable source. Thanks, and keep the good stuff coming!

Matthew Desmarais
Boston, MA

I had the pleasure of reading Jonathan Carroll's story, "A Wheel in the Desert, The Moon on Some Swings" [March 1994]. I would like to express my gratitude for this section as a break from the technology, making us realize human creativity still works behind advancements. I absolutely loved this story.

Molly Feese
Lincoln, NE

Bravo! You have taken a bold step by devoting your entire April 1994 issue to UFOs. There's no doubt that you'll come under fire by the many self-centered, narrow-minded skeptics who believe they are the center of the universe and that nothing else could possibly exist without their knowing about it.

Todd Berran
San Diego, CA

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OFFICE 2020

SMART PAPER:
There's more on the printed page than you might imagine

By Paul McCarthy

The 1960s may have seemed like the golden age for Xerox, when people like Alan Kay were busy figuring out the graphical user interface and designing icons for the Alto, the precursor to all portable computers. But Xerox is not resting on its laurels. One of the company's latest inventions, "smart paper," is a product that may do for paper what photocopies did for carbons.

Actually the paper won't have an IQ, but it will be embedded with "dataglyphs," a means of microencoding digital information. According to Beau Sheil, director of Advanced Development at Xerox, dataglyphs are not unlike bar codes. "But bar codes are big and ugly," he explains, and cannot be slipped into the pages of a book, article, or document without detracting from the overall appearance. A glyph, to the contrary, looks more like a halftone photo, just a blur on the page, and can be concealed in a logo or other graphic element. Another advantage: Glyphs contain far more information per square inch than bar codes, and there is no limit to size.

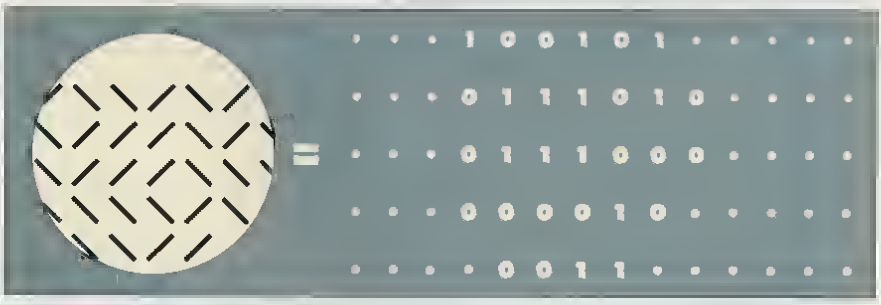
Xerox hopes dataglyphs will become essential to mail-order houses or magazine publishers who process thousands of orders. Rather than spend the time and money to key in codes for names and addresses, says Sheil, all glyphed order forms could be passed through a reader, which would automatically decode and store the demographic information. Similar possibilities exist in other office situations. Invoices could be glyphed or glyphs might be used to automatically route and sort internal office documents—one type of glyph for filing, another for copying, and another for faxing to corporate headquarters.

In publishing, industry executives have long gnashed their teeth over what they consider unfair photocopying of books and articles by copy services, universities, corporations, and others—situations in which they feel entitled to royalties. But how to keep track? With a glyph on every page, smart copiers capable of reading the coded information could tabulate the royalties owed to publishers and keep accurate account records for the institution or business. Minimum paperwork, maximum payments.

For now, only one corporation working with Xerox is ready to talk uses. Tim King, vice president for planning and development at the publisher John Wiley and Sons, puts his cards on the table. "Many people are willing to pay to copy the physical material," says King, "but in most cases, they do not pay anything for the content that is being copied, which constitutes the real value of the document." By glyphing books and articles, King expects this to change.

Of course, glyphs are still in the testing stage, making any discussion of their impact iffy but fun. For instance, a glyph embedded in legal documents could ensure against alteration. The glyph would make the document self-authenticating because it could contain the document's contents. Checks could also be glyphed so that the amount you see would have to jibe with the amount in the glyph, reducing the chances of fraud. There may, however, be some less desirable applications, such as encoding personal information in supposedly confidential questionnaires.

But for now, one thing is clear. As we move further and further into an era of information overload, the need increases for more intelligent processing. Smart paper and the decoding machines needed to translate the dataglyphs may not yet be common office products, but they do represent the changing nature of how we do work. ☒



Smart paper might never be invited to a Mensa meeting, but it may change the way we look at all that paper in our offices.

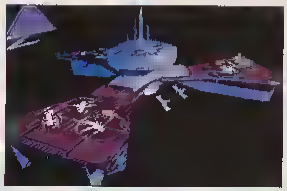
ELECTRONIC UNIVERSE

FEARLESS PREDICTIONS.
Omni's top ten reasons that 1994 was good for games

By Gregg Keizer

We're *Omni*, the publication that's not afraid to call the shots before they happen—so here we go

10 Price, not performance The debut of new desktop systems like the Pentium (in 1993) and the PowerPC (in 1994) had absolutely no influence on computer game playing. Far more important was the continued fall in price of 486-based PCs and the proliferation of multimedia-equipped machines, which accounted for three out of every four systems bought for the home this year.



Space games and simulators were only one reason that this year proved to be a good one for the electronic universe.

9 Stars got in our eyes Digital planetariums aren't new, but the latest crop was truly stellar. Maris's *Red-shift*, a multimedia you-are-there CD spin through the solar system was a feast for the eyes. Bisque's *The Sky for Windows* and Virtual Reality Lab's *Distant Sun* were also impressive.

8 The information superhighway meant games While Gore and Clinton kept spouting off about connecting to the Library of Congress, we just wanted to have fun. New hardware gizmos linked videogame owners (Sega Genesis and 3DO), and yet another AT&T cash infusion for the Imagination Network kept us from always playing alone.

7 Michael Jordon's Baseball is a *long* way away. Jordan may have ended up in the batter's box instead of back behind the free-throw line, but he's not going to show up on the cover of a baseball game anytime soon. And rumors of an impending skating simulation release—*Harding vs. Kerrigan: One on One*—were just that.

6 Virtually not at home Virtual-reality technology for the home was a bust with laughing-stock goggles that were too expensive, too low-res, too much like wearing a motorcycle helmet to the dinner table. Ditto for such things as "3-D" mice (bogus) and any desktop game that says it's "virtual reality" (major scam). VR arcade amusements of all stripes and styles, though pulled in enough bucks to keep the technology afloat.

5 Interactive movies didn't do popcorn Video-heavy and video-only CDs like Media Vision's *Critical Path* and Access's *Under a Killing Moon* pushed interactive drama to disk. All the kinks weren't worked out—some were less game, more walk-through—but at least they took a shot. And with Hollywood's increased interest in the media, we may be able to look forward to better writing, better acting, better producing.

4 Football may have moved to Fox, but NBA went to ROM Basketball games played to crowds at home almost as large as in the arenas when Acclaim's *NBA Jam*, the hot sports title of the year, debuted in March. Last year's popular coin-op, *NBA Jam*'s fast action and name players (though Shaq's not included), made videogame football seem as bland as bologna on white bread, heavy on the mayo.

3 Sonic 3, Bubsy 2 Not a score for a hockey game between cartoons, but a sign that entertaining videogame characters live long and prosper. Sega's *Sonic the Hedgehog 3* was bigger than before, Accolade's *Bubsy 2* was tougher the second time around. You shouldn't have let the commercials and ads scare you away—both were as much fun for grownups as for prepubescents.

2 Space just kept expanding Hurrahs all around for the Hubble repair job, then hoots when the Windward satellite went on the fritz, the space shuttle just couldn't get it right every time. Microsoft's *Space Simulator* did, though after a long delay in development. This out-of-the-atmospheric flight simulator was tops, topped only by LucasArts' *TIE Fighter*, the *Star Wars*-era sequel to *X-Wing*. Even further afield, Sierra's *Outpost* colony title with bits of *SimCity*, pieces of *Civilization*, was the hit among space nerds in 1994.

1 16-bit didn't die Yesterday's videogame technology stayed alive yet another year. While new entries like 3DO and Jaguar fought for market share (and sheer survival), old gear like Sega's Genesis and Nintendo's SNES swallowed dollars. Meanwhile, Sega's SegaCD add-on player and Philips' CD-I scratched back from the edge of the grave with some intriguing titles, like *Ground Zero Texas* and *The Joy of Sex*. Even those who bought a 16-bit machine in 1994 had all year, plus 1995, to play without worrying about some other box making the purchase obsolete.

DIGS

AMERICAN HEADHUNTERS

Ghoulish war souvenirs turn up in living rooms and landfills

By Paul McCarthy

American GIs returned from World War II and other wars with the grisliest of secret souvenirs: skulls of foreign soldiers and civilians.

Human skulls have begun appearing in dumpsters and on mantelpieces. Who were these people, where did their skulls come from, and how did they die?

Forensic pathologists and anthropologists are using all the tools of their trade to answer these questions. James Taylor, director of the Metropolitan Forensic Anthropology Team (MFAT) at Lehman College of the City University of New York, recently analyzed a skull with a lesion on the brain case (which appeared to have been caused by shrapnel) found in the house of a homicide suspect. Characteristics of the skull and the dental arch indicated to Taylor that the skull came from an adult Asian female. Taylor deduced the age at death, estimated at 18 to 25 years, by the incomplete closure of a particular cranial suture and the recent eruption of the third molars.

Although we human beings like to consider ourselves civilized, this recent trickle of skulls tells a different story. These are the skulls of Japanese soldiers who served in World War II, Pacific Islanders from the same period, and Southeast Asians from the Vietnam era. Researchers call them "trophy skulls" because they were taken in battle.

Hauling home booty after WWII posed few problems, according to William Maples, curator of the C. A. Pound Human Identification Lab at the University of Florida in Gainesville. No one checked bags or cared if GIs returned with souvenirs.

But during the Vietnam conflict, U.S. customs inspectors searched the belongings of returning servicemen, says Paul Sledzik, a curator at the National Museum of Health and Medicine at the Armed Forces Institute of Pathology in Washington, DC. And they found not only drugs but trophy skulls as well. Still, some GIs knew how to circumvent the system.

Because the possession of human body parts violates various state laws, some of the skulls show up when former GIs get into unrelated legal scrapes and search warrants uncover the souvenirs. Police turn the skulls over to pathologists for identification because they suspect that the skulls belong to murder victims, according to Arthur Goldman, a forensic dentist with MFAT.

Skulls also come to light in other ways, says Curtis Wienker, a forensic anthropologist at the University of South Florida in Tampa. Sometimes an ex-GI will pitch a trophy skull when packing to move to a new house. Most of the time, the skull vanishes at the dump, but occasionally it's noticed and reported to the police.

Evidence suggests that the souvenir hunters found most of the skulls in an already skeletonized state. Sledzik says he's never seen any marks to indicate that the heads were hacked off. And practically speaking, says William Bass, director of the Forensic Anthropology Center and professor at the University of Tennessee at Knoxville, removing the flesh from a skull under battlefield conditions wouldn't have been easy. "It requires a lot of boiling," explains Bass.

Regardless of the state in which the skulls were found, most of the scavengers had few qualms about altering them. Sledzik points to a Vietnamese trophy skull confiscated from a serviceman in Pleiku, Vietnam, in 1972. Its alternating stripes of Day-Glo reddish-pink and yellow simulate the American flag, and both the eyes and nasal cavity are painted Day-Glo orange.

Forensic scientists could soon see many more trophy skulls. Goldman expects a wave of Japanese skulls to wash over America in the next few years as increasing numbers of aging WWII vets die. Their families will toss out the trophy skulls, he says, "which is when we get involved." DC

WHEELS

HIGHWAY WINDS:
A surprising new alternative in the search for energy

By Steve Nadis

If it had not been for the light bulb invented by his namesake, Thomas Alva Wither may not have come up with an invention of his own. "I was driving along Interstate 75 between Royal Oak and Detroit when a light bulb went off in my head," Wither recalls. "I was watching all the vehicles drive by, blowing weeds and papers on the side of the road. I had also just read that the two biggest sources of pollution were automobiles and power plants. It suddenly occurred to me, why not use energy from passing cars to generate electricity for the utility industry?" Thus was born a new idea. U.S. Patent 5,272,378 or "Highway Energy Barriers."

To harness energy from the wind is an old idea with a new future. Artificial winds created by automobile traffic may prove to be as helpful as nature's own.

Wither's plan is to install windmills in concrete median barriers along busy highways. the aim is to harness wind currents from traffic moving in both directions. The barriers themselves would be bigger and safer than existing structures. Wither claims. Each 20-foot segment would house three wind turbines plus generating equipment and a flywheel designed to produce a steady electrical output. The electricity would be fed into the utility power grid or used to provide highway lighting when needed.

Wither teamed up with engineers at Wayne State University to determine how much of this "untapped energy source" there is for the taking. Last fall they set up an anemometer on the Southfield Expressway near Detroit and found that wind speeds averaged about 10 to 12 miles per hour for 18 hours a day. These figures compare favorably with the wind speeds generated by the giant windmill farms in California. There would be some downtime, of course, during holidays, traffic jams, or freak storms, but artificial winds should still, on balance, be more dependable than the transitory winds of nature.

Wither and Mulchand Rathod, chairman of Wayne State's division of engineering technology, have applied to the Michigan Department of Transportation for permission to conduct more highway measurements later this year. In addition to monitoring the wind speed, they also plan to test out different vertical-axis wind turbines to see which models perform best, which could provide clues about the total wind resource available along the thousands of miles of busy highways in the United States. Both numbers are difficult to calculate at the moment. Wither explains, "because this is the first attempt to harness bidirectional wind forces—that is, winds coming in from opposite directions. We're basically rewriting the books here."

If the proof-of-concept looks encouraging, the New York Power Authority just may become Wither's first customer. "It's an intriguing concept, and we'd like to help him find funding from the Department of Energy," says Mark Kapner, manager of the utility's Alternative Energy program. After a prototype-scale demonstration, we'd be interested if this approach compares favorably with other ways of capturing wind energy."

Meanwhile, the Green Institute, a neighborhood group in Minneapolis, Minnesota, hopes to have Wither's windmill put up along a new highway scheduled for construction in 1996 or 1997. Officials at both the city's Department of Public Works and the state's Department of Transportation are reviewing the proposal, though no money has yet been committed.

Wither also has a potential contractor lined up in Modern Alloys, a Stanton, California, company that has installed hundreds of miles of highway median barriers as well as helped to build 10,000 wind turbines in the state. "We've done these things separately for years, but no one has put them together before," notes executive vice president Ron Grey. "If Tom can sell the idea to the state, we can build it for him—just so long as you don't put the things in the middle of downtown Los Angeles during rush hour when nothing moves." It does, after all, take wind to run a windmill.

MIND

BRAIN WAVES AND PERSONALITY:
EEGs throw a new light on mental strengths and weaknesses

By David Snyder

Does seeing a psychotherapist actually alter brain biology? When depression lifts, does something in the cerebral cortex change? Can the positive outlook so often associated with stress-resilient people be measured?

Researchers are beginning to suspect that individual differences in brain-wave activity may shed light on why some people are more prone to emotional disorders and stress-related illnesses than others. At the University of Wisconsin in Madison, Richard Davidson and colleagues have shown that brain-wave patterns may actually help predict individual susceptibility to disorders such as depression and perhaps even a decrease in the body's immune-system function.

By measuring activity of the neocortex, behavioral scientists may be able to gauge the

Impact on the brain of stress-reduction and relaxation techniques and even cognitive restructuring.

Individual differences in brain-wave patterns also have been linked to personality traits such as optimism and pessimism. Collectively, such data may eventually lead to what has long been psychotherapy's Holy Grail: a reliable biological measure of neural changes that may occur as the result of psychoanalysis or medical treatment for stress or stress-related disorders.

Encouraged by the groundbreaking work of Davidson and his team on the relationship between brain-wave activity and states of mind, Gregg Jacobs and behavioral-medicine pioneer Herbert Benson of the Mind/Body Medical Institute of Harvard Medical School/New England Deaconess Hospital have begun a series of studies to investigate the relationship between brain-wave activity, emotional style, and stress-related illness. "These [Davidson's] are important findings," says Jacobs, who is also an instructor of medicine at Harvard Medical School. "By using state-of-the-art measures of brain-wave activity, for the first time we may be able to gauge the impact on brain physiology of all we are doing at the Mind/Body Institute—from teaching stress management to the relaxation response to cognitive restructuring." And, Jacobs adds, "we also may be able to show, via these measures of brain activity, that our techniques can be used to change emotional states."

The key to the research at Madison and the Mind/Body Medical Institute is a new understanding of something called frontal brain asymmetry: the fact that most people have more electrical activation in one frontal lobe than in the other as measured by EEG. Whether the level of activation is higher on the left or right may indicate increased vulnerability to stress, mental illness, or a decreased immune-system function. The investigators discovered that people with hyperactivation in the left frontal lobe may be more optimistic, less susceptible to mood disorders, and consequently more stress resilient.

Conversely, Davidson and his team linked hypoactivation, or less activity in the left frontal lobe compared to the right frontal lobe with negative thinking and depression. But the big question is how plastic these brain-wave patterns are and how responsive they are to intervention," says Davidson, who is a William James Professor of Psychology and Psychiatry at the University of Wisconsin in Madison.

Other researchers, nonetheless, are quick to point out that it would be a mistake to use EEG patterns to pigeonhole any individual into one personality type. Variables such as environment are too numerous, and a large part of the brain's complex chemistry—the actual facilitators of emotional states—still remains to be understood.

Says Jerome Kagan, professor of psychology at Harvard University, "There is cause for enthusiasm here in that some scientists have found that chronic moods are not just psychological but are correlated with different brain states as reflected in the EEG. But that doesn't mean the brain-wave patterns are causing these states. Whatever is fueling them is probably coming from the limbic area of the brain. And moreover, the precise mechanism causing these states is not yet known.

"So while it is interesting that these brain states can be related to brain waves, we must caution ourselves not to take it any further than that. There is no need to be fatalistic about it. Just because I have a right-activated hemisphere doesn't mean I can't be happy. Or if I'm left activated, that doesn't mean I will never be frightened or depressed. That would be a gross oversimplification of the elegant and still largely mysterious processes of the human brain."

SPACE

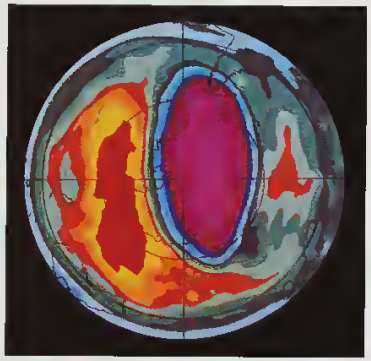
SHUTTLE VS OZONE

Does the space shuttle help destroy the fragile ozone layer?

By James Oberg

Little more than a decade ago, most people had no idea what the ozone layer was How times have changed Now, ordinary citizens all over the world argue over theories purporting to explain what causes a hole to appear in the ozone each year For better or worse the ozone layer has become a part of popular culture

One of the negative aspects to this phenomenon is that one need only invoke the ozone layer to draw intense scrutiny to something Such scrutiny has recently fallen upon the U S space shuttle program



Environmentalists and Soviet scientists claim the space shuttle contributes to the hole in the ozone above the Antarctic (right, in 1992). U.S. aerospace scientists counter that the shuttle's harmful effects are minor.

Flights of the space shuttle the U S *Delta*, *Scout*, and *Titan II* rockets and the French *Ariane V* rocket are destroying the ozone layer claimed Soviet scientists Valery Burdakov and Vyacheslave Filin several years ago In parallel Soviet space official Aleksandr Dunayev wrote that "300 launches of the shuttle a year would be a catastrophe and the ozone layer would be completely destroyed ' By comparison the Soviets *Energiya* rocket is "ecologically the cleanest ' the scientists stated Coincidentally at about the same time the Soviets began soliciting bids from other countries for the *Energiya*'s services

The Soviets have hardly been alone in decrying the perceived danger to the planet of the space shuttle s solid rocket boosters, which in the first two minutes of each launch spew tons of toxic chemicals into the atmosphere Antimilitary activist Helen Caldicott has spoken out against the shuttle saying that with each launch one quarter of 1 percent of the ozone is destroyed So far the space shuttle has destroyed 10 percent of the ozone " In 1991 well-known activist Michio Kaku a professor of nuclear physics at the City University of New York, wrote in *The Guardian* that solid-fueled rockets emit large quantities of harmful hydrochloric acid, which can rapidly deplete the fragile ozone layer "

Most of these claims have turned out to have little scientific basis The ozone layer isn't a bricklike wall to be chipped away one layer at a time Rather it's a chemically dynamic region where chlorine ions—not hydrochloric acid—cause ozone molecules to convert to ordinary oxygen molecules while incoming ultraviolet radiation causes ozone to form again

As for the Soviet scientists' allegations, they based their claims on a series of explicitly worst-case scenarios They assumed that all the shuttle exhaust gets deposited in the ozone layer Actually, only a small percentage of it does, while rain washes out most of it They assumed that all the chlorine gets converted into ozone-destroying ions, although only a fraction ever does And they assumed that the 300 flights they warned of would occur in a period of less than one year so that little natural regeneration would take place NASA isn't ever likely to launch the shuttle more than ten times a year and by the time each flight occurs, the minor damage from the last flight has disappeared

In response to concern about this issue, aerospace experts held workshops recently to assess the dimensions of the threat A panel from the American Institute of Aeronautics and Astronautics concluded that compared to other manmade sources of ozone-depleting chemicals the effects of rocket launchings were small enough to pose no serious threat In the future, however new rockets must use cleaner fuels "No matter how small the environmental effects of rockets are," noted AIAA aerospace and science-policy director Jerry Grey "we can reduce them ' Representatives of the Federation of American Scientists an environmentally sensitive lobbying group agreed with this assessment

Sadly, these cleaner fuels remain far in the future NASA engineers considered and rejected liquid-fueled boosters when designing the shuttle All-liquid systems would be more expensive and unreliable than solid-fueled systems and they decided, offered few if any safety advantages

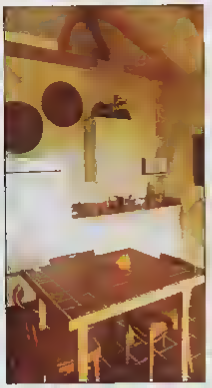
CONTINUUM

CARIBBEAN GREEN

Sun, sand, surf, and conservation. Plus, how to fry cockroaches, and the dolphin version of *West Side Story*

On the fourth morning of my stay on the U S Virgin Island of St John, I awake before daybreak, partly due to the heat and several renegade mosquitoes in my tent, but mostly to the proximity of the Caribbean and the promise of an early morning swim I am a guest at the Maho Bay Camps where the water is blue and the accommodations green

The campground, built in the mid Seventies by New York–based developer Stanley Selengut, consists of 114 platform tents and several cold-water bath houses hidden in the brush above Maho Bay The success of the campground prompted him to build on the same property a village of condominium style accommodations called 'Harmony A Center for the Study of Sustainable Resort Development " Counting on travelers who want more from their vacations than just idle luxury, Selengut hopes to attract conscientious people interested in education conservation and a good time



Far resort developer Stanley Selengut, a vacation in the Caribbean is an opportunity to teach conservation.

"The goal of Harmony" Selengut says 'is to demonstrate that an ecotourism facility can balance both nature and culture, and can, in fact be mutually enhancing " He believes people on vacation are relaxed and open to new experiences and hopes guests at Harmony will incorporate what they learn about saving energy and the environment in their own homes He does not charge a room rate for the accommodations but 'tuition "

What makes Harmony unique is the attention Selengut put into designing and building environmentally sensitive structures and its independence from the island's utility systems The units are constructed primarily from recycled material, complete with ceramic tiles made from crushed light bulbs and recycled clay, throw carpets from plastic bottles doormats from recycled tires and decking from a composite of sawdust and bits of plastic Solar panels and wind turbines supply power, supplemented by an overall passive energy design Experimental hardware is also used to harness solar energy which powers up refrigerators, ice machines, and even outdoor ovens

Some of Selengut's concepts are as sophisticated as occupancy sensors that turn off power, others are as basic as collecting rain in cisterns Instead of a thermostat, each unit features a portable computer so that guests can monitor their energy supply and make usage decisions accordingly The intention is to break guests of the idea of energy-on-demand, to have them forgo showers when water is low and sacrifice daiquiris until the sun shines

Selengut is trying to set a standard for an industry otherwise known for its waste As it turns out, his efforts are not in vain The Travel Industry Association of America recently published a report that suggests the majority of travelers prefer travel companies that help preserve the environment and that they are willing to pay 8 percent more for environmentally conscious services

Traveling green doesn't have to be limited to costly retreats or trendy resorts There are numerous ways travelers can preserve the environment regardless of the accommodations "Every step leaves a footprint,' the American Automobile Association reminds avid wanderers in their booklet *Environmental Tips for World Travelers* The booklet suggests travelers visit popular destination sites off-season and historical sites off the beaten path, refuse to purchase items made from endangered animals and plants, and take public transportation when available or bike or walk Of course, guests should conserve water, turn off lights and adjust thermostats when leaving a hotel room Tread lightly, AAA pleads, and don't litter —*JANET STITES*

CONTINUUM

Is it live or is it video? At England's WorldLife Centre Project the animals, like this Bengal tiger, will remain in their natural habitat while visitors view video footage of them via satellite link

IT'S A ZOO OUT THERE!

Soon a zoo will open in England in which the only animal will be the most frightening and dangerous species of all—man.

Riding a trend against keeping animals in captivity, the WorldLife Centre Project, planned for central England, will use satellite links and computer-generated images to allow visitors to experience the world of animals in a revolutionary way.

"There's a genuine public thirst for an understanding of wildlife that's not being met in most traditional zoos," says project chairman William Travers. Instead of gathering at the monkeys' cage for the two-o'clock feeding, visitors might watch primates searching for food via a satellite link to the Amazon rain forest. In addition, a visitor will be able to "see what it's like to live 17 feet tall as a giraffe or a quarter inch tall as an ant. What we want to do is give people a different perspective on the world and not an anthropocentric view of the world based on human beings," Travers explains.

> GABRIEL FALLOPIUS, PROFESSOR OF ANATOMY AT ITALY'S PADUA UNIVERSITY, DESIGNED THE WORLD'S FIRST CONDOM IN 1551

Traditional zoos, he adds, not only endanger the welfare of the animals, but also create an unrealistic impression of animal life. "Animals kept in unnatural circumstances develop abnormal behavior. The way they're housed can be very detrimental to our understanding of a species."

Travers hopes the new project will set an example for zoos, helping to make the notion of taking animals out of the wild and putting them on display a thing of the past. "There's a very big danger in having an ego that demands that animals be available to you. We've got to get away from that."

—Peter Callahan

THE REDEEMING QUALITIES OF ZEBRA MUSSELS

Although zebra mussels were first sighted in North American waterways less than a decade ago, they've already earned a nasty reputation for their expensive habit of clogging and damaging water-intake and drainage pipes in the Great Lakes area. Now Cornell University scientists, working with Smithsonian Institution researchers, have discovered a good side to the creatures. The gray-and-white-striped mollusks are rapidly cleaning murky waters of algae and filtering toxic substances from polluted rivers and lakes.

Native to Europe, zebra mussels apparently hitched a ride here in the ballast water of international ships, according to Cornell University biologist Edward Mills. While utility and other industries currently use chlorine to kill mussel larvae in drains and pipes, zebra mussels flourish in the Great Lakes and nearby waters. "Parts of Lake Erie, for example, contain 20,000 to 90,000 zebra mussels per square meter," Mills points out. "Each one can filter a quart of water a day, so we are talking about an enormous amount of water cleaning going on."

Zebra mussels clog pipes, but they also fight pollution

> A WAVE BREAKS WHEN THE WATER DEPTH BECOMES LESS THAN ONE-SEVENTH OF THE DISTANCE BETWEEN WAVE CRESTS

To find out what chemicals the mollusks absorb, Mills and fellow researchers collected hundreds of zebra mussels from three New York rivers—the Hudson, the Niagara, and the Genesee—and lakes Onondega, Oneida, and Ontario. Cornell toxicologist Donald Lisk then analyzed shells and freeze-dried meat from the small mollusks and found high concentrations of toxins, including cadmium and selenium, in the soft tissue of the mussels from almost all locations. "PCBs were the highest in mussels from the Hudson River, reflecting its known contamination," Lisk says. "DDE, a metabolite of the pesticide DDT, was found in mussels from Oneida Lake and Lake Ontario. This research indicates that you can analyze zebra mussels as indicators of pollution."

Lisk reports still another good side to zebra mussels. Their calcium-rich shells remain untainted by pollutants and could be used in fertilizer or chicken feed.

—Sherry Baker

Zebra mussels could prove valuable in detecting the type and amount of toxic substances that are polluting particular waterways

IBM is among the companies interested in using very-high frequency sound waves to test electronic circuits

SUPERCALI-MICROSONICS-EXPIALIDOCIOUS

You can bet the sound of it would surely be atrocious—if you could hear it. Physicists at Brown University in Rhode Island have devised a method for producing very-high-frequency sound waves that emanate at an inaudible 31 octaves above middle C. And, no, they didn't build an extremely long piano, nor did they mold the tiniest of dog whistles. Instead, the scientists aimed a rapid-pulse laser at a piece of metal, causing it to twitch back and forth at a speedy 10⁹ hertz—on the order of a trillion cycles per second.

The soundmeisters are working with some companies, including IBM, to harness the vibrations as a microsonar diagnostic tool for the computer industry. The process would give manufacturers a method of deducing how well thin films of metal are adhering to microelectronic circuits, without dissecting the circuits. The device's high-frequency laser pulses will produce sound waves in the metallic film that will then bounce off the circuits' interface and be reflected back. Anomalies in these reflected waves will give manufacturers badly needed information on the border between the coating and its substrate.

IBM and others are interested in this from the point of view of being able to test structures they've made," says Humphrey Maris, one of the Brown researchers.

—Pat Janowski

CONTINUUM

You've tried spraying cockroaches, feeding them poisoned bait, trapping them. How about electrocuting them?

ANY LAST REQUESTS, MR. COCKROACH?

Fried cockroaches—not very appetizing, but it could sound pretty sweet to someone plagued by the household pests.

Greg Jefferys, Australia's Inventor of the Year in 1991, has created a device that will indeed electrocute the insects. The Cockroach Zapper looks like a large, open clam with metal plates inside. Special bait attracts roaches into the Zapper, where the bugs' feelers touch the top plate while their legs stand on the bottom plate. "Whammo! Fried cockroaches," says Jefferys, an organic-vegetable farmer who invented the Zapper when his family moved into a roach-infested house.

> THE FEET CONTAIN ONE-FOURTH OF ALL BONES IN THE HUMAN BODY

Frying the roaches exterminates them more effectively than poisons because it also kills the egg capsules females carry. While the 12-milliampere current proves fatal to cockroaches, it falls well below the 30-milliampere level generally considered safe for humans and even small pets.

In laboratory tests, the Zapper killed 90 percent of existing roaches in six days. Most houses, according to Jefferys, need only one Cockroach Zapper, which operates on household current or a battery and comes with a 12-volt adapter plug that fits any electrical system.

Jefferys manufactures the Cockroach Zapper himself and so far has sold 30,000 units in Australia. He plans to have the device in U.S. markets imminently at a price of about $80. If you can't find the Zapper, call Zapper Sales in Brisbane to order; from the United States, dial 011-61-7-2077-523. —Peggy Noonan

A SPORTS SHOE FROM DOWN UNDER

Like many athletes, David Miers suffered knee problems that threatened his career. Unlike many athletes, Miers has a background in science. So when the Australian Rules football player was faced with an early retirement, he set to work designing a sports shoe he hoped would take the stress off his aging knees. The result is Blades.

It took Miers a few years of "trial and error and a hundred different designs" to come up with a configuration he liked for the new shoe, but the time appears well spent. In his first season wearing the new cleats, Miers was named his league's most valuable player. "Then the other players wanted the boots," says Miers, who credits the shoes with allowing his knees to hold out for an extra four seasons.

Blades' secret lies in the steering principles of Formula One race cars, whose outside wheels turn faster than the inside ones. The new shoe gives an athlete added control over lateral movement, replacing the traditional rounded studs with rows of bladelike cleats. It takes the stress off the turn," says Miers. "It feels smoother. It's a matter of sole thickness, cleat shape, tapering, and balancing where the pressure is."

While Blades have caught on Down Under, the shoes have yet to land in the States, although Miers will sell to U.S. customers; call 011-61-3-842-9322 to order. —Peter Callahan

The Blades shoes' unusual cleat design eases knee stress and gives added control in turns.

CONTINUUM

DOLPHIN GANGS

It may not be *Bottlenoz 'N the Hood*, but gang activity plays a part in dolphin life

Gang behavior in animals isn't news. chimpanzees and baboons may form a gang to fight their enemies for instance But until now, in only one species had scientists observed two gangs team up to tackle a third—*Homo sapiens* Now scientists know that dolphins exhibit similar behavior.

Dolphins form extremely complicated allegiances and enmities that continually change, and each dolphin must perpetually reevaluate its relationships with other dolphins to discover its place in the hierarchy and who its friends and enemies are One group of dolphins can be friends with two other groups in one context but foes in a different situation This kind of "variable interaction" between groups previously had been seen only in humans, according to Richard Connor, vice president of the Dolphins of Shark Bay Research Foundation in Ann Arbor Michigan

Connor and fellow graduate student researchers sponsored by the University of Michigan have closely studied about 100 dolphins that regularly visit Australia's Shark Bay They found that two groups of male dolphins occasionally gang up to kidnap fertile females from other dolphin groups Connor says The team also saw female dolphin groups chase a band of male kidnappers to retrieve a kidnapped friend Female dolphin behavior is more subtle than that of males, which makes it harder for biologists to analyze, Connor adds —Peggy Noonan

NINE OUT OF TEN ORGANISMS IN THE WORLD LIVE IN THE OCEANS.

Gentility is what is left over from rich ancestors when the money is gone.'
—John Ciardi

TRAFFIC VISION

Who says there's nothing to watch on television? In Los Angeles, a city that churns out new shows as fast as Detroit builds cars viewers can now tune in to *Freeway Vision* a display of the L A freeway system's current traffic which frequently rivals the soaps for sheer drama despair and unlikely plot twists

Using information gathered by sensors embedded in the pavement a computerized map of the freeways airs on a local cable channel during rush hours Updated every 30 seconds, it gives viewers a realtime display of the current speed of traffic by using colored lights, from green to red, to indicate how fast cars are moving—or not moving, as the case may be

"It's a new world that's opening up," says Chuck O Connell, deputy district director of the California Department of Transportation Radio traffic reports are fine he says "but they're not always there when you want them, and they don't give the big picture."

It's too early to tell how much of a role *Freeway Vision* plays in easing congestion—no small feat in car-choked Los Angeles—but O Connell has high hopes The key he says is helping motorists make the best use of time If they can plan ahead "they're better served, and the public is better served."

Of course, *Freeway Vision* won't do you much good if you're already on the road without access to a television. Computerized freeway signs can help, but for now, at least, L.A. motorists frequently find themselves up a creek without a paddle —Peter Callahan

Freeway Vision *aired on a Los Angeles cable channel displays the current speed of traffic on the city's highways*

THE CELESTIAL COLLISION OF THE CENTURY

TARGET

PAINTING BY KIM POOR • ARTICLE BY JAMES OBERG

JUPITER

Coming to our solar system this summer *Killer Comet from Outer Space* The story A comet splits into fragments and hurtles into a planet's atmosphere, raining down shopping-mall-sized boulders onto the defenseless surface and wreaking planetwide havoc

It's not a movie It's real But don't panic yet—the planet in question is not Earth but Jupiter

Late in July, pieces of a mysterious comet will begin to crash into the solar system's largest planet, each with the force of up to a million megatons—a million million tons. For perspective the most devastating H-bombs measure only in the tens of millions of tons Jupiter will experience such blasts not just once, but a dozen times or more over a period of several days

What will such a barrage do to Jupiter and indeed to the solar system as a whole? No one knows for sure, because this is the first time an event like this has taken place in the age of modern astronomy These forces are quite simply unprecedented in the history of planetary science "It's a once-in-a-lifetime deal," exults professor of planetary science Jay Melosh "It's like there's an *Under Construction* sign out, with things happening right before our eyes " says astronomer David Levy

Astronomers are probably also wishing for a better view The luck of the cosmic dice has placed the impacts on the side of Jupiter turned away from Earth, so no human eye will actually view them. Several distant spacecraft will, however, and they'll transmit images and other readings *Galileo* has the best vantage point It's even now pulling slightly ahead of Jupiter as it heads to intercept the planet at the end of next year Although billions of miles away, *Voyager 2* has a direct view of the bombardment, enabling it to measure forms of radiation that never reach Earth A handful of other deep-space probes such as *Ulysses* and *Clementine* will also witness the event, although from less-than-perfect perspectives

From Earth itself and orbits around it, observers will see only the blasts aftermath when the target region on Jupiter rotates into view a few hours after the impacts Composed largely of gaseous clouds of hydrogen and helium, Jupiter has no surface to crater Still the explosions are bound to leave noticeable traces in the planet's atmosphere, which mountain-top observatories and the Hubble Space Telescope will document

For the armchair astronomer, it may well pay to keep an eye—and a telescope—to the sky during the impact Nobody really knows how Jupiter will react to the cosmic shelling It might flare up briefly Some experts think it could brighten over a period of hours to days Or it might look exactly the same as usual. Those who watch from the Northern Hemisphere need to use their time well. It will be brief, because Jupiter rises in midafternoon and sets about midnight Only the few hours after sunset before the planet and impacting objects sink into the western sky will provide a good view. To get the best Earth-side view, go to the Southern Hemisphere, where the midwinter darkness will provide many more hours of visibility

Predicting the results of the blasts is the hard part for astronomers and planetologists Figuring out how the impacts themselves will take place proves somewhat easier Here's *Omni*'s scenario, compiled with expert help

Each object falls onto Jupiter at a rate of 37 miles per second—five times the speed of an Apollo capsule returning from the moon Physics tells us that an object's energy is proportional to the square of its velocity meaning that these Jupiter-bound projectiles pack an immensely powerful punch Even the solar system's largest planet, named after the king of the Olympian gods, is going to take notice that it's under attack

As each object enters Jupiter's magnetic field it's deluged with electrical charges Surface dust particles stream off, weaving visible strands along the force lines. Some of the dust may later settle into a new planetary ring

The giant planet's powerful gravity tugs each object faster and faster, while setting up terrible, tearing stresses within the object's core Moments before impact the comet fragment may fracture, sending a blizzard of dust whirling off into space As the projectile whizzes through Jupiter's outer atmosphere of hydrogen, heat buildup burns off surface layers and deceleration forces equal to hundreds of times Earth's own gravity crush and pulverize the remaining material

With a flash of visible and thermal radiation, the object finally disintegrates For several seconds, energy flow equivalent to a solar flare bursts forth on the planet The blast may pack as much power as the supposed asteroid impact on Mesozoic Earth 65 million years ago that scientists suspect may have killed off the dinosaurs by setting off drastic ecological changes, or it may be "only" a tenth as great To look at it another way, the force may be roughly comparable to setting off one Hiroshima-sized atomic bomb for every human on Earth

Shock waves rush outward into the surrounding atmosphere some plunging deep into Jupiter's interior and soon reflecting off of denser, deeper layers A spurt of superheated hydrogen ions may streak out into space through the channel carved by the object's violent entry moments earlier, wreaking havoc in the magnetosphere

The surrounding atmosphere, boiling in the fireball's heat, roils with cataclysmic storms marked with kaleidoscopic colors Wisps of surviving dust daub the upper atmosphere in streaks and spots of gray Shock waves circle the planet repeatedly, leaving physical and thermal traces, and atmospheric chemical soups, mixed and heated violently perform intricate whirls

Almost as interesting as the blasts themselves is what will cause them—fragments of a puzzling celestial body dubbed Comet Shoemaker-Levy 9 upon its discovery in early 1993 and officially called Comet 1993e First showing up in images as a dot and then a rectangle, Shoemaker-Levy eventually proved under higher magnification to consist of a train of objects Perhaps the best—and certainly the most poetic—description "pearls on a string "

Co-discoverer Levy calls it simply "the strangest object we had ever seen," and planetologist Clark Chapman says its "surely the most interesting comet ever discovered " But how did it come to take on that peculiar form? Paul Chodas at NASA's Jet Propulsion Laboratory tried to find out by using computer simulations to project the object's orbit backward in time While he cautions that his results may be less than accurate due to incomplete data on the comet's current path Chodas speculates that the parent body was probably captured by Jupiter's gravity decades ago and has already made many orbits around the planet, each taking about two years Prior to capture, the object most likely had a nearly circular orbit close to the plane of the solar system, suggesting that it may have originally been an outer-belt asteroid or an errant member of the Trojan asteroid families that share Jupiter's orbit some slightly ahead and others slightly behind it on its path around the sun

But once the comet entered its wildly erratic orbit around Jupiter, the sun's gravity severely distorted its path every time it moved past its maximum distance away from the planet—the apojove, which is about 40 million kilometers from Jupiter Viewed from Earth, that translates into a point about four degrees southwest of the brilliant planet's position in the night sky Some captured objects can pick up enough tug to break free again from a planet that's captured them, but others randomly lose more energy and fall back closer to the planet, as this one did The perijove—the point at which it's nearest the planet—of its last pass in July 1992, brought it too close to Jupiter for comfort Something—most likely the giant planet's gravity—disrupted the object into dozens of smaller pieces at that time The dust released from the disintegration formed the dust tails trailing the fragments scientists concluded from their studies of the dynamics of the comet's breakup Interestingly, scientists have found no traces of the comet itself, much less a tail, in photographs taken before Shoemaker-Levy's discovery, indicating that the original comet was either quite small or unusually dark, Chodas says Sunlight reflecting off of the expanding cloud of debris made the comet visible after its breakup

When finally detected, "the pearls" seemed one of the most beautiful astronomical discoveries in decades Then, as their shifting position allowed a computation of their past and future trajectories, the beauty turned into a

beast The fragments didn't simply adorn the space near Jupiter They were plunging straight back against the giant planet

Notice of the fragments collision course with Jupiter spurred the worldwide space science community to a frenzy of activity They've spent the last year discussing the anxiously awaited event by fax phone and E-mail and face to face at conferences and hastily organized symposia For scientists who dream that their careers might encompass one good supernova or a single spectacular comet or a lone pioneering space probe the meeting of the pearls and the planet amounts to nothing less than a professional peak a momentous defining event "An astronomer has to be happy he's alive," says astronomer Steven Maran He and others have wasted no time analyzing every step of the objects perilous journey toward Jupiter and the possible results of the violent impacts

Alex Dessler former head of Rice University's space sciences department and now with the Lunar and Planetary Laboratory of the University of Arizona has devoted years of study to Jupiter s magnetosphere As the objects cross Jupiter's magnetopause from interplanetary space about a month before impact their tails could brighten due to the explosive disruption of the dust grains forming the tails he says Dust particles from the objects will take on electrical charges and leak off into space, flowing along magnetic force lines 'Brighter tails could reveal the shape of the magnetosphere Dessler told *Omni* "The dust sheet could extend a full degree from Jupiter" and may be visible through small telescopes

Mihaly Horanyi of the University of Colorado's Laboratory of Atmospheric and Space Physics has hypothesized as well about how the vast new amounts of dust may affect Jupiter A specialist in the electrodynamic effects of plasmas and fields he believes that the micron sized dust particles will act in particularly spectacular ways because they'll be buffeted by electrodynamic forces as great as the planet's gravitational forces The dust particles may even wind up orbiting Jupiter as a new ring he says Horanyi endorses a decades old idea that the Jovian rings, which may not be very old in astronomical terms could have formed from dust forced off earlier disintegrated passersby "The Voyagers found that most of the current ring particles are uniform in size about a micron in diameter" he explains "I find that coincidence very suggestive"

Roger Chevalier and Craig Sarazin, astronomers at the University of Virginia have concentrated not on dust but on the actual impacts, preparing a detailed prediction of the sequence of events First on their scenario is the fragmentation of each object in its final seconds as it heads toward the planet undergoing various thermal processes each of which will emit different wavelengths of radiation The initial energy pulse will be in the ultraviolet spectrum, they say If observed carefully by the reactivated UV spectroscopes aboard the Voyager probes the emissions could provide brief but recordable readings that could help determine the ill-fated objects composition

Next comes the actual disintegration, creating a visible burst that scientists originally estimated would for a few seconds outshine the full moon as seen from Earth if only the blast occurred on the near side of Jupiter, more recent calculations suggest that it will be a good deal fainter Still the burst will illuminate nearby moons and rings Those watching from Earth may see the planet's limb or outer edge brighten from atmosphere-refracted light although Sarazin told *Omni* he

'Those two are ahead of me Doc"

didn't expect that great of an effect

After the energy pulse comes the shock waves. "Explosions in a stratified atmosphere can produce dramatic effects," Sarazin says. "As the shock wave moves from lower to higher levels, it accelerates." He hopes to see a "shock breakout" effect where the explosion literally blows the top off the atmosphere just above the blast.

Sarazin and Chevalier also expect that heat and physical shock will induce chemical reactions deep within Jupiter's atmosphere. Color changes might be dramatic." Sarazin speculates. The refractory material from the object will be deposited in the upper atmosphere,' adding to the color variations, and the pulverized dust will create dark smudges in the atmosphere's transparent hydrogen.

Such spectacular visual effects on the visible outer layers of Jupiter's atmosphere must last one or two hours if they're to be carried by Jupiter's rotation around to the side visible from Earth. But that may not be a problem, notes NASA planetologist Kevin Zahnle. He expects the fireball of each impact to "rise explosively out of the atmosphere" within a minute, transporting water and other less volatile materials normally trapped below the visible cloud layer. This aftereffect gives planetary scientists their first look at Jupiter's lower atmosphere, allowing them to verify their hypotheses about its composition.

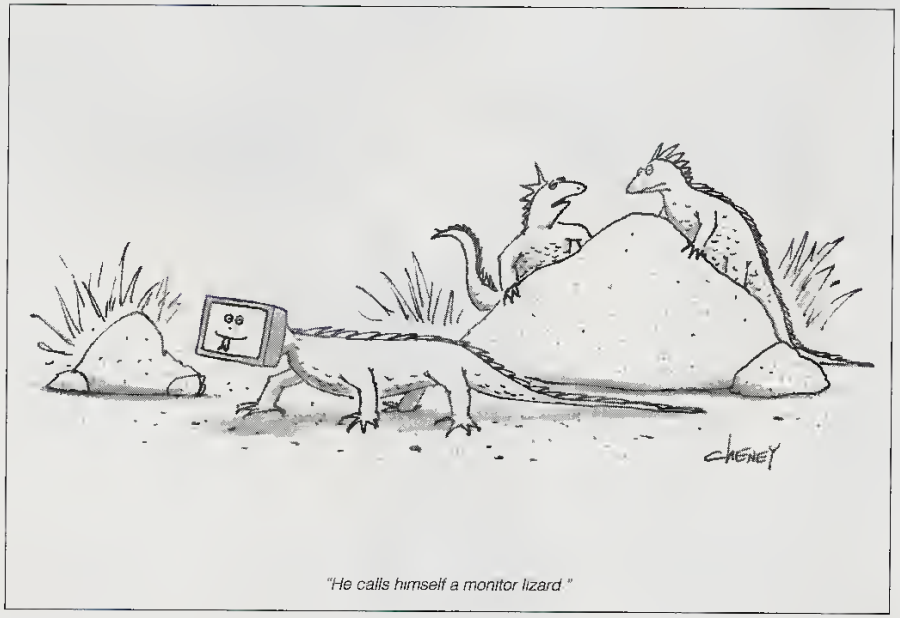
The shock waves that move downward instead of upward most interest Mark Marley, an astronomer at New Mexico State University. As the waves move through increasingly dense lower layers, their speed and direction will change. About a fifth of the way to the core, they'll encounter Jupiter's mysterious phase-transition region, where supercompressed hydrogen turns metallic. Human technology is decades if not centuries away from probing these regions directly, but the impact detonations can do it for us. The metallic state of hydrogen hypothetically results from extremely high pressures that have never been achieved in Earth's laboratories.

"We don't really know the transition pressure," Marley explains. "We don't even know if the transition occurs distinctly or gradually." But the shock waves rebounding back into the upper atmosphere will contain that information—if we can detect and time them. "Timing is essential," he stresses.

Marley expects these rebounding shock waves to leave a clear trace across the face of Jupiter. "There should be a detectable ring as the atmosphere heats and then cools in the compression wave," he told *Omni*. And if some atmospheric chemicals are at near-saturation densities, the compression and heating might leave bright clouds "like from the lee waves across mountain ranges" on Earth. Speeding faster than the planet's already break-neck spin (Jupiter completes one full rotation in just ten hours), these waves will move from left to right across the disc as seen from Earth.

As if the light, heat, and shock effects weren't enough, "we anticipate robust radio emission,' announces Joe Rornig, one of the Voyager experimenters. Instruments aboard the distant Voyager probes—but probably not receivers back on Earth—will pick up these radio signals.

How will all these cataclysmic fireworks affect the weather on Jupiter? "We predict observable effects resulting from meteorological adjustment of the atmosphere for several months after the collision," a team of astronomers from the Massachusetts Institute of Technology reported at a recent space conference. These new weather patterns could involve new belts of different colors or, just perhaps, the creation of a new Red Spot to join Jupiter's famous original.



"He calls himself a monitor lizard."

Talk about a new Red Spot began even before the discovery that Shoemaker-Levy would crash into Jupiter. At an April 1993 conference on asteroid hazards held in Erice, Sicily, scientists discussed the issue of planetary impacts. The impact nature of the dinosaur extinction and of numerous other terrestrial extinctions has won widespread acceptance, and the dominant role of impacts in forming the topography of the solar system's dozens of rock and ice worlds has long been recognized. But few scientists had thought about the role of major impacts on the gas giants such as Jupiter and Neptune. It seemed obvious that these huge, gaseous planets swallow up falling objects without a trace.

But some disagreed with that assessment. Physicist Edward Teller, for one, inquired deeply into the nature of Jupiter's Red Spot, in particular into theories of its origin. Teller's familiarity with artificial thermonuclear explosions gave him an intuitive suspicion that a tremendous, upwelling fireball on a gas giant might form an Earth-sized hurricane that remains stable indefinitely. It might wander to a more convenient latitude and it might absorb smaller hurricanes, but once started by an impact, it might last essentially forever.

The upcoming collision will help scientists figure out whether the Red Spot resulted from a similar, much earlier celestial impact. After the initial flush of excitement about an event unique in their lifetimes, astronomers realized that such an occurrence can't be particularly rare in the solar system's lifetime, vastly longer than our own. "Collision of such comets with Jupiter probably occurs about once per century," co-discoverer Gene Shoemaker told his colleagues at a conference last October. Astronomers recently discovered several objects whose trajectories, when traced back through computer simulations, indicate that they escaped from similar orbits around Jupiter. Additional statistical studies show that most comets that do hit Jupiter are not in captured orbits, like the pearls, but are moving randomly past the planet.

If such events happen regularly, scientists have to ask what traces they might have left. And in fact, there are many puzzling features of the Jovian system—not just the Red Spot and the planet's ring—that could actually be hitherto unrecognized consequences of earlier giant impacts. Many of them lie not on Jupiter itself but on two of its moons, Callisto and the younger Gany-

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POLITICS OF Apollo







Article by Piers Bizony

Great journeys of discovery often appear dismayingly neat and tidy after the fact. Columbus found America in 1492, the books say. The Wright Brothers made the first powered airplane flight in 1903. Lindbergh flew the Atlantic in 1927. Astronauts landed on the moon on July 20, 1969. Epic adventures of courage, intelligence, and determination are reduced to dry facts suitable for regurgitation in history classes and documentaries.

But behind all the names, dates, and places lie marvelous stories, and the

While senator, Johnson began pushing the United States into space before Kennedy even campaigned for the presidency.

mission that culminated in Neil Armstrong's first dusty footsteps on truly alien soil is certainly no exception. Writers, historians, and filmmakers have already examined it from many points of view: the colorful, rebellious astronauts; the engineers and scientists charged with getting those men to the moon and returning them safely; and the charismatic, doomed president who gave his country a vision of a future in space. Perhaps the most overlooked story of Apollo, however, is the political one: How did the notoriously moribund U.S. government manage to meet John F. Kennedy's famous deadline safely and on budget? Therein lies a tale.

As with any good story, the characters matter as much as the plot. And Apollo gave us some great characters: Kennedy and his legendary speech; rocket scientist Wernher von Braun, a modern Merlin; and, of course, Neil Armstrong, first man on the moon. There were others, of course, on whom the light didn't shine so brightly: managers, department chiefs, administrators. They didn't often make the cover of *Life* or *Newsweek*. They didn't fly on the rockets or make dazzling speeches. They were only engineers and bureaucrats, after all, plodding dully away in the background. Schoolbooks tend to skip over people like George Mueller, Robert Gilruth, George Low, Chris Kraft, Joe Shea, Rocco Petrone, Max Faget and so many others. They get the credit they deserve in some academic texts, but populist history can't be bothered with most of them.

Sometimes, it can't even be bothered with politicians. Two men in particular fought hard and sly in the ruthless Washington arena to get an American on the moon, but history usually skips over them, too, forgetting one and despising the other.

One of these men cared far more about space than Kennedy did. He also steered through some important civil-rights legislation and tried to recreate Roosevelt's New Deal in 1960s America, but it's chiefly for his flawed handling of Vietnam that we remember Lyndon Johnson. He was pushing us into space before Kennedy even campaigned for the presidency. As far back as 1957, Senate majority leader Johnson chaired a Senate subcommittee in response to the Soviets' Sputnik while President "Ike" Eisenhower dithered, convinced that spaceflight was a waste of effort. In 1958, Johnson urged the United States to accept failure in space now but to set a future goal that Russia could never match—precisely the theme taken up by Kennedy three years later.

Johnson crafted the 1958 legislation that created NASA as a civilian agency, calming Eisenhower's fears that the military-industrial complex might add space to its lethal list of playgrounds. He outsmarted the Pentagon by focusing on the National Advisory Committee for Aeronautics (NACA), which had existed since World War I to oversee research into new airplanes and was only beginning to look at space. The Pentagon looked at Johnson's legislation and saw only a dull document that changed one letter in NACA's name and apparently altered minor details of the old outfit, and so it raised no objections. Johnson was delighted at the Pentagon's mistake. The paperwork "must have been whizzed through ... on a motorcycle," he chuckled. In its first year, newborn NASA proceeded to hijack most of the Pentagon's military space projects.

NASA's first administrator, Eisenhower appointee T. Keith Glennan, didn't care much for space, by his own admission, and hoped all the fuss would die down after the Mercury "man in a can" shots were completed. But he put the agency on solid footing. He also allowed detailed plans for future space flights to be formulated, though he never truly believed they would amount to anything. He was amazed when the entire country went crazy for the first Mercury astronauts.

Eisenhower gave way to Kennedy's "Camelot" in 1961, and Johnson sacrificed his influence in the Senate to become vice president. To give him something harmless to do, Kennedy put Johnson in charge of the Space Council, which was supposed to be a presidential responsibility. This move reinforced the perception of the space agency staff, still struggling with the Mercury program, that Kennedy didn't really care about them. But Johnson, frustrated in so many policy areas as vice president, managed to retain his influence in the space program precisely because Kennedy wasn't much concerned with NASA during his first months in office.

With Kennedy in office, James Webb stepped into the top slot at the space agency. At 55, he thought he was at the tail end of an already successful career in management and government, and he didn't really want the NASA job. Senator Robert Kerr recommended

Webb to his friend and ally, Johnson. Kennedy's brother Bobby once said of Webb, "[JFK] frequently said that had he realized . . . how important [NASA] was going to be, he never would have made Jim Webb the head of it . . . [Webb] was rather a blabbermouth."

Webb turned out to be one of the best things that ever happened to NASA. Like Johnson, he came across as something of a Southern good ol' boy, which may partly explain why the socially sophisticated East Coast Kennedys initially misjudged him. Behind the accent and bumbling manner, he matched Johnson's cunning when it came to playing political games on Capitol Hill.

One of Webb's first moves was to place NASA's new Manned Spaceflight Center about as far away from the rocket-launch facilities as possible. What the hell did Houston, Texas—an oil town—have to do with the space business? everyone wondered. The answer: absolutely nothing, and that was a problem Johnson and Webb were keen to solve.

Trudging up to Capitol Hill on the lookout for cash, NASA's people had to face Senator Albert Thomas of Texas, who chaired their appropriations committee—a man who could reduce fund-seeking bureaucrats to tears with his harsh and detailed questioning. He had often "suggested" to Glennan that NASA build something in Texas, but Glennan insisted there existed no sensible reasons for doing so. Webb and Johnson, however, calculated that the political advantages of putting a big facility in Texas far outweighed the physical drawbacks. Webb accepted a very convenient donation from Rice University—arranged partially by the powerful Senator Kerr—of 1,000 acres located just outside Houston, and Thomas's aggressive attitude to NASA quickly evaporated.

Houston took NASA to its bosom like a fond mama and provided stout political support. Suddenly it wasn't just an oil town anymore; it was the home of both oil and space, which was Thomas's goal all along. Johnson and Webb cut the senator a deal, like the good Southern players they were. This unorthodox bit of business, somewhat distrusted at the time, helped secure NASA's long-term future.

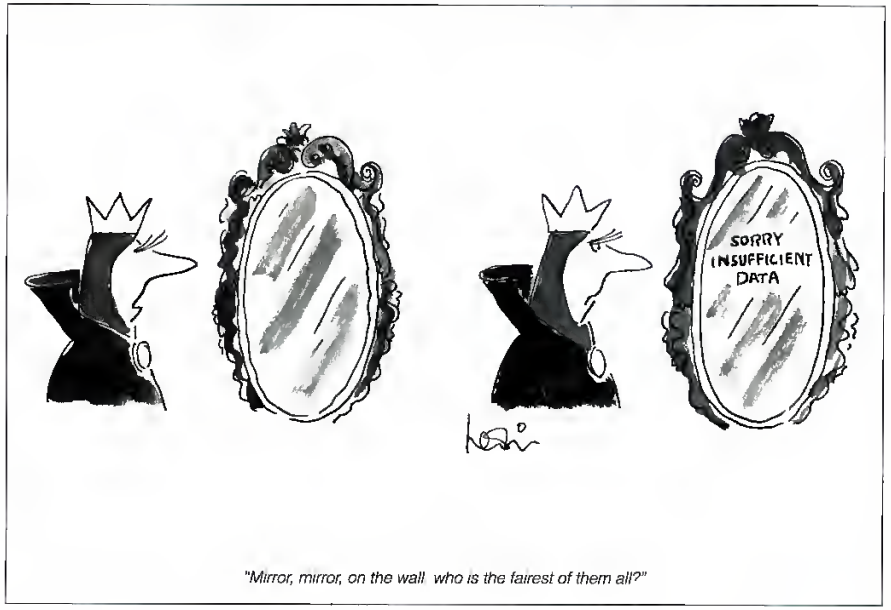
Meanwhile, Kennedy became very interested in space and much more reliant on Webb after a particularly embarrassing week during April 1961. The Soviets put Yuri Gagarin into orbit on April 12, and the Bay of Pigs invasion of Cuba backfired just five days later. Kennedy turned to Johnson and asked him to come up with a suggestion for beating the Soviets: a trip to the moon, a space lab, anything. Johnson, in turn, pushed Webb to come up with a lunar landing scheme, although even Webb wasn't sure yet if it could be done. NASA's engineers had started planning Apollo on paper in the agency's earliest days, but Kennedy's famous speech in May 1961 surprised NASA as much as it did the rest of the country.

How much would a trip to the moon cost? Webb consulted his people, who, naturally, waxed enthusiastic about going to the moon but hesitated to set a price. Too low, and they'd never get there; too high, and Congress would never agree to fund the project. Eventually, they told Webb it would take $10 billion to get the job done. He told them to go away and think again and be realistic this time. They came back with a figure of $13 billion.

Webb then calmly reported to Kennedy—and the fearsome Albert Thomas—that a moonshot would cost upwards of $20 billion.

Where did he get that figure? asked one of Webb's startled deputies.

"I put an administrator's discount on it," Webb replied.



"Mirror, mirror, on the wall, who is the fairest of them all?"

This cool bluff enabled NASA to reach the moon on time and on the stated budget, with enough leeway in its total spending of $40 billion over those years to initiate the *Viking, Pioneer* and *Voyager* probes, which might never have been funded otherwise. Every year, of course, NASA still had to fight Congress for its funds, particularly after Kennedy's death. Webb's "discount" meant that Congress had a high figure to claw back from, and what it left NASA to play with amounted to just about enough. Only after 1967 did the slide into genuine shortfall begin.

Every large organization has its share of dustups, resignations, and reshuffles. The space people had their own power struggles, naturally, but under Webb the agency quickly settled into its stride, and a remarkably happy team set to work. NASA became a "flat" organization. Junior staffers had only one or two levels to go through if they wanted to alert superiors about a problem or get a decision. There was also very little jockeying for position under Webb. Everybody enjoyed their work too much to bother. Occasionally, senior staffers would even request a downgrade of their status so they could work on some particular aspect of the program that interested them.

Webb had more than just NASA to handle. He faced the task of taming the industrial companies that would actually build the space vehicles and equipment. To some of these powerful corporations familiar with government contracts, NASA looked like a fat cash cow begging to be milked. Webb and his managers attempted to impose strict controls on the agency's relations with contractors. You didn't "do lunch" with them, and you certainly didn't do them any favors.

Some of the contractors found it difficult to adjust to Webb's way of doing business. By comparison, building missiles and jet planes for the Pentagon was much easier. In the rather shadowy world of defense procurement, the failure of a missile here or there doesn't matter much, not when you're building hundreds of them. But the civilians at NASA were harder to please. They intended to put people inside those missiles and then show everything live on national television. Understandably, they demanded standards of quality control much tougher than those for most military hardware. Failure of any kind was unthinkable.

NASA eventually awarded the contract to build the Apollo capsule to North American Aviation, a controversial choice. It developed into James Webb's only major crisis: the *Apollo 1* fire of January 1967, in which three astronauts—White, Chaffee, and Grissom—died of asphyxiation during ground tests. North American just didn't seem to understand that a crewed space vehicle was a very sensitive beast. It had to be *perfect*. NASA, after all, was basically flying people into space atop giant stacks of explosives.

After the *Apollo 1* fire, NASA personnel tore apart the next Apollo capsule, fresh from the North American plant at Downey, California. They found more than 1,000 critical faults in wiring and construction. Then they tore the contractor apart. And Congress did the same to NASA. It was Webb's darkest hour.

Another bluff was called for.

Webb summoned North American's chief executives into his office and told them, straight out, that things had to be done NASA's way or not at all. That might be difficult, replied the executives. Webb then contacted several other companies, asking them to submit bids immediately for completion of the Apollo capsule. North American got the point and reorganized its construction effort from top to bottom.

Webb's bluff resulted in an upgraded capsule that NASA and the astronauts quickly came to regard as a very fine spacecraft. Apollo's conical command modules came to symbolize flawless can-do technical excellence. But if Webb had taken the contract away from North American and given it to someone else, NASA wouldn't have achieved a lunar landing inside Kennedy's deadline. Webb and NASA would have failed in their task.

Who said a desk job has to be boring? In his own way, Webb handled risks as great as those the astronauts took, and day by day he lived with a constant and secret fear that a mission would be lost and space crews would die. His NASA prevented that from happening. When *Apollo 13* exploded on the way to the moon (through no fault of North American), there was enough margin in the spacecraft and skill on the ground to get the crew back home safe and sound. Good management saved the mission.

Webb also understood that Kennedy wanted more out of him than just rockets. The young president wanted to boost standards of education and industrial excellence in general, using space as a lever. So Webb instituted NASA-related education programs, which turned out thousands of degree holders while more mainstream education bills languished on Capitol Hill.

The moon program was arguably one of the most investment-effective social schemes of all time. In the peak years of Apollo, the program employed close to 40,000 Americans in dozens of different facilities. At that time, NASA was the seventh-largest government department. Of course, the agency heard criticism of the vast sums of money involved in Apollo, but the cash definitely wasn't wasted. Nearly a half-million additional contractor employees, in any number of companies, fed their families out of Apollo and recycled their salaries into the U.S. economy.

Kennedy may have made the speech and guided the social aspects of Apollo, but the program owes its success as much to Johnson as to Kennedy. Johnson became president in November 1963 at the cost of JFK's life—a terrible prize. He won the 1964 election in his own right, but the Vietnam crisis had already begun to destroy him. Eventually, he paid the price of national failure in that war. He died a broken and misunderstood man in 1973 after having quit politics without running for a second presidential term.

Webb retired before the moon landings took place when it became clear that Johnson's days were over. He knew he had no future under the new

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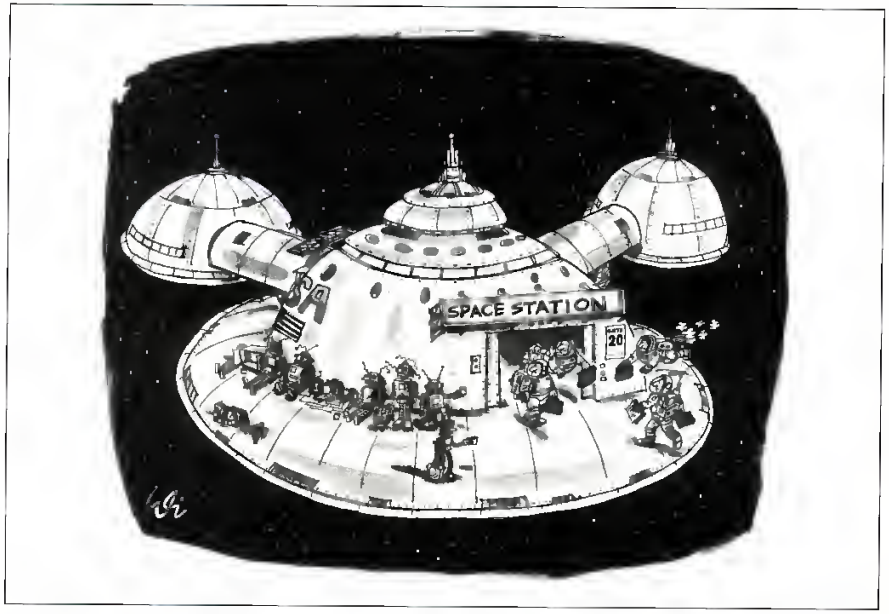

be in the form of a carbon copy, microfilm, or rapidly degrading thermal fax paper, barely legible in the original. Other files were lost or routinely destroyed on a regular basis.

Still, one had to start somewhere, and CAUS was determined to track down and make public as many of the existing documents as it could. In its quest for truth, the new group would put out a newsletter called *Just Cause*, and, with the help of UFO researcher Brad Sparks and attorney Peter Gersten, tread legal waters no UFO group had entered before. "We were full of fire," Zechel now recalls. "We had served the government notice, we weren't going to take their stonewalling anymore, and if necessary, we would haul them into court."

The euphoria was not misplaced. As the Seventies unfurled, most UFOlogists felt that all they needed in the battle against the governmental Goliath was one good slingshot. And now that slingshot, in the form of the newly enacted Freedom of Information Act, or FOIA, was here.

Signed into law in 1966 by a Democratic Congress under President Lyndon Johnson, FOIA (affectionately called "foya") was created so the public could access all but the most highly classified government records. Nine categories of information were originally exempted from scrutiny, beginning with those affecting national security and foreign policy and then trickling down into fairly mundane materials like maps. UFOs, of course, weren't mentioned at all.

Then, in the mid Seventies, the Nixon administration gave FOIA more muscle still. Time limits were imposed on agencies receiving FOIA requests. Affordable fees for the search and reproduction of requested documents were established, and courts were empowered to decide whether or not specific documents fell within the act's guidelines.

In the real world outside the halls of Congress, however, the soldiers for CAUS found land mines strewn across the battlefield. The first CAUS célèbre, Zechel states, occurred before the Wisconsin group was officially formed. It was 1977, and Zechel, Sparks, and Gersten made their stab at wielding the FOIA through the auspices of the now-defunct Ground Saucer Watch, a UFO group based in Phoenix. In 1975, it turns out, the Phoenix group's director, Bill Spaulding, had written the CIA complaining it had withheld a vast quantity of information on UFOs.

"It wasn't an official FOIA request as such," Zechel says, "but more like an accusatory letter. Surprisingly, the CIA responded."

Specifically, Spaulding had referenced the case of one Ralph Mayher, a marine photographer who claimed to have filmed a UFO over Miami Bay in July of 1952. Mayher went on to become a celebrated news cameraman with ABC news in Los Angeles. Not surprisingly, under the circumstances, he also signed on as consultant to one of the more prominent UFO organizations of the day—the National Investigations Committee on Aerial Phenomena, or NICAP. Only years later did Mayher learn that, unbeknownst to him, his original film had been turned over to the CIA for analysis.

Looking into the matter, the CIA's response to Spaulding was expected: Its interest in UFOs was virtually nonexistent, the Agency declared, and had been ever since 1953, when a panel of scientists met in Washington to declare the phenomenon a public-relations problem, nothing more. But much to Spaulding's surprise, the spy agency also released two documents relating to the Mayher case. "The Agency had blacked out about 70 percent of the documents," Zechel states, "and also referred to three other related documents still in their possession."

AS THE SEVENTIES UNFURLED, UFOLOGISTS FELT ALL THEY NEEDED IN THE BATTLE AGAINST THE GOVERNMENT GOLIATH WAS A SLINGSHOT. THEN THAT SLINGSHOT, THE FREEDOM OF INFORMATION ACT, ARRIVED.

Zechel retained Gersten, who in 1977 filed a suit seeking full release of all five documents. The case wound up in federal district court as *GSW vs. the CIA* under the jurisdiction of Judge John Pratt. After protracted legal maneuverings, lawyers for both sides finally met with representatives of the attorney general's office in Washington in July of 1978.

"At that meeting," according to Zechel, "I had threatened to have the CIA prosecuted for making false replies under the FOIA. Ultimately, the Agency agreed to search all of its files for UFO records and to stipulate which ones it would release and which it wouldn't. As the FOIA was structured at the time, the CIA was also obligated to account for any deletions on an item-by-item basis."

As Zechel recalls, the CIA missed its original 90-day deadline by 88 days. "Then they dumped a stack of documents on our desk about two to three feet thick, heavily blacked out, and with none of the deletions accounted for," Zechel states. "We now had 30 days to try to identify and contest the deletions, which was humanly impossible."

Instead, Gersten filed a motion claiming the CIA stood in contempt of court and clearly had not acted in good faith. The motion was filed after GSW's own 30-day response deadline had expired, however, and Judge Pratt summarily dismissed the suit. "We were one day late," Zechel recalls, "and that effectively ended the suit."

But when all was said and done, the CIA decided to release some 900 pages of UFO-related documents. Indeed, like the CIA, many agencies decided to release documents even when courts did not force their hands. A request for UFO files from the FBI, for instance, netted almost 2,000 pages. By scrutinizing documents obtained from the FBI and CIA, moreover, CAUS researchers were able to identify witnesses. They could also pinpoint relevant incidents likely to be described in documents on file with a host of other government agencies.

Ultimately, CAUS would be responsible for the release of between 7,000 and 8,000 UFO-related documents from a who's who of official entities, including the Air Force, Coast Guard, Navy, Defense Intelligence Agency, North American Aerospace Defense Command, Federal Aviation Administration, and others.

Among the major tidbits revealed were a series of sightings reported from October through November 1975 by the northern tier of Air Force bases from Montana to Maine; several of these sightings involved personnel stationed at Minuteman silos. CAUS also uncovered a September 1976 file on an Imperial Iranian Air Force jet that reportedly locked its radar onto a bright UFO only to have its electronic weapons system fail.

CAUS's most celebrated suit, however, was the one it launched against the supersecret National Security Agency (NSA) in December 1979. The case was not fully resolved until March

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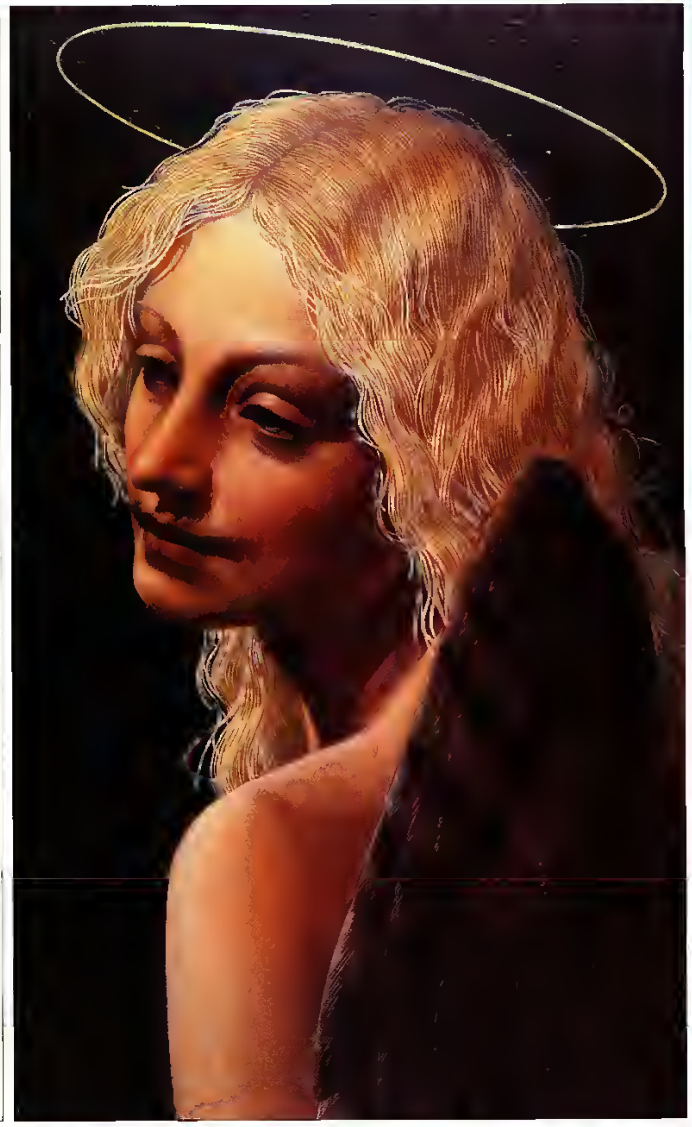
QUEEN OF ANGELS

A COMPASSIONATE HEALER IS MOVED BY THE PLIGHT OF A HELPLESS STRANGER AND IS REWARDED WITH A GLIMPSE OF WHAT MAY BE THE ULTIMATE MYSTERY—OR MAY NOT BE.



FICTION BY KATHE KOJA ~ ILLUSTRATION BY JIM HIMSWORTH

In the water-green half-light his lips protrude, moist starlet red. Glossy and swollen as sweet infection, his irises are gray. When she touches him, he makes no sound at all, but his lips move.

He might ba praying, or trying to speak.

Ha naver says her name.

Down the hall again, still. Just after nine on tha heavy clock, white face in dust behind bland mesh and big black numbers you could see from either end of the hall, the all-purpose institutional clock. Hospitals and schools. And prisons. And nursing homes. Walking, her back threatening to lock, that feeling again like grinding bones in sockets scraped dry and she leanad for a moment against the wall. Tired inside and out, calf muscles cramping like they had all day, every day, she was so tired of working here. Continuing care, right. Tired of bending over, of tha smells and the way shit feals betwean your fingers, you're wearing gloves but that doesn't reaily help, does it? The endless rosary of pills, meds twice a shift and she was tired of that too. Tylenol and vitamins, and Darvocett. And Xanax. She wished she could have some Xanax. In the room closest to her, Mrs. Reichert was screaming again. Pratty soon they would all be screaming.

She was so tired of hearing people scraam.

She had been here for four years, but they were all still people to her, helpless. Most of the aides called them by their illnesses, their ailments, walking tragedies: the Parkinson's, the CVAs, the Alzheimers. a whole family's worth of Alzheimers. Strokes and dementia, congastive heart failure.

Her name was Deborah, but he never said her name.

The first tima she saw him he was wrapped like a pupa, mummy in white, bony and incongruous, shivering mute with some vast disturbance, he could not talk, his family talked too quietly and at such length that she could not stop to listen, she had work to do. Count meds, her fat shifting pile of paperwork: charting BMs and electrolyte counts, blood and urine, all the fluids rich and thin, a whole future in a plastic sample container. I can tell you where you'll be in a year, six months, six weeks.

The family was in a hurry, despite the time they spent talking, she saw them go. None of them said goodbye to their—what? Husband? Brother? Little brother. He was barely forty, she saw. Elliot. His name was Elliot, and he had had a stroke, a cardiovascular accident. Some accident. With good care he would live a long time, but he would never know a minute of it.

Would he? Did they know, the ones whose brains took disaster's brunt while leaving their bodies intact, slow wreck of blood and shoaling bone, andlessness replicated with each breath, each intubation? The nurses and aides debated this, when they had time: a few minutes with coffee or a Coke, one of the aides dropping ashes on his shoes, sneakers. She wore sneakers too. She used to wear regular nurse shoes but found she liked sneakers better, sometimes she had to move very fast and the crepe soles had slowed her down.

"Does he even know he's in there, that's what I wonder." The aida dropped ashes again. "I mean, *look* at him. Look at any of 'em."

She shrugged. The other nursa sipped coffee, cursed softly for a scalded lip, shook her head. "They're not thara anymore, no way. They're just empty bottles." The image seemed to please her, she said it again. "Empty bottles," and when Deborah shrugged again, "Come on, Deb. You know that."

"I don't know anything."

Her back locked again in half a motion, dry pestle grind. The aide put out his cigarette. "Hey Deb," the other nurse said. She had a jaundiced bruise shaped heavy as a thumbprint above her left eyebrow. "You really believe that? That they can hear us, they know what's going on?"

No. I don't know. "I don't know what I believe."

"If it ever happens to me," quick paper squeeze betwean strong fingers, tossing her empty cup in the trash, "I know what I want and fuck my family. No code, no way."

"Get a MedAlert bracelet," Deborah said. "'Slow Code.'"

Full code meant resuscitate, no code meant what it said. All the patients wanted was a way out, but sometimes the families were obdurate: do everything possible, they said. Guilt and rage and terror,

as if keeping them alive meant anything anymore, rag talismans strapped and bleeding and feeding from tubes, tubes for food and tubes for shit and someone's daughter, someone's niece, someone's grandson shaking their heads. Bring her back, they said. If anything happens, bring him back. Slow code was the compromise, the last mercy unspoken. Stop for a drink of water, stop to check your watch. Inside the room the decision is in progress, relentless as the process of birth. We did everything we could, and it is a fact, like oxygen, it is simply the truth.

Elliot was a no-code.

Nothing was too likely to happen to Elliot, though, except for an essentially empty head he was in pretty good shape. Waxy as a still Pietà Christ, long muscles in the cheap cleanser-blue pajamas and less trouble than a potted plant; the smell from his body was warm, the way a baby is warm, damp smooth skin against a sheltering cheek. Deborah's notes on his chart were routine. She never wrote down the way he smelled, the peculiar oval shape of his lips as if steeped in a pleasing dream. He never screamed, cried, cried out. No one ever came to see him.

Which in its way was good. Immersed in permanent solitude, he missed no one, unlike some of the others, the daily pitiful litany. Where is my husband? Where is June, my daughter June? Is Michael here? A very few of them had families who came every day, to nurse their own, each deadening chore made sacred by abundant martyring love. To feed, coax with homemade delicacies mouths too slack to chew; to wash them, to change their laundry, soft pastel percale, bright flowers. To read to them, to talk. It was sadder that way, hideous the families' suffering, but it made Deborah feel obscurely better. The ones she hated to see were the ones who came once a year, hectic with their own agenda, guilt and loathing vivid as a blood trail and full of complaints and rages for the staff. Perhaps the patient has not had her diaper changed this hour, perhaps the patient's hair has not yet been washed. They explode as if finding vivisection in process, curse and call names. Last month a man poked Deborah in the name badge, stiff finger so hard the thin plastic edge eased like a needle through her uniform and into her skin.

"I *don't*," poking, "want to see my mother like this. *Ever*. Do you understand me?"

Go fuck yourself. "What's the matter?" leaning a little away from him, his pointing finger, his bitter cigarette breath. His mother was Mrs. White, Susanna, another CVA, victim of a carotid artery angioplasty that loosed a clot unseen like death itself come claiming through her veins. Quad and trach and tube-feed and oxygen, that was Susanna. She had two daughters living three thousand miles away, and a son close enough for daily visits. It was two days after Christmas, his annual appearance and he poked Deborah again.

"She *smells*," he said.

"We'll take care of it," Deborah said.

"Don't patronize me," he said. "I'm paying for all this."

And heaven too. "We'll take care of it," she said, in the tone of voice she sometimes used when a patient was particularly hysterical, an iron gentility that usually worked on some level and it was working now, the man was turning away, pulling on his coat, expensive coat. After he had gone she went into Susanna's room and stood beside her for a moment. In the room a faint antiseptic smell, less offensive than an open container of Vicks. Susanna's closed eyes were lidded in layers, like sand dunes, like snow drifts. Deborah felt tired, exquisitely tired, exquisitely sorrowful, but did not cry. Sometimes the patients cried, when the pain got too bad. "Kill me, Debbie." That's what they said. Kill me, Debbie, oh, Debbie let me die.

"I can't do that," she would say. "That's not what I'm here for." Then she would go home and vomit—or sit in a chair without moving, without taking off her coat or shoes, a peculiar red illness moving like a secret snake through stomach and lungs as if her body itself were crying, tears of slow and heavy blood.

Elliot never cried. Or moved. Or spoke. Elliot's muscles were holding up surprisingly well, he was not withering as quickly as expected. The first time his eyes came open, Deborah immediately beeped his doctor, who upon inspection informed her that what she had reported had not happened.

Nothing there, pale gray as winter water frozen in the last moment of motion. Drowning Elliot, slender bony chin, sarcophagus profile and her stethoscope brushed against his chest as now she bent, back painful, to adjust the slender slope of a tube.

and his eyes did not move

and from his lips extruded a delicate drop of matter as fragile as a pearl, that rolled across his cheek to lie like an angel's tear on the black-stamped linen of his bed.

She picked it up.

There in the baggy pocket of her clinician's coat and her hand kept moving to touch it, roll it between nervous fingers, she had checked him twice as often as necessary through her shift but there was no change, no others like it lying beside him, Elliot inert, winter windows gray with the breath of others, it was a creamy color, hard as bone.

Maybe it was bone.

She checked him once more before leaving, the pillows, the linen beside him was bare. His lips looked slightly sore, as if chapped by the wind. His vitals were okay. "Elliot," she said, not to him.

His mouth moved, lips pursing almost like a kiss, an exaggerated Hollywood kiss, but nothing came out, nothing she could see. Her hands shook as she bent to the pillow, the face upon it calm as a dead saint, his eyes did not open, but moved, slow, slow, beneath the shelter of his lids, back and forth like thoughts, the nature of rumination, the play of muscles whose services are by time made moot.

"Elliot?" she said again, to him, a question.

In the hall the sound of the midnight shift, the aides talking quietly to one another, the pearl was in her hand as she left the room.

Instead of sleeping she sat up, the pearl before her on the kitchen table, a space pushed clear of half-empty cereal boxes and Sanka jars and a napkin holder shaped like a triangle. She looked at it dry-eyed in the wash of overhead light. It was not bone, it was not a tooth, or part of one. It was not a gallstone, or kidney stone, it was not a real pearl. She had an impulse to cut it in half, scrape its surface with a nail file but in the end did not, left it whole, left it there on the table on a pale paper

THE FIRST TIME SHE SAW HIM HE WAS WRAPPED LIKE A PUPA, MUMMY IN WHITE, BONY AND INCONGRUOUS, SHIVERING MUTE WITH SOME VAST DISTURBANCE, HE COULD NOT TALK.

napkin and when she slept at last dreamed thinly, not of it or Elliot but of walking forever on a helix still and dusty, no feeling at all but the silent grind of sand beneath her feet.

According to his chart, in two shifts' time Elliot had not produced anything other than some unexceptional urine, but the rest of the last shift had been busy. Hakim Richardson had had another stroke and was sent to the hospital, Mr. Zelinksi died. Mary Yost had escaped her restraints and ate half an Efferdent before she was caught. This brought on some reminiscences of a former patient, an Alzheimer's who ate soap, slim motel-size bars of Ivory, she would not touch another kind.

"Ivory was her brand," the day nurse supervisor said, smiling as if at the antics of a particularly precocious child, or a clever pet.

"Maybe she liked the taste," Deborah said. She was irritable with lack of sleep, her eyes as sticky-dry as the bottoms of her shoes, she had stepped in something on her way down the hall, back from Elliot's room. Today he seemed paler, his closed eyes did not move at all. His hair looked dirty. There was nothing on the pillow or sheets but she lingered, wanting somehow not to touch but to reach, to connect.

Screams from down the hall, someone hollered "Deb!" and she ran, stethoscope banging back against her chest, pounding dull and painful like a little metal heart.

By the time she gave report to the midnight shift it was 11:30, there were still narcotics to count, she had to finish up charting but—stopped, inevitable, before Elliot's door, tired now, and ready to concede it as sheer strangeness, to reaffirm her correct decision not to chart the pearl, any of it—to tell no one.

Inside, a distinct smell, not one she knew.

Her heart felt strange, tight in her body like an overdeveloped muscle and she approached Elliot as if he might spring up, already she saw his eyes, closed and restless back and forth and then a soundless string like bubbles, spit bubbles and there were at least a dozen of them, popping from between his lips to roll on a snail's path of drool down to the wet square between pillow and blue shoulder, thirteen, fifteen, she swept them all into her cupping hand, hot and wet and her hands were shaking hard enough to be clumsy; she thought she might have dropped one of the pearls but now he had stopped producing them, nothing there but saliva and closed lips.

His eyes had stopped moving.

"Elliot," whispering, the air between her lips warm with that smell, "Elliot." Urgent. "What do you want?"

Nothing.

She had to count the narcotics twice to make them add up correctly, her hands so awkward the other nurse noticed, asked if she were all right. "Fine," lying, what a poor liar she was. "Just tired." The pearls made a wet square in her pocket, visible moisture. Did anyone see? She almost ran a red light going home, stumbled in the kitchen and scraped her shin against the bare leg of a chair. There were too many pearls to fit on the napkin so she hunted up a little jar, little glass cosmetic jar long bare of whatever sweet cream folly it had held, still trapped inside the faint emollient smell. The pearls lay three deep, nestled in the smell, matte against the glass and she took them with her to the bedroom, set them square on the scarred night stand so she could lie on one elbow and consider them: light on, eyes open. There were seventeen, she counted them twice and firmly, seventeen pearls that were not pearls. Elliot's extrusions. Elliot's, what? Voice? Words. Pearls of wisdom, and she smiled a little but without true humor, there was nothing funny here, there was nothing that she understood. Maybe you had to be like he was to understand, maybe you had to be locked like a boat stuck in ice, like a bricked-in pet, a fetus bobbing endlessly in faint formaldehyde against a jar just like this one, here in her hand.

filled with pearls.

that as she watched turned from pale to pink, to dark pink, to red, heavy red and then almost brown, like menstrual blood. Like the surface of a fresh scab. Like an insect crushed juicy and left to dry, mummy-dark on the plain of a screen.

She did not know whether to scream or drop the jar, or call and see if something had happened to Elliot, or empty the pearls down the toilet and pretend she had never seen anything; in the end she did nothing, and in that elongation found sleep to be a long nod, waking to instant consciousness with the pearls primly jarred beside her, safe and snug and surely there.

The day shift nurse's report, hurrying through the patient list till his name, leaping out—and beside it, no change. Nothing.

"How was it?" not so much casual as flat, peripheral gaze. "Anything interesting?" Anybody extrude anything, you know, pearls? No?

"Same old same old." The day nurse supervisor, purse in hand. "You're short-handed today, looks like David called in sick just a little bit ago."

She shrugged, felt as if there were wires pulling her down the hall, thin almost invisible flesh-colored wires. "Have a good one," the day nurse said.

Elliot's room smelled of nothing: dust, furnace exhalation. His sheets had not been changed. She could see the faint indentation, pattern of wetness dried where the pearls had been. He lay very still as always but informed somehow by a new—weariness? Can one be weary who never moves? Exhaustion, then, say, or say weakness and see its signs, around his lips faint brackets, wrinkles, deeper around the eyes, forever closed in sockets bruised and plummy as an old man's, the skin there softer, soft as the skin of his lips unmarred by blisters, by fluid, by pearls.

"Deb."

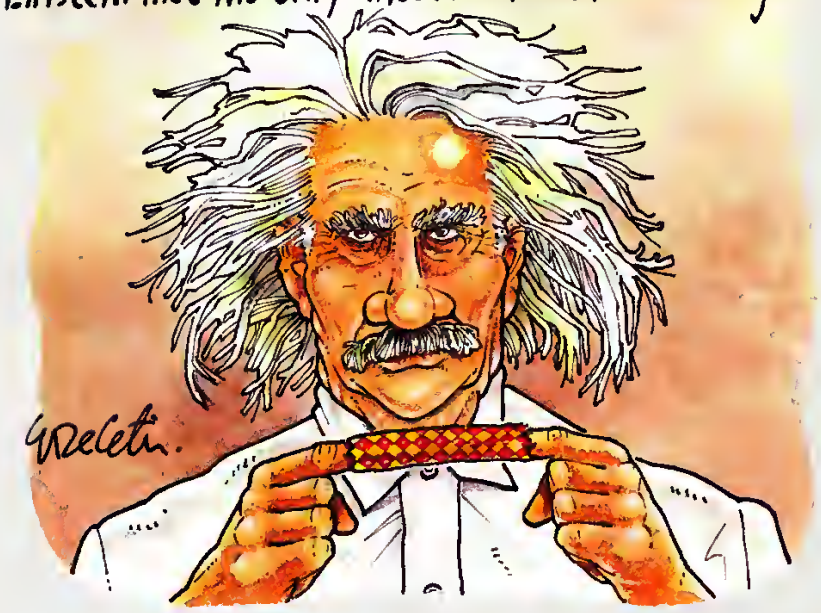
Crossly, and her own huge startle, from the doorway, leaning in. "What're you doing? Come on, we need to get going." The other nurse, bruise above her eye now a fruity green, harassed already. "Did you know that asshole David called in sick? Again?"

Down the hall, grinding spine and the tug of wires and it stayed that way all day, even the patients seemed worse, fractious, shrieking, there were fights and falls and everything, showers, meals, meds, running late, she did not see Elliot again but did not cease to feel the wires. A headache began about ten, heavy, thick behind the curve of her forehead like beating blood, three Tylenols with a grimace of cold coffee and as she swallowed thought, Did Elliot feel it, when the pearls came out? Did they hurt?

CONTINUED ON PAGE 60

> HE HAD LOST MORE WEIGHT, HE LAY LIKE PAPER IN THE BED, LIKE SOME CUNNING WASP'S CONSTRUCTION OF WHAT A HUMAN BEING MIGHT BE, SPUN GRAY AND WEIGHTLESS: DEATH'S COCOON.

It wasn't until he fathomed Brownian motion and the photoelectric effect as well as the theories of atomic spectra and relativity that Einstein met his only insurmountable challenge.

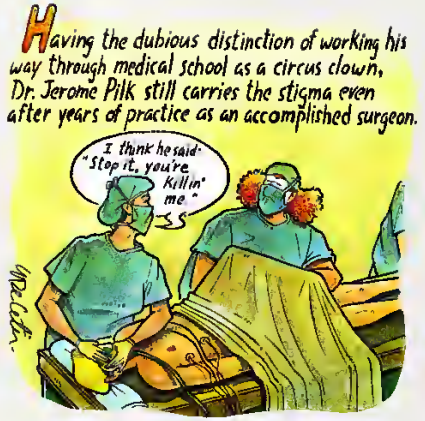


GREAT MOMENTS IN SCIENCE

SCIENCE

Theories, formulae, experiments, postulates—and laughter. That's right: Too often science is depicted as cold and humorless. This new feature is designed to remedy that.

SATIRE BY ERIC JAY DECETIS


Having the dubious distinction of working his way through medical school as a circus clown, Dr. Jerome Pilk still carries the stigma even after years of practice as an accomplished surgeon.
I think he said "Stop it, you're Killin' me."
©DeCetis.


And to this very day the whereabouts of Keekoh, the world's first and only human-to-baboon liver transplant recipient, remains a mystery.
Buuuuurrrp.
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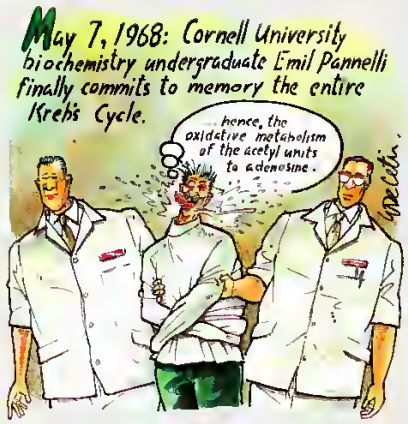
May 7, 1968: Cornell University biochemistry undergraduate Emil Pannelli finally commits to memory the entire Krebs Cycle.
...hence, the oxidative metabolism of the acetyl units to adenosine.
©DeCetis.


Early zoologist and part-time street musician Antonio-Paulo Giaccometta ponders an alternate partner in hopes of increasing revenue.
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In an attempt to resolve the problem of frequently misplacing a most common household appliance, TV repairman and entrepreneur Allen Kotter tests the world's first surgically implanted remote control.
Wheel... of... Fortune!
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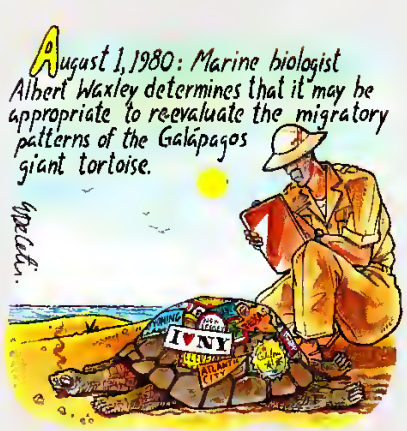
August 1, 1980: Marine biologist Albert Waxley determines that it may be appropriate to re-evaluate the migratory patterns of the Galápagos giant tortoise.
I ♥ NY
©DeCetis.


Spring, 1952: Although touted as the nutritional baby food of the future, the new puréed red cabbage and sea bass combination proved to be a major marketing disaster.
©DeCetis.


Although his quest for the elusive fountain of youth was never fulfilled, Spanish explorer Ponce de Leon did, however, inadvertently in early 1520 stumble upon the fountain of warts, acne and unsightly fever blisters.
What?
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INTERVIEW

GARY NABHAN

A DESERT ETHNOBOTANIST AND WRITER RESCUES THE RAREST NATIVE PLANT SPECIES—AND DINES BETTER IN THE PROCESS.

PHOTOGRAPHS BY JOHN RUNNING

Near a spring-fed lake used for irrigation, Gary Nabhan watched as an elderly Tohono O'odham Indian picked at overgrowth. The Indian's beautifully tended plot is one of a pair of desert oases, on either side of the United States–Mexico border, that has been farmed by the O'odham for centuries. According to ethnobotanist and nature writer Nabhan, it is one of the most species-diverse five-hectare sites in any North American desert.

The old farmer stopped beneath a pomegranate tree, wiped his brow, leaned on his hoe, and began to tell Nabhan how he couldn't figure out what was nibbling at his crops until he came down in the middle of the night to catch the thief in the act: leaf-cutting ants. Leaf-cutting ants may be a *minor* problem for the peoples formerly called the Pima and Papago. Few O'odham youngsters have interest in living in the desert in the ways of their grandfathers. Fewer each year are listening to their folk science of the desert stories, maintaining their traditional plant gathering, or learning to tend their native crops. Nabhan does. Vested in keeping these desert traditions alive, he and the elderly O'odham are kindred spirits.

A MacArthur fellow and Pew scholar, Nabhan is a scientist and an active proponent of indigenous rights. Indeed, it is the synergism between native plants and indigenous cultures that most informs his writing and research. These plants helped shape and succor cultures within the Sonoran Desert, he says. They served as sources of energy, cures, and characters in tribal legend.

NATIVE SEEDS/ SEARCH COLLECTS AND REDISTRIBUTES INDIGENOUS SEEDS AND PLANTS THROUGHOUT THE SONORAN DESERT REGION. FROM THE TOP: MAGDELENA BIG CHEESE SQUASH, BEIGE LIMA BEANS, TEPARY BEANS, AND PABRAL CUSHAW SQUASH.

Nabhan and his wife, Caroline Wilson, live in what he euphemistically calls the "Stinkin' Hot Desert" National Monument in Arizona's Sonoran Desert, the most biologically diverse arid land in the world. Their backyard is naturally landscaped with mesquite, chollas, and prickly pear, along with some 2,000 other species. Although Caroline, an interpretive specialist for the National Parks Service, had been a fan of her husband's writing, before meeting him she had pictured "an old man with a bow tie and baggy seat." The 40-something Nabhan is casual and bearded, with muscular legs—hardly the bespectacled geezer his wife had conjured up.

Nabhan was born into a Lebanese-American clan and raised 40 miles from Chicago in the Indiana Dunes, so ethnic culture and wide open spaces were early determinants in his career as an ethnobotanist. As a child, however, his first interest was art—until finding out he was colorblind—then writing and literature. He only discovered biology when attending Prescott College in Arizona. Much of his work centers around Native Seeds/SEARCH, a nonprofit conservation organization he co-founded in 1983 to preserve traditional seeds and crops of the U.S. Southwest and northern Mexico. As his writing points out, cultural change, land transfer, and environmental degradation have been contributing to the steady erosion of crop diversity since the arrival of Columbus. Over the last decade, Native Seeds/SEARCH has collected and redistributed seeds to more than two dozen tribes and keeps 1,200 folk varieties of 15 pre-Columbian crops in its seed bank.

When I first spoke to Nabhan in Guatemala, where we were both studying Spanish for a few weeks, he noted that the underlying theme running through his work is the necessity of a multicultural approach to environmental issues. "There are some 70 different cultures in the U.S. Southwest. Any solutions must involve them and not be based solely on the dominant culture's paradigms," he said.

A month later in Tucson, we began the day at Native Seeds/SEARCH, then went to see the deforestation along the Arizona-Mexico border before driving out to the desert oasis. Toward the end of the day, as we returned to the national park, Nabhan, a devoted runner, was anxious to get in a few miles before dinner. "I've been thinking about writing a book on the natural history of running in the wild places," he threw in offhandedly. "It's a completely different way of seeing the land than walking."

—Carol Goodstein

Omni: Do you identify with traditional Indian ways?

Nabhan: I am not an Indian and am not trying to be, but I respect all ancient ethnic traditions. As I began to work with native peoples, I realized that the best artists and singers in ceremonies had detailed knowledge of native plants. In part, this was because the plants used in ceremonies and the images, songs, and motifs in ceremonial art were often related to the plants that were used for healing.

Omni: What part did your own ethnic heritage play in your choice of careers?

Nabhan: A big part. When I began working with native people, I probably put them on such a pedestal. Being shy, I had virtually no long-term friendships with them until I had a Thanksgiving dinner with a Pima family on the reservation. The grandmother found out I was Lebanese and asked me for some recipes. It dawned on me that there could be a reciprocity between my learning about their foods and their interest in mine. Virtually every orally transmitted ethnic tradition is imperiled in some way, whether it's Australian Aborigine, Mediterranean, or Native American.

Omni: As a scientist and non-Indian, how have you managed to overcome the very justifiable suspicions Native American cultures have toward the dominant society with its history of oppression?

Nabhan: I've had the most success in cross-cultural science when I've worked with the people in their fields or taught in their schools, getting to know their families and gradually developing a reciprocal exchange of information. Some families are interested in the insights a Western scientist may have about the desert, but they don't necessarily wish to freely give away their traditional knowledge until

they understand the context in which it might be used. Often Western scientists suggest a very different context: knowledge about a medicinal plant, for instance, serving to guide major pharmaceutical development. Now more than at any other point in history, native communities are being selective in what kind of scientists they allow in their communities and the way they structure their relationships with them. This is a healthy, long-overdue trend.

Omni: Did you consciously decide to pattern your life on an approach characteristic of the way traditional Native Americans live?

Nabhan: At one point I was told to choose between being a scientist or poet and writer, but in my mid twenties that dichotomy vanished. I thought to make my life whole, I needed to see those interests and loves integrated. A college marine ecology teacher who appreciated my writing and scientific illustration, along with field work, said those things weren't mutually exclusive. "Keep all of that up. It will reinforce what you observe in the field and the new insights you bring to marine biology." Hearing a scientist say, "Don't specialize," made a big difference.

Omni: What relevant ethnobotanical information have you learned from Native Americans?

Nabhan: Living on a day-to-day basis with these plants and seeing gradual changes in their populations and size over time, the elders in Native American cultures are often the best source of information about endangered species. They know the threats to plants as well as where to find them. Certain cultures actually contribute to the biological diversity of their home ground rather than what we always hear, that people only deplete diversity. The desert oasis we visited is so diverse because wild plants have been transported there, and others persist because of protection.

There's always some symbiosis between the flora of any area and its indigenous people, largely because not all of the local plants are purely wild. Even in the starkest environments where everything appears to outsiders to be pure wilderness, longstanding land-management traditions have often powerfully influenced plant productivity. People transplant and disperse medicinal plants, use fire to manage habitats to increase the abundance of basketry and food plants, collect and divert floodwaters to irrigate wild plant populations. We found century plants had persisted on prehistoric terraces for hundreds of years after abandonment by prehistoric farmers.

Omni: What's wrong with the popular notion that equates conservation with a return to a state of wilderness?

Nabhan: Certainly wildness is a key to conservation. If we planted an area with 100 species of domestic crops, it would lack the qualities and diversity an area with 100 wild species has. The key factor here is that critics have extrapolated the worst-case examples from our own culture to show that humans can only decrease the natural diversity around them. Misguided scholars claim that if humans are present, it inevitably means a decrease in diversity and the health of an ecosystem. I'd argue that indigenous cultures—not just in the Americas, either—have found ways of augmenting the natural diversity of particular sites without greatly diminishing the wild state.

Omni: So how do Native American farming methods sustain the diversity of the environment?

Nabhan: For a decade, I studied the conservation benefits of O'odham farming practices in the Sonoran. The O'odham could conserve and increase not only the moisture-holding capacity of soils, but nitrogen contents as well. Nitrogen is the nutrient that most limits the productivity of desert ecosystems. They allowed certain desert legume trees to persist in their fields and planted a variety of nitrogen-fixing crops. They hauled leaves and composted detritus from other trees into their fields. These practices enabled them to achieve nitrogen levels comparable to Midwestern corn fields—deep, rich prairie soils with maybe 50 times the nitrogen content found in most desert soils.

Omni: Could these techniques work on a widespread scale?

Nabhan: Certain native farming traditions work so well because their vocabularies describe the geomorphology, rainfall patterns, emergence of weeds, stages of the frost-free season—all the limiting factors affecting crop production in a place-specific way. You can't take Navajo farming practices or principles—or even seeds—and transport them from the Colorado Plateau to the Sahelian or Gobi Desert and expect similar success. Only in ecological principle could some methods work on a widespread scale. For instance, many desert farming traditions utilize storm runoff, through what we call rainwater harvesting and concentration, rather than rely on pumping fossil ground water.

Omni: What led to the decline in agricultural diversity?

Nabhan: The arrival of Europeans on this continent immediately caused a huge decline in the number of farmers. In some areas, European-introduced diseases wiped out 75 percent of the native farming population within the first 50 years, and farming systems were overwhelmed by exotic livestock and weeds. Europeans seldom adopted Indian foods but imported their own. Less land being farmed by native people and fewer native crops being grown on the remaining land greatly reduced diversity.

Omni: How does hybridization contribute to loss of diversity?

Nabhan: Hybridization is not the problem per se, for it can occur naturally. The issue is what plants are being artificially hybridized for. To support plant-breeding research-and-development costs, hybrid crops are genetically engineered to be widely adaptive. Native crops were locally adaptive and fine-tuned to fit particular conditions. Over this last half century, locally adaptive crop ecotypes have been replaced by genetically adapted varieties with higher yields. These new varieties don't adapt to the environment but require alterations in the environment to fit the crop. To outyield the locals, hybrids need artificial inputs. In our region, about 60 percent of the pre-Columbian crop varieties have been lost since European colonization. In other parts of the Americas, 90 percent are now extinct. We compare the seed inventory archaeologists have compiled from looking at agricultural remains in caves and prehistoric ruins with those described by missionaries and colonists and with what exists today.

Omni: How do you decide which seeds to reintroduce?

Nabhan: It's technically possible to reintroduce and reestablish a number of plants in areas where they formerly occurred, but without a human community willing to protect that habitat, to monitor and safeguard the plants, the whole effort might have no long-term hope for survival. Plants now need people to reestablish some cultural ties with them, just as much as they need a good habitat, pollinators and seeds. Our work targets the most endangered species, the rarest ones that have some capacity for resilience. We can hardly avoid letting some of the most depleted species completely fall through the net. In the last few years, we've been asking Native Americans to list the rarest plants in their communities; then we've done surveys to see which seeds are now found in only one or two communities.

Omni: If a seed species is virtually extinct, how do you recover it?

Nabhan: This is one area where modern technology can help conservation of plants in the field. For instance, one agave, or century plant, species was down to just a couple dozen individuals that were so far apart we were afraid pollinators wouldn't be able to find them and move pollen from one plant to the next in the year they were flowering. So we collected pollen and froze it cryogenically. The next time one of the century plants came into flower, we backpacked in the frozen pollen and hand-pollinated the plant.

Omni: How did Native Seeds/SEARCH begin?

Nabhan: I was seed collecting for the USDA seed banks on the reservations of the Southwest, when the Meals for Millions Foundation asked me to grow out some for redistribution to Native Americans participating in their projects. They said, "We're trying to promote the growth of vegetables in their gardens for their nutritional benefit. But when we bring them broccoli and Brussels sprouts seeds, they never want them. They keep asking for the seeds their grandfathers grew." So I was gradually incorporated into working on the Tohono O'odham reservation. After a year or two, we began to get so many requests from other Native Americans on other reservations and from organic gardeners that we incorporated for nonprofit tax-exempt status as Native Seeds/SEARCH. By that time, I realized these crops were worth saving, not only for plant breeders to incorporate genes into future hybrids, but because they still had cultural value in their present forms.

Omni: What goals do you hold for plant conservation in the next century?

Nabhan: I'd like to see us have new mixes of perennial and annual crops to minimize soil erosion and nutrient depletion. Such polycultures would buffer us from the consequences of drought and hot spells but still be responsive in years with a lot of rain. An agricultural system for desert areas includes water-efficient crops like prickly pears and century plants on the edges of terraces, with the inner spaces planted at times when there's enough rainfall to support annual crops. Those fields would still have some productivity every year, but in areas of average or above-average rainfall, short-cycle or quick-growing annual crops could increase productivity.

I'd also like to see agricultural systems based on the ecological relationships between wild-crop relatives and their ecological associates. We've already done this with wild chiles, which almost always grow beneath mesquite

trees or red-fruited shrubs. Because they can't tolerate direct sun without being vulnerable to diseases and pests, we've intercropped wild chiles with nurse plants that provide shade. These intercrops have sustained themselves for four or five years without any additional irrigation, showing that native intercropping systems can work in a contemporary setting.

Native Seeds/SEARCH is seeking to buy a farm that will be an experimental training site for Native American students. Native Seeds/SEARCH hopes to conserve both crop diversity and the cultural knowledge associated with native agriculture. I don't know if we have the traditional knowledge to guide the use of these plants—they're simply germ plasma, test-tube DNA—without a cultural context. We currently have five Native Americans on staff working to conserve their people's traditional knowledge associated with plants.

Omni: Certain seed companies are now selling native seeds. Is there any harm in that?

Nabhan: Some food and seed companies are simply capitalizing on the romanticism or mysticism they associate with all indigenous cultures and treat them as if they're still noble savages. This overlooks or discredits a vast amount of pragmatic, technical knowledge existing within the farmers and plant specialists in any single culture. They also talk about the American Indian view of nature as if the great diversity of cultures in North America, cultures that spoke over 200 different languages, all viewed nature in exactly the same way. Each of those cultural-linguistic traditions probably has its own unique insights into the workings of the natural world, different and complementary to what Western science has come up with.

Also, some of these companies ought to buy the seeds directly from Native American farmers so that people are benefiting economically. Instead, the seed companies are claiming that they have Hopi blue corn, but they're buying it from farmers in Texas or Colorado rather than dealing with the Hopi farmers.

Omni: How has loss of native crop varieties led to health problems among native peoples?

Nabhan: Solomon Katz of the University of Pennsylvania has demonstrated that people's genetic makeup has evolved in synchrony with their food collecting and processing practices. After tens of thousands of years with one set of foods processed in a certain way dominating their diets, people physiologically adapt to the digestibility and nutrient levels of those particular foods. If you have a feedback loop like that working for a millennium, then suddenly your metabolism stops receiving the requisite triggers to keep that physiological system running smoothly, a variety of maladaptations results.

Take diabetes. Native Americans in the desert historically ate five to six times the amount of soluble fiber that the average American eats today. Although old nutrition texts regarded soluble fiber as indigestible or antinutritional, we now know it's a source of calories and a means of controlling blood sugar and cholesterol levels. In the past, these peoples didn't need to evolve a genetic means of dealing with high blood sugar or cholesterol levels because soluble fiber buffered them from adverse effects of temporarily high spikes of sugar consumption.

During this century they suddenly shifted to a diet high in sugar and fats with little soluble fiber. Now, their genetically controlled metabolic factors have nothing to help control these adverse effects. They develop pancreatic stress and insulin malfunctions that lead to the highest levels of diabetes in the world. Desert areas contain many plants with mucilaginous seeds, like psyllium, an ingredient in Metamucil, and chia seed. These soluble fibers rapidly absorb water and retain it. So a germinating seed can buffer itself from drying out in the first couple of weeks of life.

Similarly, most cacti are rich in mucilages that enable their photosynthetic tissue to hang on to all the water available to them, so they can continue their food-making activities even during times of drought. The same soluble fiber has an adaptive function in helping desert plants survive which, coincidentally, protected desert people from high blood sugar.

Soluble fibers control blood sugar so well that if regularly included in a diet, diabetes is never triggered. In some areas of the world where incidence of diabetes is highest, local people had abundant sources of soluble fiber in their diet until the last 50 to 75 years, when their diet was Westernized. Without this critical fiber, these people rapidly developed non-insulin-dependent diabetes. This is as true for the Australian Aborigines as it is for the Indians of the Southwest United States, Mexican Indians, and even Yemenite and Ethiopian Jews.

Omni: Would the diet you designed for Indian diabetics work for non-Indians?

Nabhan: No matter what population of

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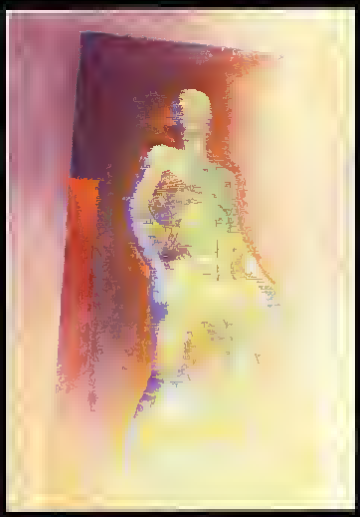
ANTIMATTER

UFO UPDATE:
A Harvard psychiatrist says alien encounters, while traumatic, may be our gateway to God



For the past three decades, students of UFO abduction have hailed from outside the scientific community. Their ranks include an historian, a social worker, and an artist. Despite the diversity of their backgrounds, these researchers have all agreed on one thing. The aliens, they say, are evil, inflicting on their human victims only misery and pain.

But now, Dr. John E. Mack, professor of psychiatry at Cambridge Hospital, an affiliate of the Harvard Medical School, and a Pulitzer Prize winner, has broken the mold. The first world-class scientist to jump on the abduction bandwagon, Mack agrees that alien abductions do, indeed, take place. But unlike other researchers, he says the abduction experience can be spiritually uplifting, a key to inner growth.

To back up his theories, Mack has recently published *Abduction: Human Encounters with Aliens* (Scribner's), the chronicle of eight male and five female abductees whose stories have been elicited through hypnosis. The tales they tell, says Mack, who has worked with 80 abductees in all, "reveal many examples of great personal growth, a reexperiencing of past lives, and a deepening concern for the fate of the earth."

Joe Noonan, for instance, is a 34-year-old psychotherapist who runs a professional development and training business. As quoted in Mack's book, Noonan says his alien abductors are "midwives" who help him stay connected to his divinity. "Unconditional acceptance and understanding are always an integral part of my E.T. experiences," Noonan explains.

Eva, a mother of two, says that for her, abduction has been "a process of awakening." The aliens "need us for their own reasons," she says, but they are also "helping us to evolve as a race."

But if aliens connect us with the cosmic realm, why do they cause so much pain? "It's possible," says Mack, "that the alien presence, however traumatic, may be part of a larger process bringing us back to our common source."

But most of Mack's fellow investigators put little stock in his ideas. "I haven't seen the positive spiritual components that John Mack reports," says David Jacobs, an historian at Temple University and author of the book *Secret Life*, a step-by-step examination of the abduction process. "Most abductees don't like this phenomenon, feel that it's a detriment to their lives, wish that it had never happened to begin with, and hope that it never happens again."

Many abductees also vehemently disagree with Mack's findings. According to Wendy, a food manufacturer who says she has been repeatedly abducted, "I've been forsaken by God, not enlightened by him. Why isn't he answering my prayers and stopping this?" Adds Sheila, a 32-year-old mother of three, "Saying I benefited spiritually from being abducted by aliens is like saying an Auschwitz survivor benefited spiritually from being treated like a laboratory animal."

And how do Mack's colleagues in psychiatry feel about his abduction research? John O'Brien, CEO of the Cambridge Hospital, has only praise. "John," he says, "is a nationally recognized clinician and researcher, and we encourage him to pursue his interests, whatever they are." As for the American Psychiatric Association, it does not endorse Mack's work. But Dr. Michael S. Aronoff, spokesperson for the New York county district branch says, "the Association generally views any responsible scientific research into human behavior as useful for the progress of information."—*ANITA BASKIN*

ANTIMATTER

ANCESTRAL PSI

While researching a group of German families who emigrated to New York in 1710, San Diego–based genealogist Henry Z. Jones, Jr., made a startling discovery. "I had no reason to think I was related to any of those 874 families," he recounts. "Totally at random, I picked one name, Dietrich Schneider, for my researcher in Germany to track down." Jones was shocked to learn he is a direct descendant of Schneider.

That was just the beginning of what Jones calls his trips into the "Twilight Zone" of genealogy. Frequent bizarre coincidences and feelings of déjà vu have convinced him that psychic phenomena frequently help people trace family trees. In fact, after hearing colleagues mention similar tales, Jones contacted 300 geneologists, asking if they had experienced intuitive nudging while researching their family trees, ultimately using the material for his new book, *Psychic Roots: Serendipity and Intuition in Genealogy* (Genealogical Publishing Company).

For example, an Ontario man kept dreaming of a portrait of his grandfather—a painting no one believed had ever existed. Then, while sightseeing in an English castle, he was amazed to find the portrait of his dreams.

Another genealogist, searching in a library in vain for references to an eighteenth-century relative, was startled when a book fell from a shelf onto her head. Idly leafing through the tome, she quickly spotted Revolutionary War records documenting her ancestor's life.

But Cornell University psychologist Thomas Gilovich, who has studied seemingly meaningful coincidences, says that statistically these spooky genealogical tales aren't evidence of contact with the other side, but rather "completely in the realm of chance."

—Sherry Baker

INTUITION: THE MAJOR INGREDIENT WHEN TRACING YOUR FAMILY TREE?

LICENSE TO BELIEVE

When Ottawa, Kansas, physician Scott Corder went public with his belief in UFOs, he got more than he bargained for. In fact, his proclamations alarmed Richard Gannon, then–executive director of the Kansas State Board of Healing Arts, so much that he suspended Corder's license pending a psychological exam. "The board felt there was a distant possibility of mental impairment," Gannon said. "The issue wasn't whether an individual believed in spaceships, but rather whether a doctor was fit to practice."

Corder's UFO claims centered on a Kansas woman who claimed to be in contact with "Peter," an E.T. she says is the apostle of Biblical fame. According to Corder, the woman visited Peter on his starship and received information "proving that her contact with extraterrestrials is real." It was after Corder detailed Peter's prophecies—including predictions President Bush might be assassinated—to the FBI, CIA, and the Defense Department, that the board suspended his license.

Insisting his sanity was intact, Corder refused to see the designated psychiatrist and lost his license, his practice, and even his home.

He then sued the state of Kansas, claiming he had been denied his constitutional right to believe in UFOs. To settle the case, Corder finally submitted to a psychological exam, and it was declared that he could "practice with reasonable skill and safety."

"Once we got the results," says Lawrence T. Buening, new executive director of the Kansas state medical board, "we set aside the emergency suspension and reinstated his license in full." As for financial liability, the judge declared officials free and clear. Corder, however, has decided to appeal.

—Peggy Noonan

HE SUED THE STATE OF KANSAS FOR DENYING HIS RIGHT TO BELIEVE IN UFOs

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MUSIC OF THE SPHERES

While studying astrophysics at the University of Milan and operatic singing at the Conservatorio di Musica Verdi, Fiorella Terenzi found a way to combine astronomy and music—she converted radio signals from distant stars into otherworldly tunes that earned her a Ph.D. in physics and a budding recording career.

To come up with her spacey music, Terenzi focused on UGC6697, a galaxy 180 million light-years from Earth that pumps out enormous radio energy. Picked up by radio telescopes on Earth, the radio waves are recorded as digital data. In order to convert them into sound, Terenzi used a computer and special sound-processing software.

Since it required eight hours of number crunching to produce a minute of celestial sound, Terenzi worked six months before she heard her first galactic "song." Although there's no recognizable melody or beat, she was surprised at the musically interesting tones.

Island Records was impressed as well. It has recently released Terenzi's first CD, *Music from the Galaxies*, featuring six "songs" taken directly from UGC6697 and a seventh spacey tune, featuring violin and flute, written by Terenzi herself. Now living in Los Angeles, Terenzi is currently working on a second CD using sounds from a variety of celestial objects. She is also taking her otherworldly music on the road, performing concerts on a keyboard.

"As a scientist, I'm interested in how these sounds reflect the chemical properties of galaxies," Terenzi relates. "But when I compose, I have a philosophical approach. These are nonhuman sounds, the sounds of the universe embracing us in a cosmic hug."

—Sherry Baker

LAW

ENVIRONMENTAL RACISM:
When civil rights are used to protect more than individual liberty

By Peter Callahan

Tired of living next to dumps and freeways, low-income and minority citizens are fighting an old form of racism with a new kind of justice.

For most Americans an environmentalist is someone who recycles trash, preserves the wilderness and saves whales. But there are several groups in the country working to change this definition.

Environmental justice is a growing area of legal practice which uses civil-rights laws and strategies to thwart potentially dangerous projects from devastating already poor and disadvantaged areas. For instance, a lawsuit filed in West Oakland following the 1989 earthquake charges that the proposed construction of a freeway through a predominantly black neighborhood constitutes a form of environmental racism. As Kirsten Levingston, a former counsel for a regional division of the NAACP, explains, "We're using old and new civil-rights strategies" to fight this kind of discrimination.

Communities have long fought against siting dangerous projects in their neighborhoods, but their protests often attract little attention. However, in 1982, black residents in Warren County, North Carolina organized to oppose the siting of a PCB landfill in their community. The protest mushroomed into what some have termed the largest civil-rights demonstration since the 1960s, resulting in more than 500 arrests. The United Church of Christ Commission for Racial Justice lent its help to the fight—and then began studying other instances where race may have played a factor in siting hazardous-waste facilities. The 1987 report found that while economic status played an important role in the location of such facilities, race proved more significant.

What many in the environmental justice movement hope to see is not just success in efforts to stop specific projects, but a new definition of what constitutes environmentalism. "The white middle-class environmental movement of the 1960s and 1970s built an impressive political base for reform to combat the damage by our chemically-centered industrial society," says University of California sociologist Robert Bullard, a leading figure in the environmental justice movement. 'However, it gave little attention to the implications of the NIMBY (not in my backyard) phenomenon.' In many cases the NIMBY cry has often resulted in what Bullard terms the PIBBY principle. Place in blacks' backyards. The effect is a society divided, literally and psychologically, by freeways, landfills, and hazardous-waste dumps.

In the past few years, dozens of grass-roots organizations have sprung up around the country to fight the problem, many of them situated in the South, a region Bullard characterizes as "our Third World." And increasing awareness of the issues facing minority communities by national organizations like Greenpeace, coupled with new legal strategies, may help, too.

According to Levingston, educating the general public about the problem is the key. "At least the general public will be aware that communities of color are used as dumping grounds. Now government will be given the opportunity to demonstrate its belief in this concern."

Of course, a little arm twisting will help, and Tom Soto, president of the Coalition for Clean Air, thinks that's just what will happen. 'We're tired of the old argument that 'we're going to build an incinerator and create 50 jobs.'" Too often, Soto argues, the industries think that low income and minority people do not care about their environmental safety. However, he claims, "In the next ten years, we're going to see an emergence of political power in these areas. In the past people put up with it, but not anymore."

QUEEN

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Did he know she was there?

Troubled dreams, the headache was there when she woke, the pearls were still that deep blood-rusted red. A bad day, bad week, the pearls stayed dark but no new ones came, his fragility increased but no one seemed to see. Her day off came without relief, she had copied his records and spent the day going through them, going through the literature to see if there was anything she might begin to lean on, learn, understanding's crutch but then her disgust and weakness harsh as pain, she pushed the books and charts away and took up the jar. Reliquary was that the name? The resting place for relics, saint's bones, last drops of holy blood, in the light the pearls lay smooth, gentle distortion against the glass and she wept, finally, slow tears that ran against her cheeks, crying with her mouth open dull as a cow's and hands palms-up and flat against her legs like a postulant's prayer, the confession of a man on his deathbed, a voice without inflection imbued with flat and terrible haste.

His weakness accelerated, deeper the weights that held him, the hands that pulled him down: death's hands, death's fingers slipping like thread through the skin of his silence, weaving like strands through the hair brushed clean and flat against his quiet forehead. And she watching, knowing. It was the making of the pearls that caused this deterioration, but how to chart that? How to explain without evidence! Show, tell, see? How? Unable to spend time beside him, still she checked, quick, compulsive, watching for eye movement, the telltale drop of pearls, the deepening weakness like a road leading only one way. No one caught her, or rather she caught no one watching, but they were curious, or would be, one day they would ask.

Let them. Stubborn, she would not stop; she had to know. Watching him and tired, more headaches, the pain in her back and snapping at the aides, she did not make mistakes with the patients but neither was she kind—and regretted it, riding home and she wept at a red light and wished for the first time that Elliot would stop, just stop.

Die?

No

When she got home she saw that all the pearls had turned black.

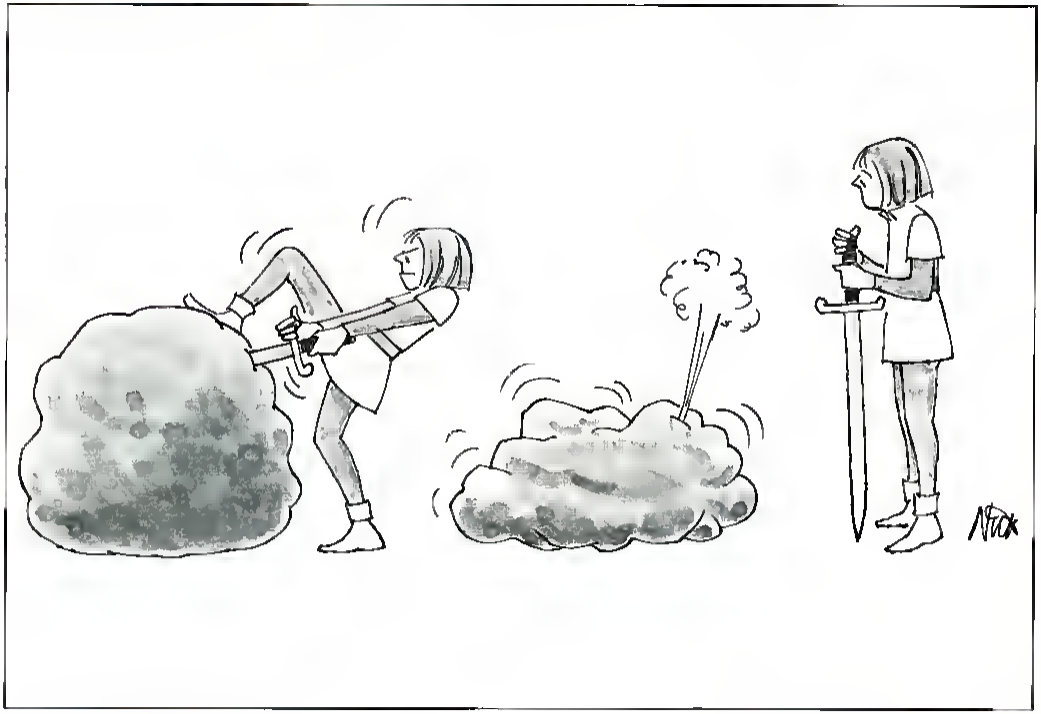
The next day she tried her best, pathetic avoidance of his room, tried to leave his maintenance to others, tried to do her job and only her job. Not to worry; not to participate, not to understand but only to work and if he wanted to spit pearls then let someone else find them, oh, someone who would call out, "Hey *Deb!*" and show them to her, warm and slick in the rubber valley of a palm amazed and, What do you make of this? And she would shrug.

He had lost more weight, he lay like paper in the bed, like some cunning wasp's construction of what a human being might be, spun gray and weightless: death's cocoon and *no*, instantly, her denial. No.

This morning, checking the pearls, she saw that one of them had deteriorated, turned seemingly to dust, or ash, human ash, gray talcum against the side of the jar.

Dark, clean sheets and on the bed beside him, only watching as his eyes beneath their lids began to move, back and forth like fish in elemental motion, back and forth and the instant bubble of pearls, two, three, a handful. Watching, heart beating breathless and she had a wild desire, in the shadow of those moving eyes, to

eat one



and raising it to her lips, her shaking hands and inside her mouth, warm, warm on her flat tongue, against her palate like a special stone and she spat it out, gently into her palm that closed instinctively around it like petals concealing the flower's heart. His hand, inert in its place, seemed nonetheless to touch hers, one finger crooked closer than the rest, heaven's rebus and she swept the rest of the pearls into her pocket, rose clumsy and at once at voices in the hall, she almost forgot her purse, there on the floor, tucked under the bed like a visiting friend. Out of the room like a criminal but she did not feel bad, or sad, felt instead the intense absorption sha had felt once... when? Long time, her premed courses and learning, slow, the mystery of the body, its failures and desires too stringent to be less than exigencies, less comprehandible as logic than commands from spirit to flesh, less truly understandable than the nature of life, and entropy, daath's sweeter sister, hand in hand in decays pavane begun as soon as birth. The way organs rot, and breathing slows, the way wrinkles and scar tissue form.

The way paarls turn from white to black, to dust.

Driving home, beneath streetlights the pearls glimpsed and already turning and then she was turning too, quick deliberate reversal and back, streets and streetlights and she did not look at the pearls again, did not stop at the desk to speak to the midnight shift nurse. Instead immediate to his room, no more pearls but the moving ayes so rapid and intense and she bent to him, spoke his name now with such assurance that in tha speaking his own lips moved, sluggishly at first but then with surer animation. Did he know she was there?

She snapped on the small overhead, aquarium color, her hands ware sweating but absolutely firm. His mouth kept moving, she chacked his vital signs, they were very bad. BP and temp, pulse and respiration and after she had charted them, meticulously charted them, she set aside har pan and took up his hand, it was cool, and scarred across the palm, some old scar from the days of light and motion, days of a life now lost to this pitiless vacuum of weakness, held his hand, death's hand in the dark as a mother holds a child, tenderly, tenderly. Sha said his name, "Elliot," softly in his ear but did not expect racognition, an answer, anything, his lips kept moving, strongly, as if he spoke now through a wind, a torrent, a peeling storm and she said "Elliot" again, the pearls in her pocket between his body and hers and she thought she could hear it, that wind, could almost feel it wash across her own skin, the absolute clarity of cold and his hand now colder, his lips moving in one long gnmace, one last powerful rictus and then nothing, silance, no wind at all.

And understanding then, with a calm vouchsafed by Elliot as himself and more than himself, as circumstantial conduit, meant to show her what she was meant to see, to be angel for the dead, the queen of angels; to accept for and with them, mediatnx, what death is meant to be. Accept as well for herself, angel, finally of mercy. Can she doubt it now, now with his hand in hers, cool and damp as modeling clay and she finds she can go anywhere, feel anything, reach any state she chooses... coma, nirvana, the bright dead bliss of no feeling at all. His lips are heavy, purple as a leathery grape, inside him avarything is light, ether and feathars, weightless as tears in the middle of the night and she will stay beside him until the family comes at last, to find him laved and anointed, dead king propped beside her in his cloak of spirit-white, her pocket ripe with pearls of purest darkness turning slow to palest ash, and one beneath her tongue, black and sure and secret as tha secret that leads us finally to where at last and always wa were always meant to be ☒

For Denice

APOLLO

CONTINUED FROM PAGE 53

president of 1969, Richard Nixon. In later years, just crossing a room or putting on his shoes cost Webb as much effort as running. NASA, Parkinson's disease felled this burly, powerful man like a rusting Saturn rocket.

When the great moment came, it was Nixon who congratulated Armstrong and Aldrin on the moon during a special TV broadcast, enjoying a glory that was not properly his. NASA wanted to recover the Apollo crew in the carrier *John F. Kennedy*. Nixon's people demanded and got the *Hornet* instead. A very tired Johnson watched the liftoff. The great *Saturn V*, thundering off the pad, was as much his achievement as anybody's, but that day, strangers and newcomers got the political credit. This injustice demoralized him so that he failed to notice that Nixon didn't even attend the historic launch in person but instead sent his vice president, Spiro Agnew.

In the years since, not a single U.S. president has stood up and once more committed the nation to a great adventure in space. Kennedy's brave speech urging his nation to the moon will be remembered for all time. What a great man we lost there. This twenty-fifth anniversary of *Apollo 11* is a time to reflect not only on Kennedy, but on Johnson, Webb, Thomas, and the incalculable others—engineers, technicians, managers, administrators, government staffers—who turned Kennedy's vision into a glorious reality. ▫▫

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TARGET

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mede, which consist of some of the oldest hard surfaces in that region of space. Planetologists Paul Schenk and Jay Melosh have drawn attention to a class of surface feature called a "catena" or chain. These are "impressively straight" lines of as few as six and as many as 30 impact craters with diameters up to 18 miles, stretching as far as 430 miles across the surface. Voyager photographed about 20 catenas on Jupiter's moons, mostly on the sides that face the planet.

"Split cometary nuclei"—in other words, fragmented comets—"may be responsible for at least some of the crater chains," Schenk and Melosh suggest. Computer models of breakup and subsequent impact appear to support this hypothesis. "From the number of crater chains on Callisto," say the planetologists, "we estimate a frequency of fragmentation of between 50 and a 100 years." The vast majority of the fragments, of course, miss the moons entirely and either vanish into space or fall back onto the planet. But over billions of years, a random few have left permanent records of their former existence by smashing into Callisto and Ganymede.

Impacts like these and the one about to occur on Jupiter have implications far beyond the Jupiter system, and they hold compelling lessons about Earth's own history and possible future. Jupiter may be a larger target than Earth, but it's also far less fragile. Having developed the sensory capability to anticipate such impacts, humans are now on the verge of creating the technological means of averting them. What's happening to Jupiter has already happened to Earth, and without human intervention it's going to happen again someday. Nothing less terrible than rockets and thermonuclear explosives may prove adequate to prevent it.

And despite their intricate analyses and careful computations regarding the Jupiter collision, scientists expect—even earnestly hope for—surprises. "I'm counting on lots of things nobody expects to happen," Dessler says optimistically. "Afterwards, of course, we'll be able to explain them easily. It's possible that Jupiter could swallow the comet without so much as a burp." Afterwards, too, we may understand the dynamics of our solar system a bit better, but we may also be a little more frightened of the perils it has in store. Such is the gift and the price of Jupiter's pearls. ▫▫

COSMIC

CONTINUED FROM PAGE 56

1982 when the Supreme Court refused to hear Gersten's appeal. Although the agency admitted to having approximately 57 documents pertaining to UFOs in its files, it successfully refused to release them, citing national-security concerns.

Despite the progress, Zechel can't help wishing that CAUS had been able to do more. "I felt we could inflame the public and marshal tremendous popular support,' Zechel says, "but we never got beyond four or five hundred members. We were constantly hampered by a serious lack of funds and the usual personality conflicts."

As for Gersten, he expresses disappointment that not every known document was turned over to CAUS, especially those from the CIA and NSA, but concedes that "they were probably withheld for legitimate reasons. I suspect they were protecting their own intelligence sources and technology.' Gersten performed all of his work for CAUS pro bono, but estimates that his fees would have come to nearly $70,000. "And that's in 1970 dollars," he says.

As the decade of the 1970s came to a close, Zechel left CAUS and has since founded the Associated Investigators Group. CAUS, meanwhile, continues under different officers and still puts out its publication, *Just CAUSE* on a regular basis.

"What's changed most is the FOIA itself," says Barry Greenwood, the newsletter's editor and current CAUS director of research. "The act was essentially gutted by Executive Order number 12356, signed by President Ronald Reagan. Among other changes wrought by Reagan's general secrecy order," according to Greenwood, "is the fact that agencies are no longer required to respond within a reasonable period of time. Searches, when they do them at all now, routinely take between six months and two years. The fees have gone up, too," Greenwood complains. 'One agency cited us the enormous search fee of $250,000. It's very discouraging."

Pennsylvania researcher Robert Todd was also involved with CAUS early on, but his experiences have left him disillusioned with both David and Goliath. "The UFO community won't be satisfied until the government admits it's behind a vast cover-up," says Todd. "Is there a lot of material still being withheld? Without a doubt. But does that prove the government is engaged in a massive conspiracy, or that it's merely a massive bureaucracy? I can't state this strongly enough: I don't believe there's a cover-up at all."

A spokesperson with the CIA's Freedom of Information office in Washington, DC, refused a telephone request to talk to someone regarding the agency's Freedom of Information Act policy, explaining that all such inquiries would first have to be submitted in writing to John H. Wright, information and privacy coordinator. Following agency guidelines, *Omni* has submitted a written request for explanation of CIA policy as well as UFO documents, past and present. The request is still pending, but remained unanswered at press time. Results of our inquiry will have to wait for a future edition of the magazine.

As far as the UFO community is concerned, the work of CAUS, Zechel-style, remains undone. These days, says Todd, "getting any kind of document out of the government is a lengthy, time-consuming process. First, they consider the FOIA an annoyance, after all, they're understaffed and saddled with budget constraints. Second, the nature of any government is to control the flow of information."

INTERVIEW

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adult-onset diabetics is put on a high-soluble-fiber diet, there's a marked improvement in blood sugar and cholesterol levels. However, in some studies insulin sensitivity is more highly increased for indigenous diabetics than for European diabetics. This may indicate that a more physiological adaptation to slow-release foods persists among indigenous peoples compared to their European counterparts.

Omni: Has the link between these foods and controlling diabetes been established in the lab?

Nabhan: Analysis of the insulin and sugar responses to about three dozen Australian desert plants and a dozen American desert plants rich in soluble fiber has shown that the majority of these staple foods are slow-release foods. The carbohydrates within them are slowly digested and can be gradually absorbed into the tissue, so they don't produce rapid rises in blood sugar and stress the pancreas. We now know many of these plants work to maintain healthy insulin metabolism.

Omni: You've recently studied desert-food diet and exercise. What did you find in experimenting on yourself?

Nabhan: Last year we conducted a study at the National Institute of Fitness where six O'odham health workers, one Hopi health worker, and I ate four to six servings of slow-release desert foods a day. By walking or running between five and nine miles a day, we tried to duplicate the physical activity levels that their grandparents would have maintained. Over the two weeks, we observed a three-and-a-half-pound drop in average weight, a percent and a half loss in fat weight per person, and about a 30- to 35-point drop in blood sugar and blood cholesterol levels per week. And we enjoyed most of the foods and exercise.

We ate a mix of wild and cultivated foods that control rapid rises in blood sugars nutritionally. These foods had never before been combined into an experimental diet to see their cumulative effects. There's no ancient knowledge that certain foods are good for diabetes because Native Americans have only been facing this problem for the past 50 years.

Omni: Wendell Berry says that by paying attention to what we eat and where our food comes from, we all can become part of the agricultural cycle.

Nabhan: Right, and we become part of the wild cycle too. We need to remember that our very existence depends on the lives and deaths of other species. By eating, all of us participate in interspecies communion.

Omni: Do you consider yourself more a writer or a scientist?

Nabhan: I'm primarily someone who draws upon the naturalist trance to help inspire my writing and scientific discoveries. The naturalist trance, as biologist E. O. Wilson suggests, is a state of alertness to other creatures. It probably first evolved as hunter-gatherers sought their food. As a coincidental benefit, this hyperalert state also allows ecologists to gain, through all their senses, the prevailing context of any habitat within which they're working, a gestalt of their immediate environment and the dynamic working within it. By having contact with wild habitats and trying to put myself into that trance, I'm able to gather insights about a place, plant, or animal that hasn't necessarily made its way into Western science to date. At the same time, the naturalist trance is the wellspring for more creative insights than many nature writers have come upon. Naturalists train and cultivate this extended state of alertness just like a musician cultivates a heightened sense of sound.

Omni: Do you feel as "connected" when you're in temperate forest as you do in arid lands?

Nabhan: I'd make the distinction more between what I feel in closed forests and open landscapes. I work better in deserts, dune areas, prairies, and coastal areas, and less well in tropical, temperate, closed-canopy forests. Even though I grew up near the temperate forests of the Midwest, I spent most of my time out on the Indiana Dunes, an open landscape. I grew accustomed to that openness and to the distances with which sounds travel across it.

Omni: How can urban- and suburbanites better relate to the land, establish an integrated relationship with nature?

Nabhan: Wildness hides in all our cities and suburbs. We have to seek it out. Taking time to observe migrating insects that come through our neighborhoods may not be as dramatic as watching rhinoceroses mating on TV, but nevertheless, such modest acts are one way we can make contact with other organisms. And only by that contact with other organisms can we put our own lives in perspective.

Unfortunately, the fad in environmental education is to give kids computer games about ecosystems and nifty nature videos. This is not moving them toward more contact with wild species but is taking up more of their time in activities other than real contact

OMNIPORIUM

OMNIPORIUM

OMNIPORIUM

with the natural world. That's ultimately going to work against us. Instead, we need to sensitize people to the complexity of the natural world.

Omni: What's unique about the Sonoran Desert?

Nabhan: Of the American deserts I know and the African and Australian deserts I've visited, the Sonoran is the most variad. In any particular area, there may be as many as 500 kinds of plants with more than 20 different architectural strategies for dealing with drought and heat. Giant cacti live next to deep-rooted legume trees, which live next to vines that die during winter but may have massive tap roots sustaining them underground.

Some plants have weird shapes and sizes, like out of science fiction. One endangered plant, called the boojum, looks like a punk artist's version of an upside-down carrot. It grows in areas getting four inches of rainfall a year and can reach 40 feet in height. Lewis Carroll talks about boojums in *Alice in Wonderland.* He came up to a strange being and said, "Ho, ho, ho, definitely a boojum!" So a scientist near the turn of the century who went out in this area with his kids didn't know what the hell he was seeing, and so as not to lose face in front of them said, "Ho, ho, ho, definitely a boojum."

The saguaro cactus that you see in all the desert movies is an indicator species of the Sonoren Desert. There are actually two larger, called cardoon and echo, that reach up to 50 feet. The saguaro may live 200 to 300 years, but only one in 10 million seeds from a saguaro survives the first ten years. One frost per century may knock back a large proportion of the population. It may take 50 to 80 years before a favorable rainfall in back-to-back years allows recruitment of a new generation. So in any location, all the standing giant cacti may have germinated over just six years during the last 300.

Deserts are defined by a rainfall-to-evaporation ratio rather than just rainfall alone. A manmade desert may also have a similar ratio but lack the interdependence between plant and animal species that keeps natural deserts vital. Most manmade deserts may receive more rainfall than natural deserts but retain none of it as soil moisture.

Omni: What factors are leading to the deforestation of the Sonoran Desert?

Nabhan: The conversion of native vegetation to African grasses with the aim of increasing cattle production. Over 170,000 hectares have been converted from a complex community where hundreds of species flourish to monocultural pastures dominated by one alien

species, buffet grass To have 300-year-old cacti and 500-year-old trees bulldozed off the land and replaced by a single African grass is a devastating transformation But this alien is now being ravaged by a spittlebug epidemic, and the plan to increase cattle productivity is beginning to fail

Also, within the last decade, the demand for mesquite charcoal for flavoring and smokeless barbecuing has exerted tremendous pressure on the Sonoran Desert Mesquite charcoal can be purchased from Maine to Washington state, and 95 percent of it is being removed from the Sonoran Desert, from areas where the trees are very slow growing And the mesquite is not the only tree being turned into charcoal, the desert is being drift-netted so to speak Five or six other legumes critical to the stability of the desert ecosystem are being cut as well Ironwood trees for example, which are nurse plants and protect cacti from desert extremes

Omni Could the Sonoran Desert end up like the Sahara?

Nabhan Rather than turning into a Sahara, my guess is the composition will be skewed or impoverished Mesquite is a resilient plant, growing back in maybe 50 to 100 years Ironwood has very, very low recruitment rates There's 45 percent more plant cover and 35 percent more plant diversity in ironwood-dominated areas than in random desert plots Eliminating ironwood from a 20-square-mile area could measurably deplete overall plant diversity there Indeed, the collapse of the ecosystem is already occurring along the coast of Sonora near Kino Bay, with most of the mesquite and ironwood cut down People have to travel 30 to 50 miles to get wood Since cacti are dependent on starting their lives under these trees, we think cactus regeneration will be set back about 500 years

Omni Are there any protective measures being taken?

Nabhan The Ironwood Alliance is a coalition of conservation groups, desert scientists, businesses, and craftspeople from both sides of the border We've gotten the Anzona-Mexico Commission, a quasi-governmental organization, and the [Mexican] state Sonoran government to pass legislation making it illegal to cut live ironwood and export it We're also exploring the use of aerial surveys of GPS's [Geographic Position Systems] to help pinpoint the location of clandestine charcoal pits By flying over an area with a little microcomputer on board, we can send signals to satellites that will beam back our coordinates to 75 feet in accuracy We locate wood-cutting operations the Mexican government can't find, and they can choose to close them down

Omni What effect will NAFTA have on this deforestation?

Nabhan It will devastate both natural ecosystems and traditional farming in Mexico Even though Mexico has some very good laws on the books and dedicated environmentalists at high levels of government, most admit they haven't enough watchdogs in the field with the right skills and technical background to stem major disasters A million Mexican farmers and their families, it's predicted, will be displaced due to competition with U S and Canadian subsidized farmers So 5 out of the 80 million Mexicans will be displaced over the next decade—moved off of their land into cities, or to work as farm laborers for corporate farms Since these small farms sustain the most crop diversity their loss will have the most devastating impact on crop diversity of any political event since Cortés's conquest of Mexico

FEEDING BODY AND MIND

THINGS EATEN ON A DESERT DIET:
Wild plants mesquite pods, cholla cactus buds, cactus fruits, prickly pear pads, chia seeds, acorns, and psyllium seed
Cultivated plants tepary, lima, Anazasi beans, corn, and chiles

FAVORITE RECIPE:
Desert Chilaquiles
1 c chopped prickly pear pods
1/2 c onions
4 T chopped cilantro
1/2 c tomatillo husk tomatoes
6 tortillas (preferably blue corn)
1/8 c wine or H_2O
8 or 12 oz can enchilada sauce
goat cheese
Over a campfire, put all ingredients except enchilada sauce and cheese in frying pan Tear tortillas into 20 to 30 pieces each and add to mixture Cook 5 minutes Cover with enchilada sauce When hot, sprinkle with goat cheese and serve with sour cream or yogurt

RECENTLY WON:
MacArthur Award, 1990

RECENTLY WRITTEN:
Gathering the Desert, *Songbirds, Truffles and Wolves*, *An American Naturalist in Italy*, and *The Geography of Childhood*

GAMES

BATTER UP:
Take this challenging quiz about America's favorite pastime

By Scot Morris

Baseball buff Joli Quentin Kansil tells me of an amazing play that happened in a minor-league game. With no outs and runners on first and second, the batter hit a pop fly toward the shortstop. By the infield fly rule, the batter was out. Each out must be credited to a fielder, and if no fielder directly makes the out, credit goes to the nearest fielder. So the shortstop got credit for the first put-out. The runner on first ran on the pitch, rounded second, and ran past the other runner, who was returning to second. He wes out for passing a runner, and the out was credited to the closest fielder—again, the shortstop. The ball hit the man returning to second, and as a result, the shortstop was credited with an unassisted triple play without ever touching the ball!

That bit of esoterica prompts this collection of my favorite baseball questions.

1. What is the maximum number of participants that can ba on the field directly involved in the play et one time? (Count umpires and coaches but not menagars or bullpen players.)

2. A pitcher faces 27 batters and strikes them all out, yet his team loses 6–0. How is this possible?

3. How many hits in one inning can a team gat and yet not score any runs?

4. Walter Johnson, Bob Gibson, and Don Drysdale have all thrown four strikeouts in one inning. Explain.

5. During a nine-inning game, the Mighty Casey came to bat nine times, once

in each inning. What is the fewest number of runs that Casey's team could have scored in the game?

6. There are six ways a batter can reach first base safely without getting a hit. A walk is one. How many others can you name?

7. Willie Mays hit more home runs in the first inning than any other inning. Some theorize it was bacause Mays got tired as games went on. The real reason is simpler. What is it?

8. In one baseball game, the Rockets beat the Fliers 9–0, yet no man ever crossed second base. There are two possible answers.

9. Name four terms used in both baseball and music.

10. Name seven terms that are used in both baseball and bridge.

11. Players rarely excel at two professional sports, much less three. In the 1950s, one person played for the Brooklyn Dodgers (baseball), the New York Knicks (basketball), and the New York Rangers (hockey). Who was that player?

CORRECTION. In February, I named four U.S. presidents whose last names are spelled with four letters: Polk, Taft, Ford, and Bush. Several readers argued that Taft is spelled with only thraa letters. By this logic, three presidents should be added to the list. Who are they?

ANSWERS

1. Twenty. Nine defensive players, four umpires, two coaches, three on base, one at bat, and one on deck.

2. He was brought in as a relief pitcher after six runs scored in the first inning.

3. Six. Three singles, followed by three runners hit by batted balls, the runner is out, but the batter is credited with a single.

4. If a catcher drops the third strike and fails to throw the batter out at first, the men is safe.

5. No runs. Casey bats first in the lineup, and in the first inning, he end the next two batters walk, and the next three strike out. In the second inning, the first three men walk, bringing Casey to bat again, but the three base runners are each caught off base by the pitcher, which brings Casey to bat again at the top of the third inning. This cycle repeets until the game ends.

6. Error, hit by pitch, catcher drops third strike, catcher's interference, fialdar's choice.

7. Mays always batted third in the lineup, so he elways came to bat at least once in every first inning.

8. A. The Rockets and Fliers ere women's teams. B. The Fliers forfeit the game. When a gama is forfeited the rules state that the score shall be recorded as 9-0.

9. Here are five: pitch, score, run, slide, and tie.

10. Here are 11: diamond, club, ace, rubber, grand slam, deck, signals, lead, steal, double, sacrifice.

11. The player was or ganist Gladys Gooding.

The presidents are Adams, Adams, and Nixon. DO

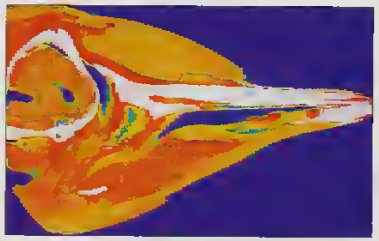
ANIMALS

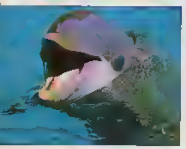
DOLPHIN SONAR
A biologist and physicist team up to find the source of sound beams

By Nina L. Diamond

How does the dolphin create its sonar signal? Scientists have long been puzzled by that question offering many theories and attributing the sonar mechanism to so many different dolphin parts that if the dolphin had a big toe, scientists would have considered that, too.

Finally, it took two enterprising young scientists from different fields—biology and physiology—working together and a novel computer simulation to come up with a possible answer.





The computer-generated images taken from CAT scans of real dolphins allow researchers much greater flexibility as they search for the source of sonar pulses.

It all started when biologist Ted Cranford, finishing up his Ph.D. at the University of California at Santa Cruz, "had a notion of how the dolphin sonar worked and thought, *How do we find out?*" First, as a dolphin made sounds, he peeked into its blowhole with an endoscope, recording video images. "That gave me suggestive evidence that things were happening in the area of the 'monkey lips.'" Cranford recalls. (Monkey lips? Don't worry, we'll get to that.) He computerized CAT scans he took of dolphins who had died of natural causes. That way, he could take a dolphin apart over and over again without cutting into the real thing. Next, he needed someone who knew the physics of sound. Enter Jim Aroyan, a Ph.D. candidate at the University of California Santa Cruz, specializing in acoustical physics who's also an accomplished guitarist.

With a computer program that would simulate sound propagation, Cranford and Aroyan were on their way. "We built a dolphin's head model in the computer from the CAT scans, redigitized it, and assigned sound characteristics to the geometry of the parts of its head," says Cranford, now a research associate with the National Research Council. "The geometry is the most important element. You can move the sound source to different locations and run the simulation to see if the beam comes out in the right place—in front of the animal's head—with a pattern similar to a real dolphin's." There's only one place in the simulation where it comes out just the way it does in real life and, fortunately, that's exactly where Cranford and Aroyan theorized it would be. "When you put the sound source where my hypothesis says it should be, the model puts out a sound beam very similar to that of a real dolphin," he says.

In the process, they weren't just looking for an answer to a nagging question, they were blazing some brand new research trails. "No one had tried to simulate sound propagation through dolphin tissues before," says Aroyan. "We've opened up a whole new field, simulating bioacoustics."

Why was the problem of dolphin sonar unsolved for so long? "All previous studies were inconclusive," says Aroyan. "That's because scientists were working with real dolphins on what we call the *near field*—close to the sound source—and they were hearing complicated signals and lots of interference. It was difficult to map it back to the source. Simulation on the computer was the perfect tool for this."

The major question," he continues, "has always been, How are dolphins producing their pulses and how is the pulse focused into a forward beam?" Aroyan's and Cranford's computer simulation seems to have answered both aspects of the question. "We found strong evidence that the source of the sonar pulse is two to three centimeters above the dolphin's nasal plugs in an area Cranford named the MLDB—the monkey-lips dorsal bursae—just below the first air sac below the dolphin's blowhole."

When a dolphin breathes, air enters through the blowhole into the nasal passages. As the air leaves the respiratory system, the pull of the larynx pressurizes it before funneling a bit of air at a time up through two small liplike parts (the monkey lips) located near the top of the nasal passages. These lips vibrate when air passes between them, and when they slap together, they produce the pulse. The dolphin stores air in a sac above these lips and recycles it back down to repeat the process, that way, it doesn't have to resurface each time it needs to send out a series of pulses. "When those lips close," Aroyan says, "the sound is pulsed into the dolphin's tissues, into the melon (the round forehead area), and directly out into the water."

In the end, the success of such an interdisciplinary collaboration may prove to be Cranford's and Aroyan's most important achievement if it encourages other similar collaborations. "There's a great deal more that can be done by having physicists and biologists working together," says Aroyan.

EARTH

CHEMFETS
How intelligence is changing chemical processing

By Kent Patterson

Hidden behind government secrecy for nearly half a century, the Hanford plant in central Washington produced plutonium for the nuclear weapons of the Cold War. Along with the power to destroy whole nations, it also produced some of the deadliest nuclear waste on the planet. Now more than 800,000 tons of liquid radioactive waste stews in a chemical soup stored in gigantic tanks on site. Given time, even the strongest tank will leak. The Columbia River flows nearby. A leak could endanger the river valley all the way to the Pacific.

Right next door to Hanford, the Pacific Northwest Laboratory (PNL) at Richland, Washington, has been awarded the job to help stop the worst from ever happening. With help from scientists around the country, the PNL must invent methods to remediate the situation by chemically converting the dangerous goop into something less dangerous.

"This waste is probably the most complex chemical processing ever attempted," says Dr. John LaFemina, a computational chemist and program manager for Materials and Interfaces for the Molecular Science Research Center for PNL. "For starters, no one knows what's in the goop. It's incredibly complex, containing every element on the periodic chart. Conventional chemical analysis is hopelessly inadequate. Samples drawn from one part of a tank tell nothing about what lurks a few feet away, and analyzing radioactive materials is expensive, slow, and risky."

If the conventional analysis is not working, then it falls to the chemists to develop unconventional alternatives. LaFemina's group hopes its work with ChemFETs—that is, "large array chemically sensitive field effect transistors"—will help analyze the waste more efficiently, at less cost, and with increased safety. Given an unknown goop, ChemFETs sniff out target chemicals as easily as a bloodhound sniffs out a rabbit. Even better, in the waste-processing plants of the future, ChemFETs will feed their information directly to computers. The controlling software then decides on the proper response, adding a pinch of this or that to the recipe, until the goop is processed into something safer, all without the touch of human hands. "Intelligent processing" may revolutionize not only how we handle toxic waste, but eventually all chemical processing, from recycling plastic to making breakfast cereal.

ChemFETs have many advantages over conventional chemical sensors. They are so small that biologists have used ChemFETs to sense the pH (a measure of acidity) inside the bloodstream of living animals. PNL has succeeded in putting eight ChemFETs on a silicon chip smaller than Lincoln's nose on a penny. They hope to put a thousand on a silicon wafer the size of a soda cracker. There's room on the same chip for the data-processing microcircuits that put the *smart* into these "smart sensors."

Gary L. Bukamier, a leading manufacturer of ChemFETs, feels that ChemFETs have a brilliant future, though a short one. "I believe that ChemFETs are only stepping stones to a whole new chemical technology," he says. Already an entire family of sensitive transistors has evolved. Two common types are ion-sensitive ISFETs, which have ion-sensitive gates, and GASFETs, which are specialized to detect gases.

But right now, ChemFETs will help find out how to stop all those tons of waste leaking out of their storage tanks, and that's a big enough job for even the most revolutionary device.

The problem of storing toxic waste is a hazard for all of us. Help, however, may be on its way as smart sensors work to tame the deadly chemical soup.