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VOL. 6 NO. 11 AUGUST 1984

CONTENTS

Chesley Bonestell created this month's cover, Rhea From Saturn, 40 years ago Now ninety-six years old and still painting, Bonestell is the acknowledged master of astronomical art. His work conveys the majesty and mystery of the cosmos

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FIRST WORD

By Peter J. Ognibene

"Even with a security budget of $100 million, the Olympic games in Los Angeles could fall prey to electronic saboteurs."

The specter of violence has haunted the Olympics since 1972, when a Black September terrorist group murdered 11 Israeli athletes at the Munich games. In the dozen years since this carnage, incidents of global terrorism have increased many times.

Olympic organizers aware of the potential dangers to athletes and spectators in Los Angeles this month, have engaged the efforts of no less than 60 law-enforcement agencies and 17,000 guards. The FBI will have 700 agents on hand, and special antiterrorist units such as the Army's elite Delta Force, will stand poised in reserve. Athletes and visitors alike will need electronic I.D. cards to get into restricted team housing areas, and there will be concrete barriers to prevent car bomb terrorism. The cost of this massive security effort may exceed $100 million.

This emphasis on physical security is understandable even without the participation of the Soviet Union and its satellites. While conventional bombs and bullets continue to present the greatest potential danger, security officials in Los Angeles might confront something new, something they may not be ready for—electronic sabotage.

Holding no reverence for innocent life, terrorists kill to destroy their enemies and to draw attention to their cause. Their goal is, in a word, disruption. Because the Los Angeles games, more than any previous Olympics, will rely heavily on computers and telecommunications technology, rather than athletes, could become a vulnerable target.

Olympic officials are reluctant to discuss their preparations against technological terrorism, so it is difficult to assess the adequacy of their safeguards against electronic saboteurs. But given the extent to which these games depend on high technology, officials should be aware of the following scenarios.

Gridlock. About 675,000 visitors will pour into the crowded Los Angeles Basin; most will travel by car on freeways and roads that are already overcrowded. If an inside conspirator were to reprogram the computers that control the city's traffic lights or slip in a circuit board that would trigger malfunctions, roads would become a shambles. Alternatively, an outside saboteur might find a way to tap into the wires over which the traffic lights are coordinated, and then jam those signals.

Scoring. The events will be held at 23 sites spread over an area of 4,500 square miles, from canoeing and rowing competitions at Lake Casitas, 84 miles north of the Los Angeles Coliseum, to equestrian events at Fairbanks Ranch, 111 miles south. If the times and raw scores from the various sports are transmitted to a central facility, an electronic eavesdropper could intercept and possibly alter the data before they reach the main computer. When the margin between winners and losers is measured in hundredths of a second or in tenths of a point, a small change in the raw data could make an enormous difference. And if any falsification of the scoring were detected, it would probably trigger an international outcry and bring into question the integrity of the host country.

Skyjamming. Most of the Olympic telecasts will be carried by satellites which can easily be jammed on the uplink (the transmission from the ground station to the receiving satellite). The operation would not have to be conducted in California; skyjammers could operate from ships at sea or from another country. They could then blackmail the broadcasters into giving them free air time to present their political grievances and to state their demands before a worldwide audience of millions.

These three scenarios have several things in common. In contrast to the Munich attack, machines, rather than people, would be the targets. Though some of the scenarios require inside participation, most could be executed by a small but sophisticated team of computer and communication experts operating on the outside. The techniques and machines are available now. Indeed, industrial spies and electronic embezzlers have pulled off similar stunts using off-the-shelf equipment. In France and Italy, extremist groups have been attacking government and corporate computers with guns and explosives. In Rome, for instance, it took two years for the Italian government to reconstruct auto registrations and drivers' licenses after a bomb knocked out the motor-vehicle ministry's central computer.

So there is little new about extremists attacking technology. But the pertinent question for public-events officials to ponder is, Can they prevent high-tech attacks on their own technology?

With banks and industrial secrets, electronic criminals have a clear motive: millions of dollars. There would be no such direct payoff for disrupting the games, but a terrorist group that managed to skyjam the Olympic broadcasts would receive global attention.

These scenarios may not come to pass in Los Angeles. Nonetheless, our government must realize that there is more to security than physical safeguards. The potential already exists for saboteurs or terrorists to use technological weapons to disrupt businesses, banks, telephone communications, and sporting events. If we fail to broaden our notions of security to include attacks by technology on technology, the consequences will one day prove catastrophic. ◻◻

Ballantine Books has just published The Big Byte, *Peter J. Ognibene's novel about high-technology intrigue and computer sabotage.*

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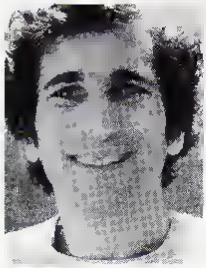

GROSSINGER

PELLEGRINO

DURDEN-SMITH AND DESIMONE

HOUGH

Does life exist out there in space? Although the question is asked constantly, the answer eludes us. But perhaps we've been searching in the wrong place. Evidence from the robot space explorers *Voyager 1* and *2* suggests that beneath the surfaces of some of the moons of Jupiter and Saturn, life might be thriving.

In "Quest for Souls on Ice," on page 44, astronomer/paleobiologist *Charles R Pellegrino* describes ways to scout out extraterrestrial life. Schemes range from sending robot helicopters to the surface of Titan to launching spaceship-submarines to explore the liquid interior of Enceladus. "It is possible," Pellegrino says, "that one or more seas are sandwiched at different temperatures between different pressure phases of ice. Each may be capable of sustaining living cells. And given flaws or corridors in the ice, life might be able to pass up or down from one sea to another. The image begins to resemble the Buddhist concept of different planes of existence."

Pellegrino has written a number of books, including *Timegate*, to be published soon by TAB. At Brookhaven National Laboratory, he coordinates design studies for the next 70 years in space. Among other projects, he is now working on antimatter propulsion and the industrialization of Mercury, which may turn out to be the most valuable piece of real estate in the solar system.

While astronomers brainstorm on exobiology, innovative biological psychologists are exploring the influences of drugs and hormones on human fetuses. June Reinisch is one such researcher. She has been called the Joan Rivers of science for her candid, crackling remarks on everything from parthenogenetic lizards to the future of sex in America—a topic she is well qualified to discuss. Reinisch directs the Kinsey Institute in Bloomington, Indiana, and her journey to this singular appointment within the scientific establishment is dramatic. She had been a driving young rock-and-roll promoter. Today she's promoting advanced sex research.

Jo Durden-Smith and *Diane DeSimone* explore the person and her work in "Kinsey 84: The Science of Sex Identity" (page 68). "Reinisch has an extraordinary persona," Durden-Smith says. "She has an enormously powerful voice that emanates from a petite frame. She is going to make the Kinsey Institute a felt presence again in this society."

John Todd, the subject of our interview (page 76), is also on his way to becoming a powerful presence in the world of technology. Todd, the heir apparent to Buckminster Fuller, is trained in naval architecture, physics, and solar energy—to name some of his disciplines. In 1969 he founded the New Alchemy Institute to explore models for renewable energy systems. And he's preparing "arks"—inexpensive, high-speed fishing/sailing craft—to be used in place of power boats in Third World countries.

Our interviewers *Richard Grossinger* and *Lindy Hough*, have known John Todd since the Sixties. The three were drawn together by their mutual interests in social ecology. Grossinger is an anthropologist and author of the trilogy *The Night Sky*, *Planet Medicine*, and *Embryogenesis*, the last to be published by Avon Books (October 1984). Hough is an editor, writer, and poet. Currently she is writing *Love and Power: The Transformation of the Shadow in the Nuclear Age*. They are copublishers of North Atlantic Books, in Berkeley, California. "We don't think that interviews have really captured John's work," Grossinger says. "He has moved from a predominantly apocalyptic view of the world to an emphasis on constructive preservation of our natural systems. He is convinced that every technological design or invention should—and can—be reconciled with our ecological system." *Omni* senior editor *Pamela Weintraub* added supplementary material to the interview after visiting Todd at his Cape Cod home.

In this month's fiction offering, "Itself Surprised" (page 48), *Roger Zelazny* takes us to a far-flung spaceship lost in the cosmos. But the derelict craft has no room for humans. This is another in a series of Berserker stories, tales of self-replicating killer spacecraft. Zelazny has published more than 100 stories, articles, and books. He has won the Hugo Award four times, and the Nebula Award three times.

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AUGUST

LETTERS

COMMUNICATIONS

Conversations With the Future

I have been an *Omni* subscriber since its first issue and have always found it to be the most intellectually satisfying magazine on the market.

The interview with James Watson [May 1984] was yet another in a series of interviews that has fulfilled one of my lifelong desires—to question pioneers in various fields of science and philosophy.

I hope *Omni* will publish a book with all the interviews, including the photographs. I would like to reread them from time to time. Thanks so much for admitting your readers into the private world of creative minds.

Miriam Hersey
Coral Gables, FL

Your wish is our plan. The Omni Interviews *(edited by Pamela Weintraub, published by Ticknor & Fields) went on sale April 30 and is available at local bookstores.*

Demon Rock and Roll

In "Corporate Devil" [Anfimatter, April 1984], Jack Chick claims that large corporations are unleashing the devil upon us, especially through rock music.

I am thirty years old and have listened to rock and roll since I was six. I have also grown up with Procter & Gamble products in my home. I do not now, nor do I ever, plan to worship the devil simply because I use Procter & Gamble products, listen to a rock-music station, or watch MTV.

I would think that with the Soviets invading every country imaginable, Iran and Iraq at war once again, the entire Middle East ready to explode, and people starving to death all over the world, Chick could find more important things to worry about.

Andrew Eide
Chula Vista, CA

God and Science

The impartial stance taken by James Gorman in "Righteous Stuff" [May 1984] was a breath of fresh air. Not that the text in the pages of *Omni* has ever been stale, but I feel there has always been the slightest taint of anti-Christian bias (for example, the satirical attacks against creationists). While this bias has not been entirely unwarranted, it has always struck me as inconsistent that a magazine dealing so much with mystical and metaphysical realms should bypass the profound mysticism in Jesus Christ.

Much reaction against God is in reality a reaction against religion. If is unfortunate that the two are often confused. The Bible is a spiritual book, not a religious one, and although religion and science have often been at odds, God and science have never been.

Thanks for equal time.

Les Brown
Riverside, CA

Naming the President

Ronald Wilson Reagan, besides being numerologically ominous [Games, March 1984], is anagrammatically revealing. One combination of the letters reads *Insane Anglo Warlord*.

John Miller
San Jose, CA

The CIA Connection

The April issue contains an excerpt from Ronald M. McRae's book *Mind Wars* ["Psychic Warriors"], stating that I knew nothing of the CIA's backing of my Maimonides dream laboratory experiments, with psychic Shawn Robbins, until several years after they were concluded.

As a matter of fact, I never conducted any experiments with Shawn Robbins. I never mentioned her in my interview with McRae, and I made it quite clear that I was aware of no CIA money involved in the funding of our experiments.

I even requested that McRae contact Charles Honorton, a colleague who had turned down an offer of funding from a purported CIA-fronted organization.

As you can see, the statement that was attributed to me in "Psychic Warriors" bears no relationship whatsoever to the facts of the matter.

Stanley Krippner
Saybrook Institute
San Francisco

DIALOGUE

FORUM

Omni welcomes speculation, theories, commentary, dissent and questions from readers in this open forum. We invite you to use this column to voice your hopes about the future and to contribute to the kind of informal dialogue that generates breakthroughs. Please note that we cannot return submissions and that the opinions expressed here are not necessarily those of the magazine.

Kline-Fogleman Furor

Ten years ago the Kline-Fogleman wing received its first publicity, and a friend of mine nearly killed himself as a result. You have done the aviation community a disservice by publishing the concept ["Fancy Flights," April 1984].

David Butz, who now lives in Pismo Beach, California, was Santa Barbara's first hang-glider pilot. He very nearly became our first hang-gliding casualty when he tried flying his own interpretation of the Kline-Fogleman wing. The thing had a 37-foot wingspan and was beautifully built from the finest materials, all aviation-grade, and it was very stable. But it had the glide angle of a greased bowling ball and landed with sound effects reminiscent of a bowling alley.

I think it would be good policy on your part to publish a warning to hang-glider and ultralight builders to prevent a rerun of Butz's bounces. Butz did make a model of his project, complete with six-channel radio controlled pilot, which flew very well, except that the mechanical pilot often broke its arms on landing. Butz did everything conscientiously but still wound up with a useless contraption for all his efforts.

The paper plane does fly nicely.

Steven Moore
Santa Barbara, CA

It is amazing that in the past year, according to "Fancy Flights," I should have crashed into the ground, and all my controls should have become worthless, hundreds (maybe thousands) of times. "Stalling is one of the principal causes of airplane accidents. The plane turns at too great an angle to the wind, loses its lift, and crashes into the ground. The plane suddenly loses its lift, and all the pilot's controls become worthless."

Stalls are an important part of a pilot's training. I wonder how Fogleman managed to become a "weekend pilot" without practicing stalls. Is it possible that I am flying a different type of aircraft than they fly on the East Coast?

Now I do not claim to be an expert on the subject of aerodynamics. I am just an aeronautical-engineering student at California Polytechnic State University at San Luis Obispo. So I will not try to dispute the findings of aerodynamics expert John Nicolaides. But there are a few things that I do know from experience.

First, if an aircraft stalls, the immediate result is not a crash. And I personally have never even heard of "tragic stall phenomenon." Second, an aircraft will spin in either direction—any aircraft. Third, if the aircraft is being flown properly, there is no way for the wing to "tip stall." Most private pilots know this. If the wing is forced to fly at an angle that exceeds the critical angle of attack, the wing begins to stall. A spin is not the result of a tip stall. Rather, it is the result of one wing stalling before the other one.

Fancy fliers Kline (left) and Fogleman

The last thing I would like to address is the idea that the Bernoulli principle explains what keeps all ordinary aircrafts aloft. If a student pilot were to tell me that Bernoulli's principle is the only explanation for lift, I would know that he/she was not ready to fly an airplane.

Richard Wegener
Assistant Chief Flight Instructor
Pacific Wing and Rotor
Long Beach, CA

"Fancy Flights" was lacking in scientific credibility. The romantic flavor in the article resulted in a distorted view of U.S. research agencies, private aircraft experimenters, the use of scale models for testing, and the relationship of models to a full-size aircraft.

Did you have to take a unique idea with some interesting characteristics and inaccurately build its significance by false, deductive logic?

A reader without some prior understanding of the importance of lift/drag ratios, wing-loading, scale effect, fluid flow and propeller efficiency would be misled by the performance of the models. Also, your readers may not know that NASA has always provided valuable research data to aircraft designers and experimenters and does not deserve the government-is-hiding-something implication of your article.

Bernoulli does not explain everything, but publicity doesn't make a safe, efficient aircraft.

Ronald Burt
Troy, Michigan

After making your paper airplane, I realized that Richard Kline's son probably showed him how to make the "amazing airplane." I have been making crash-proof paper airplanes in school since the third grade (1966, Florida). Everybody knew how to make them. Then I went to the New York City school system for a year—the kids there could make them, too. Then I went to a new school in

CONTINUED ON PAGE 108

GAMBLING ON WILDLIFE

EARTH

By Jeffrey P Cohn

On a typical Sunday afternoon at Howletts Zoo Park in England, gambler and casino owner John Aspinall slips away from his human companions to savor the company of wild animals He joins a gorilla troop that now numbers 17 playing with youngsters a few months old as well as Djoum a 14-year-old, 400-pound male silverback Aspinall also howls in unison with wolves, cavorts with elephants and rhinos and plays with tigers There he is prostrate on the ground, a 350-pound tigress sitting, like a domestic housecat, atop his chest while four six-week-old tiger cubs prance around his head

When onlookers gasp in horror, there is good reason Two Howletts keepers have died in the jaws of a tigress only a few yards away from the scene of this playful tryst Yet Aspinall armed only with garden shears, nonchalantly stretches out a hand to pat the head of the massive feline That's my one claw against their ten he explains Usually the threat comes from a male who views him as a competitor In that event, Aspinall clutching the garden shears faces his rival, and shouts and curses in his loudest most dominant fashion while beating a hasty but dignified retreat

High-stake risks clearly have an enormous appeal to the Indian-born Aspinall A renowned gambler he used the fortune he amassed at card tables and racetracks to populate his two sprawling zoos The first Howletts, comprises 55 acres of parkland dating to the reign of Henry VIII and includes a white-marble mansion built in the eighteenth century Newer and larger Port Lympne overlooks the English Channel and its 300 acres of terraced gardens, fountains, and open fields surround a Moorish-style house built in the Twenties

Never perhaps have the rewards from gambling gone to a better cause Aspinall's zoos consist of natural enclosures that are home to some 600 animals from 60 species—mostly large powerful and rare mammals His goal is to produce self-perpetuating colonies of animals that may someday be returned to the native habitats where many of them now face extinction

Amazingly 95 percent of his animals have bred producing the first captive birth of a ratel—a fierce badgerlike predator from Africa and Asia—and the first births in Britain of the clouded leopard and the African elephant Aspinall's tigers have given birth to more than 250 young Indeed the granddaughter of his first tigress was recently sent to India for release in the wild

Other zoos are jealous of what we've achieved at Howletts and Port Lympne, Aspinall states 'Their directors have told me so Some of these colleagues support his daring practice of 'going in' with the animals Warren Iliff director of the Washington Park Zoo, in Portland Oregon and probably Aspinall's most ardent fan observes 'John is like a missionary He says and does things that force people to think about wildlife But another admirer William Conway director of New York's Bronx Zoo concedes His methods may not be appropriate or necessary at all zoos

Stronger disapproval comes from zoo officials who cite the importance of keeping wild animals wild Aspinall puts animals before people they charge And to back up their accusation they point to the 1980 deaths of Brian Stocks and Robert Wilson both keepers and both familiar with animals

Stocks the first to die had warned Aspinall that one of the Siberian tigresses Zeya was becoming increasingly unpredictable She was half tame half wild with no fear of humans and no love for them either Stocks felt that no one should go in to her enclosure but he ignored his own advice, entered alone and was killed there

Aspinall for his part, heeded neither the advice nor the bloody warning of Stocks's mauled body He chose not to destroy Zeya "We had a pact ' he explains lowering his voice, "not to shoot an animal that had killed one of us It's your own fault if you get killed because you misread an animal's mood No no, no you wouldn't want to kill a good

CONTINUED ON PAGE 113

In gamblers' terms wildlife doesn't have a chance says self-styled zookeeper John Aspinall

SERIAL MURDERERS

MIND

By Dan Kagan

There is a chilling lyric from "Riders on the Storm," an old song by The Doors. It goes:

"There's a killer on the road
His brain is squirming like a toad
If you give this man a ride
Sweet family will die
Killer on the road."

It invokes a gallery of nightmare images: homicidal drifters, pitiless thrill killers, real-life bogeymen. With a terrifying combination of randomness and precision they pick their victims, murdering strangers. Yet they do it in so organized a fashion and with such practiced thoroughness that they leave few clues for the police to find, and so they are rarely apprehended.

Men like this—they are overwhelmingly male and white—are known as serial murderers. Unlike mass murderers, who slaughter all their victims at one time and place, serial murderers kill many people, usually one at a time, over a period of months or years, in different places.

In such cases, the usual kinds of clues are often absent. Motive, a relationship with the victim—the fragmentary spoor that police are adept at piecing together—cannot be found in serial-murder cases.

Crime statistics suggest this type of murder may be on the rise. In 1966 there were 11,000 reported murders in the United States. About 5.9 percent, or 644 cases, showed no apparent motive and went unsolved. By 1982 the annual number of reported murders rose to 23,000, and of these 4,118 were motiveless, unsolved cases—a shocking 17.8 percent.

Over the past five years, 17 men have been identified as having killed at least ten people each; nine of these men killed 20 or more. The names jar the mind with a sickening jolt of recognition:

- Angelo Buono and his cousin Kenneth Bianchi. Together they were the Hillside Strangler, who raped, tortured, and murdered a total of 15 young women between 1977 and 1979.
- Henry Lee Lucas. He was convicted of two murders and indicted for 18 others in five states. Lucas claims that he and a partner killed nearly 200 people, mostly women and children. The murders occurred all over the country during the late Seventies and early Eighties.
- Theodore Bundy. He was a suave, charming, promising young Republican politician whose travels across the United States made him a suspect in the murders of at least 33 women.
- John Wayne Gacy. He was convicted in 1980 of killing 33 boys and young men after homosexual encounters with them.

The Federal Bureau of Investigation's Behavioral Science Unit is trying to learn more about who becomes a serial killer and why. By exploring the murderers' reasons for acting as they do and by identifying the factors and stimuli that influence them, law-enforcement officials hope to figure out ways to stop them.

Serial killers have several traits in common. First, there is a powerful, overt sexual component. They may rape and then kill, or kill and then have sex with the victim. They may be child molesters who kill children after abducting them for sex. They may be homosexuals who kill their anonymous partners after sex. They often express an intense interest in the most graphically violent pornography available, and some research links this obsession to their crimes. Most significantly, they are not wild-eyed maniacs. They appear perfectly normal.

Professor Ann Wolbert Burgess, Van Ameringen Professor of Psychiatric Nursing at the University of Pennsylvania School of Nursing, is leading the FBI's research. The bureau has interviewed 38 convicted serial killers, using a carefully constructed questionnaire, and Burgess's team is using a battery of psychometric and statistical analyses to study the interviews and generate a portrait of the serial killer. Burgess's goal: to discover the serial killer's rationale for killing, his feelings about it, and how he views his victims and himself.

She stresses that her work does not take the traditional angle that the killer is a victim of psychological forces. The killer is not viewed as a helpless pawn of his experience, but as a being fully responsible for his actions. Burgess acknowledges that a large proportion of

CONTINUED ON PAGE 120

Beneath the sane, even likable appearance of the serial killer, rages a calculated murderer.

MYSTERIOUS MICROWAVES

LIFE

By Doug Starr

The workers seemed as tiny as ants as they crept over the saucer-shaped radar antenna at Clear Air Force Base, near Fairbanks Alaska. It was work they were used to, but it was not going to be an ordinary day. After working for several hours, they began to feel something strange.

"We started feeling warm," says foreman Richard Eldridge. "Our heads itched as though we were wearing wool caps. Then the arcs from our electric welding torches began to waver." Finally, after a flashlight mysteriously began blinking, Eldridge was afraid that someone had switched on the radar—one of the most powerful machines of its kind in the world—and that it was cooking them like ants in a microwave oven.

Within days Eldridge began feeling weak, depressed, headachy and nauseated. Eventually, five of the six men on the radar dish that day experienced a range of symptoms, from memory loss and eye problems to weakness and convulsions. Yet Air Force doctors who examined Eldridge said that radiation probably had not caused the problems. The Air Force referred questions to Felec Services Inc., an ITT subsidiary, which employed the men and is a contractor at the base. Felec refuses comment. "I don't know what's wrong with us," says Eldridge. "But I do know there was an accident, and that I'm having trouble getting answers about what happened."

The incident last September is one more strange event in the continuing debate over nonionizing radiation. long thought to be the "safer" radiation when compared with its better-known cousin, ionizing radiation. But new studies are showing that emissions from radar, high-voltage lines, and TV transmitters may not be so harmless after all. "We're getting results we can't interpret," says Carl Blackman, a radiation scientist with the U.S. Environmental Protection Agency (EPA). The results of those studies, however, are disturbing enough to convince the EPA that stricter federal regulations of broadcasting transmissions are necessary for the public's safety.

A form of radiation once thought to be harmless may actually be shaking up our bodies' molecules.

In June, the EPA recommended that the federal government call for a reduction in the accepted levels of radiation coming from broadcast transmitters. In urban areas, such regulations could force broadcasters to cut the power of their transmitters—thus reducing the quality of radio and television reception—or to move transmitters and antennas to less-populated areas. The health of millions, some scientists believe, could hinge on what the government decides.

On the face of it, nonionizing electromagnetic radiation (NER) seems far less dangerous than ionizing radiation. X rays and other ionizing radiation come from the high-energy end of the electromagnetic spectrum; they pack enough energy to break apart atoms. Not so with nonionizing rays. Microwaves and their relatives can shake atoms, but they are not strong enough to break them.

When radar was first used in World War II, scientists believed that there was little risk. At worst, they thought, the systems could cause cells to heat up slightly. But servicemen were worried that operating a radar might increase their chances of going bald or becoming sterile. In the late Fifties, the military sponsored a massive research program in which scientists exposed rabbits and other animals to nonionizing radiation. They found that certain levels indeed caused cataracts and sterility, and so the Pentagon set a voluntary standard at one tenth of the levels at which the effects were observed.

Eastern European authorities, meanwhile, took a different approach. They set workplace standards 1,000 times stricter than those of their American counterparts, having observed more subtle effects, such as behavioral changes in workers and lab animals. "We found many effects we didn't understand," says Przemyslaw Czerski, formerly one of Poland's top radiation scientists and now a visiting scientist at the U.S. Food and Drug Administration (FDA). "But then we said, 'So what—let's set standards in the meantime to be safe!'"

For the past 15 years, though, American

CONTINUED ON PAGE 110

SPACE ROBOTS

SPACE

By Alcestis R Oberg

A multimillion-dollar weather satellite has a glitch in its computer Fixing it, says ground control would mean replacing just one inexpensive part Unfortunately, at 22,300 miles up in geosynchronous orbit (GEO) the satellite is far too high for the shuttle's space-suited mechanics to repair it

The scenario is all too credible to NASA But soon, through a sophisticated remote-control technique called telespresence such adjustments will be feasible An astronaut based at a space station or on a shuttle will send a teleoperated robot Armed with a sensory-feedback system the robot will make the repair in concert with its human partner who will feel as if he is actually at the work site (A rudimentary form of telepresence, the Canadian arm, assisted the shuttle astronauts in retrieving the crippled *Solar Max* satellite last April)

Though scientists have debated for years the question of who performs better in space—humans or robots—researchers for a NASA study titled The Human Role in Space (THURIS) now conclude that both will serve important functions

"Robots won't make people obsolete in space " says Steve Hall THURIS contract monitor at NASA's Marshall Space Flight Center in Huntsville Alabama "The relationship between them will be symbiotic"

The focus of the THURIS study is to break down space work into a set of 40 or so generic activities representative of the tasks that eventually will be delegated to automatons astronauts or both Based on performance cost and risk program managers will determine the best man/machine mix for such jobs

In this partnership solving problems will initially fall to the humans while much of the physical labor will become the robots' duty To enhance the robot's performance the machines will be given some human characteristics

For example two or three mechanical arms and hand segments could perform many jobs involved in the retrieval of a satellite But the real challenge lies in making a robot operate its arms and grapplers as fluidly as a person moves his own arms and fingers Delicate work would require robotic arms constructed of wire that bends and extends like mechanical muscles

Tactile information such as the strength of a robot's grip would be relayed to the human operator by means of force sensors or strain gauges To see his work site the human operator would wear a helmet equipped with stereoptic vision Two cameras serving as the robot's eyes would move in response to the operator's head position and would provide panoramic and closeup views

Another NASA-sponsored study Automation Robotics and Machine Intelligence Systems (ARAMIS) in which MIT's Marvin Minsky and David Akin have both participated examined the use of telepresence for satellite repair The group concentrated its research on the repair of the Space Telescope and a few other satellites all of which were originally designed to be repaired by astronauts

A teleoperated robot would be used where "you can't send astronauts " says Akin "The market for telepresence is satellite servicing at GEO When you look at the radiation environment out at GEO, you wind up having to make a lead spaceship That's not the kind of environment in which you'd care to go EVA [extravehicular activity] for long "

Engineers hope to flight-test a basic telepresence prototype system by 1987 although the design, hardware and procedures will have to be worked out before then If the difficulties can be overcome and if telepresence continues to develop, man's partner in space could become even more "human" Endowed with artificial intelligence the robot could consult with his human co-worker about the source of mechanical failures

It is unlikely however, that even the most highly evolved robot will obviate humans in space "The question is not human or robot," says Georg von Tiesenhausen, ARAMIS contract monitor at Marshall "The question is how much participation of each There's no competition Every machine has to have a human interface somewhere "

The Canadian arm a primitive form of telepresence, weds the talents of man and machine

KILLER STAR?

STARS

By Charles R. Pellegrino

Every 26 million years or so, with only two apparent no-shows during the last 225 million years something has shaken Earth with such ferocity that biological systems were literally shattered. Over and over again, fully one quarter of all known plant and animal families have vanished from the fossil record, on land and at sea, and across a spectrum of life ranging from amoebas to clams to brontosauruses.

Since the fall of the dinosaurs, about 65 million years ago, there have been two of these mass extinctions. One occurred around 40 million B.C., the other, around 15 million B.C. If we could stick around long enough, we would probably see something very similar happening on Earth 10 million or 11 million years from now.

At this writing, researchers from a variety of laboratories—Berkeley, Princeton, Los Alamos, and the University of Chicago—are taking a second look at a possible explanation for these periodic extinctions: a decade-old theory propounded by University of Massachusetts astronomer Edward R. Harrison that our sun has a sister star circling it. Geologist Walter Alvarez, of the University of California at Berkeley, and others have theorized that every 26 million years, this star sweeps by the earth, bringing with it a rain of comets that wipes out most of the life on this planet. This mysterious object has been variously dubbed the Death Star and Nemesis.

We know that something is coasting out there on the frontiers of night, yanking Uranus, Neptune, and Pluto, with its moon Charon, out of their expected orbits. If that something is a planet, it would have to have enough mass to perturb the movement of Uranus and Neptune. And it should be large enough and close enough to be visible through a telescope. Yet even with today's powerful telescopes, we see nothing. Whatever is out there must be small, dark, and monstrously heavy.

Harrison has learned that the sun is also picking up a gravitational push from something that has to be more massive than a planet. The unexplained motions of the outer planets, taken together with the push on the sun, suggest to Harrison that this object is a dying star, known as a white dwarf. That, or something small and dense like a neutron star, is exerting its influence on the solar system. The star could be an interstellar vagrant that is just passing through or a sister star that was formed with the sun and is now bound to it gravitationally. Or maybe this star once swept by the solar system and was captured by the sun.

Working from the theory that the Oort Cloud, a giant cloud of comets, circles beyond the orbit of Pluto (a theory still awaiting observational support), the group from Berkeley and Princeton has suggested that a particularly nasty version of Harrison's star passed through the imagined cometary cloud 65 million years ago. The group calculated that its passage would cause a billion comets to rain down on the inner solar system. At least a dozen of these comets are imagined to have struck the earth, wreaking unimaginable havoc and killing lots of dinosaurs. After hearing of the 26-million-year cycle of extinctions, this same group concluded that the star arrives every 26 million years.

Killer comet, lured to Earth by a dark star?

Aside from an imagined comet cloud and a not-so-imaginary 26-million-year cycle of mass dyings, what other evidence do we have to indicate that Harrison's star is a death star? Well, there's iridium, a metal almost entirely absent from the earth's crust. It is abundant in cosmic dust and meteorites. Where layers of iridium-rich sediment are found, a good argument can be made for lethal asteroid and/or comet impacts.

As it happens, there are two well-documented epochs of worldwide iridium enrichment. One occurred about 65 million years ago. It corresponds nicely with the 26-million-year cycle, but the second one, which occurred 34.4 million years ago, does not. Also, most of the dinosaurs were already extinct by the time the iridium source probably crashed to Earth. The evidence accumulated so far does not permit us to indict Harrison's star for murder.

But our model of the solar system is notoriously incomplete, and each bit of information from a Pioneer or Voyager spacecraft will fill out the picture. In April 1989, *Pioneer 10* will become the first man-made object to leave the solar system. Scientists at the Jet Propulsion Laboratory are watching it closely to see whether there is any change in the craft's trajectory—and in the trajectory of the two Voyager spacecraft also flying far-flung missions. If any of these ships deviate from their courses, they should reveal the approximate direction, distance, and mass of whatever caused the deviation.

Within the next few years, the search for a dark companion star will be joined by the space telescope and a new generation of X-ray and infrared astronomy satellites. These tools should be able to detect outbursts of visible light or X rays or heat from an incredibly dense body. In the meantime, we should find astonishment enough in the knowledge that our sun might have a companion. We need not resort prematurely, to accusing it of killing the dinosaurs. ◻◻

THE ARTS

By Bill Moseley

The cosmos ancient and mysterious sunrise over a sleeping city the promise of a new day a man and a woman walking hand in hand down a suburban sidewalk kissing as they part The beginning of some romantic French film? Hardly For as the couple separates the image of the woman freezes The background fades to black and she becomes an iridescent green silhouette with pulsing red circles over her mouth and genital area The synthesized strings rise dramatically and the film's title *Herpes The Evasive Invader* flashes on the screen While this 15-minute educational film sponsored by Newport Pharmaceuticals International Inc (NPI) of Newport Beach California may never win an Academy Award make *Variety's* top ten or even turn a profit it does succeed in rendering the story of a particularly nasty disease both palatable and occasionally even amusing And in so doing it improves public awareness of the relatively new field of immunotherapy The movie uses advanced animation technology and Madison Avenue visual smarts to deliver its message *The Evasive Invader* is meant to demystify the disease and relieve people of their anxieties about it Like the old tooth-decay propaganda the film employs a Saturday morning cartoon format Herpes viruses are depicted as bellicose evil little monsters, and the body's protectors appear as benign potatolike little fellows

Herpes is no joke Approximately 20 million Americans are afflicted with herpes simplex type 2 or genital herpes and millions more suffer from herpes labialis (herpes simplex type 1) formerly referred to as cold sores or fever blisters There are several varieties of herpes including varicella zoster virus (VZV) which produces chicken pox in children and shingles in adults cytomegalovirus (CMV) which in its most dangerous form can produce encephalitis and Epstein-Barr virus (EBV) which produces mononucleosis *The Evasive Invader* concentrates on herpes simplex types 1 and 2

Following the rather melodramatic introduction *The Evasive Invader* shows us the herpes virus itself—a fragile complex almost crystalline structure a mere eight millionths of an inch in diameter The 20-sided DNA core of the virus is surrounded by a protein shell When animation producer Ron Roesch and his team tried to generate this image line by line on a graphics computer the information they fed in was so overwhelming that the machine overloaded causing the filmmakers to opt for a simplified illustration of the virus

After some obligatory footage of the human bloodstream and disturbingly graphic photos of actual herpes lesions on anonymous lips and genitalia (taken a decade ago in a study conducted at California State University at Fullerton) *The Evasive Invader* arrives at the pith of its tale In a vigorous cartoon sequence viruses of a herpes infection wage battle against the body's immune system Robert Settineri director of media development at NPI wrote directed and produced *The Evasive Invader* One of his first tasks was to compile a list of players in the battle scenes Roesch then developed the appropriate characterizations for these players Says Roesch "With animation we created a visual vocabulary for each of the characters so that when you see a phagocyte or a herpes virus you can identify it"

The herpes viruses appear as little monsters with sharp claws triangular barbs protruding from their heads slanted red eyes and light-gray pentagonal faces highlighted by dark-gray bodies Conversely the body's immune defense team including the phagocytes and the killer T- and B-cells have been rendered in bright pastel colors These friendly fighters have no hooks or barbs and their potatolike fingers never form fists As Roesch says of his good guys "By being rounded they are not offensive"

The immune-defense team is represented as happy in its work According to Roesch this increases the film's placebo effect Viewers afflicted with herpes worry less about their infection knowing that their immune system is fighting the brave fight and for the most

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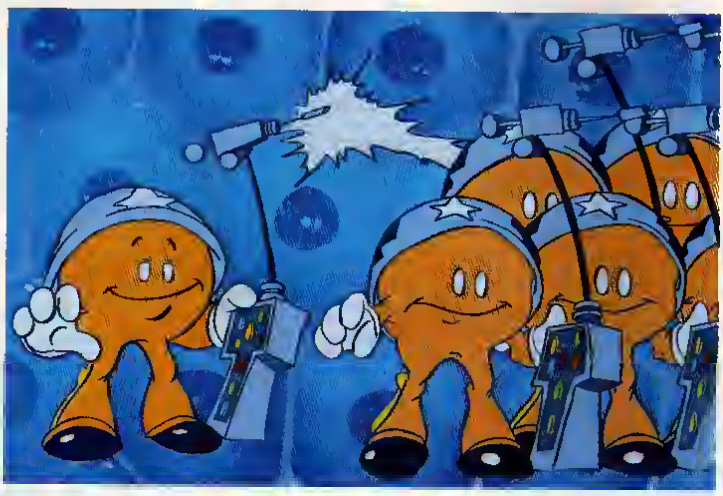

Computer graphics bring herpes viruses and phagocytes to life on animated battlefields

CONTINUUM

MEDICINE'S UNCERTAINTY PRINCIPLE

Physicist Werner Heisenberg discovered in 1927 that it is impossible to know both the location and the speed of an electron because the simple act of taking the measurements would jar this subatomic particle ever so slightly, changing its position. Although we cannot quite find electrons, we can calculate probability distributions for them with graphs that specify the chances of finding a particular electron at a given point within an atom. Officially known as the uncertainty principle, it seems to be nature's way of keeping scientists humble.

There is also an all-pervasive uncertainty principle in medicine in which probabilities take the place of hard facts. If Jimmy Jones, age seven and looking peaked, shows up in a hospital emergency room with a fever of 101°, and if his mother is explaining that he had a vague bellyache yesterday and that today he has vomited, refused food, and looks sicker, the doctor will suspect appendicitis. When the lower-right-hand portion of Jimmy's abdomen is tender, his white-blood-cell count is slightly elevated, and the results of his urinalysis are normal, there is enough evidence for any surgeon practicing by good American standards to quickly take Jimmy to the operating room for an appendectomy. At surgery, the probability that Jimmy actually has appendicitis is 85 percent.

He might instead have swollen, painful lymph glands within his abdomen, or a bowel inflammation that will become chronic. He may, in fact, have anything from a stomach virus to food poisoning to a congenital malformation. The alternate condition may require surgery anyway for treatment or diagnosis, or it may be something benign and self-limited. In about 15 of every 100 appendectomies, the organ will be perfectly normal.

If left alone, an inflamed appendix will usually rupture, with at least a 3 percent chance of the victim dying, and since the mortality rate for appendectomies is negligible by comparison, lives are saved by "overdoing it" a bit. This ensures that no one will be sent home with a pus bomb inside of him. Our diagnostic acumen can take us no further given our current tools.

Heisenberg realized that the light energy necessary to see an electron would move it, leaving some uncertainty about where it had originally been. In medicine, the mere act of looking—the diagnostic process—can itself change a patient's condition. Putting a needle into a breast mass to see whether it is a fluid-filled cyst allows drainage and shrinkage of the mass if it is a cyst. The diagnosis is the treatment.

Or take hysterosalpingography. This is the X-ray that visualizes the uterus and fallopian tubes when a special dye is injected through them. It is part of the workup of female infertility, since tubal blockage may be the cause. Not only does the test give diagnostic information, but, in the opinion of many observers, it can actually open tubes that are mildly obstructed. It is not uncommon for a woman to conceive following this test.

It was Albert Einstein's skepticism about quantum physics and its probability distributions that prompted his famous remark, "I cannot believe that God plays dice with the universe." It is too early in history to say whether he was right. Perhaps someday we will be able to chart both medical diagnoses and electron paths with precision. Meanwhile, the practicing clinician sees patients who are as different as snowflakes, and health care is an art as much as it is a science.

As medical students, we approach the discipline as if answers are either right or wrong. We take exams with multiple-choice questions and are graded accordingly. Yet when we start seeing patients, we are taught never to say *never* in discussing medical possibilities. The more we learn and see, the less we actually know about disease, although our clinical judgment improves. Dr. Mark L. Cohen, writing in the *Journal of the American Medical Association*, suggests that "uncertainty is everywhere in medicine," and he proposes something called uncertainty rounds, a planned exercise for medical students in which they must learn to accept doubt in medicine.

Even if physicians could accept doubt as an integral part of their field, it is still a lot to ask of patients. Doctors inspire confidence by appearing decisive and all-knowing, and the patient who believes he will be helped has a head start. Still, the best physicians are those who play the probabilities most skillfully, using available facts as well as their experience with the intangibles of illness. So the next time your doctor is evasive or unclear, don't automatically assume that he is too busy or disinterested to talk to you. It is also possible that knowledge of your ailment has been carried to the boundaries of certainty, and can go no further.—*ROBERT BOBROW, M.D.*

CONTINUUM

FAT ASTRONAUTS

The standard image of an astronaut is that of a lean, superfit athlete But slender specimens of the human race could find themselves out of a job when it comes to long-duration manned spaceflights

'From the standpoint of body fat we're sending the wrong type of astronaut into outer space,' says Ralph Nelson, of the University of Illinois College of Medicine "Because American and Russian astronauts tend to become anorexic in space they could lose lean body fat during long flights And even small losses of lean body mass could have unfortunate consequences if they were to occur in critical organs, such as the heart'

Nelson points out that 40 pounds of excess weight represents almost 140 000 calories which would sustain an astronaut on 2 000 calories a day for a 70 day stretch without food.

Nelson whose studies of hibernating bears led him to his unorthodox conclusion would put overweight astronauts in space and supply them with a 1 200-calorie per-day diet of essential fatty acids, proteins, minerals and vitamins Assuming an astronaut needs 2 200 calories per day the additional 1 000 calories would come from fat

'The one hundred forty thousand calories of overweight could mean one hundred forty days in space, which could spell the success or failure of a mission It means reeducation in our entire approach as to what type of individual makes a good astronaut says Nelson

As for clothing Nelson comments 'I don t think they d even have to buy new space suits They d just have to let them out in the back'—Phyllis Wollman

'Every exit is an entry somewhere else'

—Tom Stoppard

For decades we have rigorously trained lean superfit astronauts But long spaceflights may require fatter candidates

BUILDING A BETTER RACEHORSE

Are racehorses falling behind their human counterparts? Some Texas researchers think so

Gary Potter professor and horse-program leader at Texas A&M University, raised the question of physical fitness among racehorses when he noticed that the winning time for the Kentucky Derby 50 years ago wasn t much faster than the winning time today The 1980 winner for example, with a time of two minutes, two seconds was a scant three seconds faster than the 1932 Derby champion The Olympic time for the 1 500-meter run was reduced by almost 13 seconds during the same period

'The irony is that we haven t knowingly been breeding better human athletes' says Potter 'but there s been a lot of time and money spent on the process of genetic selection to find faster racehorses'

Potter attributes this disparity to environmental changes For human beings the last 50 years have been filled with great advances in the understanding of diet exercise and bone and muscle growth But racehorses have been trained and fed pretty much the same way for decades The Texas A&M team insists that horses can be made to run faster only if their training begins to resemble that of human athletes 'When the track team works out" says Potter even

Derby winners have hardly improved in the last 50 years

the sprinters are expected to run five miles with the team It s part of their overall conditioning But the very first time a racehorse runs a distance of a mile and a quarter is on the day of the Kentucky Derby

Horse trainers have been reluctant to push horses too hard according to Potter, for fear of injuring the animal 'But the body responds to work' he says 'You can work a horse correctly—building up endurance and reducing the risk of injury—through interval training'

Potter has also found that the diet most racehorses are forced to follow is inadequate 'We ve had some great results with a vitamin B [thiamine] supplement in increasing the animal s energy' he says

—Paul Dusseault

'Statistics are the triumph of the quantitative method and the quantitative method is the victory of sterility and death'

—Hilaire Belloc

DEEP ROVER

In the not-too-distant future Instead ot spending holidays by the sea, vacationers may relax *under* the ocean itselt Once there they will routinely enter their private underwater crafts and zoom off to take an up-close look at the sea s mysteries

These scenarios are no longer just fantasies according to Graham Hawkes and Sylvia Earle ot Deep Ocean Technology, Inc , based in Oakland Calitornia The company s newest creation—an acrylic, egg-shaped underwater cratt Invented by Hawkes—may well be the first step in making the ocean's depths accessible to a large number of people The Deep Rover which comes in one- or two-person models can dive to over one halt mile beneath the sea Battery powered its thrusters and propellers drive the sub at speeds ot up to four [illegible] according to Earle, anyone can learn to operate the sub in a few hours

' You wear whatever you want, no special suit is required And the seat feels like those in the first-class section ot an airliner ' Earle explains 'You have a clear three-hundred-sixty-degree view and to change direction you just slide your arms slightly in the direction you want to go You can fly through the water or just sit there and observe "

Unlike other small subs the Rover is equipped with highly sensitive robotic arms that enable its passengers to interact with the sea s environment Working with surgical precision the arms can perform mining operations and even pick up objects weighing hundreds of pounds

The oil industry has shown much interest in the Rover, and a Canadian firm recently purchased one to maintain offshore oil rigs At a price tag of $600,[illegible] private individuals probably won't be buying too many of them right now

But our motivation goes beyond industrial uses We want to develop working access to the ocean at a cost and a safety factor that anyone can take advantage of,' Earle emphasizes "It s just a matter of time until there are underwater restaurants, hotels, and industries Buildings will be maintained at sea-level air pressure and visitors will go from their underwater room to a Rover-like vehicle and never feel any pressure change Then they will take off in their craft, exploring the ocean When people have the means to really know the ocean, they will respect it and care what happens to it And a Deep Rover-type cratt will give us the means to repair some of the damage humans have done to the sea '—Sherry Baker

over Like sitting in the first-class section of an airliner, except that you have robot arms—and you're half a mile underwater

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"I never assumed I was not like my pigeons "

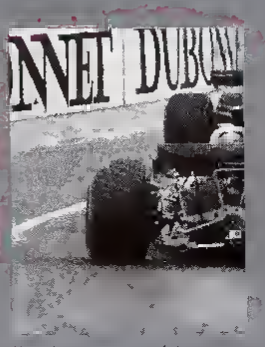
—B F Skinner

JEKYLL AND HYDE FLUIDS

Dial s for *soft* and your Corvette becomes a supersmooth boulevard cruiser Press H for *hard*, and the car's stiff suspension is instantly ready to take on the tightest curves

The secret new shock absorbers containing fluids that set solid at the touch of a button, yet revert to liquid just as quickly

These remarkable Jekyll and Hyde fluids consist of a silica gel suspended in oil Also known as electro-rheological (ER) fluids they demonstrate startling properties when subjected to a small voltage



New fluids may revolutionize automobile suspensions

For example, it the voltage is applied across a pipe carrying an ER fluid—presto—it will solidify within one millisecond Willis Winslow, an American scientist discovered the phenomenon back in 1947 But today work is led by Great Britain with the Soviet Union and Japan following close behind

According to Arthur Gerrish a director of Laser Engineering the London firm leading fluid studies, 'The potential of ER compounds is very dramatic By 1990 experts predict the fluids will be used in aircraft landing gear to cope with rough emergency airstrips, in antilock brakes and oilfield pile driving and even in fast-response 'muscles' for robot arms Predicts Gerrish, "These fluids will open up a whole new era for electronic power supply '

—John Kerr

CONTINUUM

WHALE-BEACHING THEORY

Some whale beachings may be the result of postnatal complications. That's the theory of University of Florida veterinarian Paul Cardeilhac, who believes that pregnant females may come close to shore to give birth—perhaps to escape the attention of large predators—and then get

Beached whale? The real problem may be pregnancy

themselves into trouble.

Cardeilhac, a specialist in aquatic-animal medicine, believes that his theory may apply to most whale strandings, but emphasizes that his work has been primarily with pygmy sperm whales on Florida's east coast.

"After she gives birth, the female is disoriented and certainly a little toxic," Cardeilhac says. He notes that several stranded whales were found to have been suffering from uterine infections, which may have also contributed to their problems.

Since they are offshore animals and are not used to this terrain, they tend to become stranded," Cardeilhac says. He points out that, in contrast, bottle-nosed dolphins, which normally stay close to shore and are quite familiar with reefs and shallow water, seldom become beached.

Cardeilhac stresses that there are a number of theories on whale strandings, including problems associated with diseases and ear parasites, which affect navigation. He is beginning to believe, however, that problems associated with birth are the primary cause.

And while there is no generally accepted explanation for the mass beachings of sperm and pilot whales, Cardeilhac suggests that those incidents may also be birth related. If a female is in distress and heads into shore, he says, the other whales in her group may follow her.

Attempts to save stranded whales are rarely, if ever, successful. The calves, too, are nearly always lost.

—Robert Deckert

"When a thing is funny, search it for a hidden truth."

—George Bernard Shaw

"Fun is like insurance: the older you get, the more it costs."

—Kim Hubbard

"Give me mother-luck at my birth, then throw me if you will on the rubbish heap."

—Bulgarian proverb

Fireman, police chief, or even president—these are all possibilities for children in a new fairy godmother kind of program

A WISH COME TRUE

Seven-year-old Billy Kopsaflis of Grafton, Massachusetts, dreamed of being a police chief for a day—and it happened. Then he raised his sights to governor for a day, and that also came true. But Billy couldn't content himself with such small potatoes. So this past November he was flown to Washington, DC, to spend a day alongside President Reagan in the White House.

Billy would be the luckiest kid on the block if he weren't suffering from Hurler's syndrome, a deadly bone disease. His dreams and those of ten other youngsters like him have been realized, thanks to Mary Giradin, a self-styled fairy godmother. Giradin is founder of A Wish Come True, a pioneering, nonprofit organization that aims to release ailing children and their families from the grim routine of doctor's visits and medical treatments.

"We want to give the kids a good time, like others have," says Giradin, who has worked magic over the last year from the cramped office quarters of the Massachusetts/Connecticut chapter of A Wish Come True. So far the organization has financed the children's activities with community drives and donations from individuals. "But once we're a national organization, we'll be able to get big discounts from airlines and hotel chains," says Giradin, noting that 39 other states are planning to open their own chapters shortly.

—Kathrine Jason

DESOCIALIZING MEDICINE

It is a familiar scene: physicians making house calls, caring for their patients in private clinics, or having them admitted at hospitals with which the physicians are affiliated. The only incongruity is that the setting is Romania.

The private practice of medicine was outlawed in

Romania as in all other Eastern European countries after the establishment of a socialist government According to socialist principles, all citizens are to receive the same health care regardless of their income Recently however, Romania has followed Hungary and Bulgaria in passing legislation legalizing the private practice of medicine

According to a spokesman at the Romanian U N mission this law so far applies only to a limited number of doctors those with many years of experience and well-established reputations, medical-school professors and specialists in high demand In the future it is expected that other physicians may be allowed to take advantage of this new legislation

'This new law will in no way effect the quality of health care in free state clinics,' said the Romanian spokesman Unfortunately, it appears that the more experienced doctors will be less available to those who cannot afford them

In the past Romanian doctors, like their colleagues in Eastern Europe have enjoyed the benefits of illicit private practice Penalties did little to discourage this infraction The legalization of private practice will at least enable the government to acquire a share of the profits through income tax —Daniela Faibes

'I have no time to be in a hurry"

—John Wesley

PREHISTORIC FLUORIDE

People living in central Pakistan 10,000 years ago had fewer cavities than their neighbors, and the reason is—guess what?—prehistoric fluoride

The significance of this find goes beyond dental hygiene, for the ancient teeth that John Lukacs, of the University of Oregon

Mehrgarh teeth No checkups no brushing—just fluoride.

unearthed recently in Pakistan's Mehrgarh region, north of Karachi, may overturn an old archaeological assumption Prehistoric tooth decay has always been taken as evidence of a grainy diet, and therefore of a settled, agrarian life Conversely, whenever cavityless teeth have turned up archaeologists assumed they were dealing with primitive hunter-gatherers who ate a lot of meat

But Lukacs has an alternative explanation In some parts of the world natural fluoride is very abundant in the water supply Add to this a very hot climate which leads to lots of water drinking and you get a protective accumulation of fluoride on local teeth The result—in places like central Pakistan—was that an agricultural people could go to the grave with relatively pristine teeth

Will the fluoride factor rewrite prehistory? Stay tuned 'I m surprised that some areas in Texas and Colorado, where there are high levels of fluoride haven't shown this in prehistoric samples says Lukacs But the research ers haven t been looking for it '—Tom Gauntt

'A rumor without a leg to stand on will get around some other way

—John Tudor

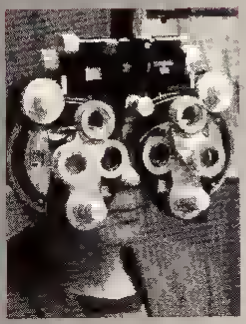
"It is not stress that kills us It is effective adaptation to stress that permits us to live "

—George Vaillant

ELECTRONIC EYE EXAMS

In just seconds computerized medical instruments can now scan the human eye and, with remarkable precision detect subtle abnormalities measure visual acuity and even prescribe corrective procedures The latest innovations include

- The automatic refractor which beams light into the eye to measure visual sharpness and then prescribes lenses
- The automated keratometer which surveys the hills and valleys of the cornea for a perfect contact-lens fit
- The automated tangent screen which tests eyesight in a way that reveals microscopic yet harmful lesions at the back of the eye
- The glaucoma-pressure instrument which bounces sound waves off the eye's surface to detect dangerous fluid buildup inside



Conventional eye gear Much cheaper but a lot slower

Yet despite the superiority of computerized equipment most patients are still being tested with conventional instruments The reason, according to ophthalmologist Joel Hirsch of Los Angeles, is prohibitive cost (up to $45 000 per instrument) plus many doctors reluctance to learn how to operate new electronic equipment

But the initial investment in time and money, says Hirsch will more than pay for itself in the long run He hasn't even had to charge patients more, he reports since each exam now takes much less time

—Eric Mishara

CONTINUUM

Killer worms: Possessing a lightning strike and sharp, viselike claws, some species of caterpillar prefer meat to vegetables

CARNIVOROUS CATERPILLARS

Steven Montgomery, a researcher at the University of Hawaii, was studying fruit flies in the Hualalai Forest near Kona, when he witnessed a 'harmless' inchworm devour one of his subjects. Because caterpillars were thought at that time to be exclusively herbivorous, Montgomery attributed the violent episode to a case of inchworm schizophrenia.

That was ten years ago. Since then the thirty-seven-year old doctoral candidate has identified 18 species of carnivorous caterpillars. Members of the pug-moth family, these diminutive yet deadly inchworms are able to catch and consume prey more than twice their size. Spiders, roaches, and flies are easy victims of the caterpillar's lightning strike as well as its sharp, vise-like claws.

By hiding in foliage and ambushing insects, the killer worm may evade the myriad predatory birds native to the Hawaiian Islands. Montgomery theorizes. Its carnivorous days are short lived, in any event. Once the caterpillar completes its metamorphosis, according to Montgomery, the insect abandons its meat-rich diet for a meager subsistence on rotting fruit and nectar.

—Bryan C. Klum

'Astronomy compels the soul to look upward and leads us from this world to another.'

—Plato

'All that is necessary is an empty space of time and letting it act in its magnetic way.'

—John Cage

TELLTALE TEARS

Tears carry so much information about body chemistry and are so easy to collect that scores of researchers have sworn tears would one day replace blood and urine samples in all kinds of laboratory tests. But that promise has never materialized because the simple act of collecting tears sets off a reaction that changes their makeup.

"You have what we call basal tears in your eyes all the time for lubrication," explains Dr. Peter Kastl, of the Tear Analysis Laboratory at Tulane Medical School in New Orleans. "But the minute you get a punch in the nose or start to cry over something sad, or let me try to collect some tears from you, the other kind of tears, called reflex tears, dilutes the basal tears and the composition of the two is different."

Within six months to one year, however, Kastl is confident that he and his colleagues will be able to set norms making tears a reliable measure for at least a few common eye problems. One of the first conditions Kastl plans to study is patient reaction to contact lenses. Some people just can't get comfortable with them, he reports, even though they have no obvious irritation in their eyes. The tears should reveal metabolic processes going on in the cornea that may suggest a course of action. Kastl also expects to monitor the healing process after cataract surgery or cornea transplant. It should eventually be possible to use tears to assess the percentage of alcohol in the bloodstream, to measure an individual's exposure to toxic pollutants, or to detect diseases.

Kastl also foresees the day when doctors could send tear samples to the Tulane lab for analysis. Whereas body fluids must be frozen and shipped with elaborate precautions, tears collected on a piece of filter paper could simply be put in an envelope and mailed. —Dava Sobel

A tear could well be the ultimate diagnostic fluid.

OUR BODIES, OUR CARS

Aston Martins may be for playboys and station wagons for the carpool-and-hair-curlers set, but it is your self-image that rubs off on your car and not necessarily the other way around, according to British psychiatrist Arthur Crisp.

Crisp started wondering how self-esteem influences the way a person drives

after he noticed that his female assistants were curiously reluctant to maneuver their cars through reasonable gaps in a traffic jam. So he recruited volunteers and simulated the traffic-jam situation with portable barriers in a parking lot near St. George's Hospital Medical School in London. He instructed his subjects to stop their cars a certain distance in front of the obstacles and then asked them to estimate whether they could drive comfortably between the barriers. Each driver was also asked for an assessment of his or her waist and shoulder width.

The result? A driver's perception of the space depended on his own estimate of his *body's* girth. Short, chubby women and men, who underestimate their shoulder breadth, try to squeeze through too-narrow spaces, according to the researcher. These people often dent their fenders. Tall, thin women and men, who overestimate their brawn, on the other hand, project their perceived largeness onto their cars and 'will probably hesitate or stop in front of a gap in traffic,' Crisp says. Such people, he adds, probably shouldn't invest in rear-engine vehicles.

—Daniela Faibes

'Time is a storm in which we are all lost.'
—William Carlos Williams

Colleges are places where pebbles are polished and diamonds dimmed."
—R. S. Ingersoll

HYPERTENSION'S MYSTERY COMPOUND

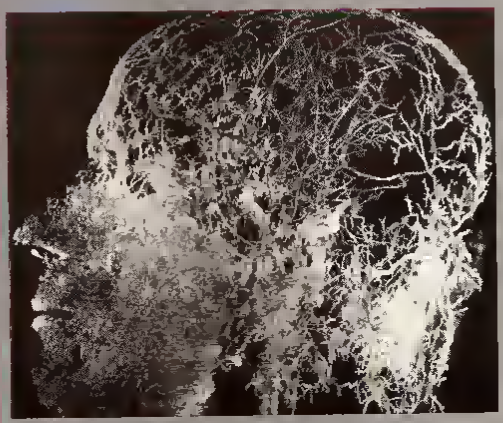
Hypertension—commonly known as high blood pressure or "the silent killer"—has long been associated with heart attacks, kidney disease, and strokes. Yet, despite the frequency of its occurrence (up to 20 percent of all Americans suffer from it), the underlying chemical causes of most types of hypertension have remained a mystery to medical science.

New research, however, by Dr. Garner Haupert, of Massachusetts General Hospital in Boston, seems to have taken a giant step toward solving the mystery, at least for a large segment of the population suffering from hypertension.

The culprit, Haupert thinks, is an as-yet-unnamed compound found in the hypothalamus, the portion of the brain that controls sleep, temperature, and emotions.

It is well-known that a substantial number of hypertensive patients are predisposed toward build-ups of excess salt and water in their bodies, probably because their kidneys do not excrete enough sodium.

When sodium and water build up, according to Haupert's theory, the kidneys send a signal to the brain, which causes it to secrete the mystery compound. (The compound, Haupert says, seems to have "the biological hallmarks of a hormone.") The substance then tells the kidney's sodium pump—an enzyme that controls the cellular balance of minerals—to slow down, and this in turn measurably increases the kidney's excretion of sodium.



The blood vessels of hypertensive people may constrict when the mystery compound orders the body to rid itself of excess salt.

The problem is that all this occurs at a price. When the sodium pumps in the kidneys are slowed, so are the sodium pumps in the smooth muscle that lines the outside of our blood vessels.

This makes the blood vessels constrict, and blood pressure can zoom. "It's an adverse trade-off," Haupert says. "The substance from the brain does its thing on the kidneys, but it also does its thing on the blood vessels."

Once the structure of Haupert's hypertension mystery substance is known (he recently spent five days in an Omaha slaughterhouse collecting 120 pounds of animal-brain material for study), the next step will be to synthesize it so that researchers can develop an antibody. "We're not promising a cure for all hypertension," Haupert says, "but we think this has the promise of being a very important contribution. The really important issue is that we're attacking the problem at its very roots."—Bill Lawren

'A lie is an abomination unto the Lord and a very present help in trouble."
—Adlai Stevenson

"One thing the world needs is popular government at popular prices.
—George Barker

"Anybody who adheres to a posture earlier enunciated, when times change, is a fool."
—Howard Cosell

CONTINUUM

I WAS A SPERM-BANK REJECT

Sperm banks reject many potential donors out of hand the old and the ill the dopers and the dopey even the dull and the ugly Now thanks to a recent round of publicity involving California s Lawrence Livermore National Laboratory a new class of rejectees has been identified those who might glow in the dark

Recently, an unidentified lab technician from Lawrence Livermore—an enormous government labora tory that concentrates on defense projects—showed up at the Oakland based Sperm Bank of Northern California and applied to become a donor As he went through a series of screening interviews questionnaires and medical tests, it became apparent that he had everything going for him—including a sperm count that one bank official called immense The only catch was his admission that he had once been exposed to an unknown quantity of radiation This instantly alerted the sperm bank to the possibility of unacceptable damage to the man s chromosomes

'If he could have documented the amount of radiation exposure he d had ' says sperm bank director Barbara Raboy, ' we would probably have consulted with a geneticist and a cancer specialist and then made a decision But the man said that he had been unable to deter mine the amount of expo sure The sperm bank was forced to reject him "He was disappointed, says Raboy 'He was the kind of guy who comes in here because he really feels he has something to offer But he certainly shouldn t feel like the Lone Ranger We reject donors for a million and one reasons

"It's our job to be selective Raboy insists 'It may be funny to talk about sperm as a product but it is for us and we want to make sure our customers get the best"

Because of some initial confusion in the media Lawrence Livermore officials saw the sperm bank s decision as discriminatory But Raboy insists that the bank would accept anyone from Lawrence Livermore who could show little or no exposure to toxic chemicals or radiation 'I'm glad to hear that ' says Livermore spokesman Ron Teunis While he won t go so far as to say that the sperm bank should set up a recruiting post at the lab Teunis does maintain that Lawrence Livermore has 'a very high concentration of good donors —Bill Lawren

Would you buy a sperm sample from this man? One sperm bank caused an uproar by refusing the sperm of a nuclear lab worker

STRIDERS OF THE OCEAN

Sea-surface cats some natives of Micronesia call them They believe that when the tiny animals are eaten with coconut juice they will help you run faster

Scripps oceanographer Lanna Cheng who has devoted a lifetime of study to these "cats" finds no scientific basis for this claim But what she has learned about this insect the water strider is amazing enough and may even provide information about the extent of ocean pollution

Of the 42 species of water strider identified, most live near a coastline Five species are truly oceangoing, however spending their entire lives hundreds of miles from land

And a precarious existence it is Like a circus star on a high wire, the peanut-size insect balances on the surface of the sea, jumping over waves on long slender legs Their water-repellent coating helps the bugs survive being swamped

With no port to call home the female locates a floating nursery laying cream-colored eggs on anything from a feather to a blob of tar Like popping rice grains the infant ocean striders molt five times until they become full-size adults

The ocean strider s diet consists of zooplankton and small jellyfish, according to Cheng In her lab she discovered they can also eat fruit flies and other freshly killed insects

Despite the difficulties of studying such a small creature, Cheng emphasizes that this is vital research As she points out, "The ocean strider is the only creature to have mastered living on the boundary of air and sea and this is where airborne pollutants first come in contact with the oceans "

The oceanographer is currently studying how the insect copes with toxic substances Cheng has discovered that ocean striders deposit an ultraviolet-absorbent material in their cuticle, which she believes, offsets possible damage from the sun

—MaryJane T Murphy

"Evolution is far more important than living"
—Ernst Junger

The hint of subterranean oceans orbiting Saturn has stirred new interest in a

QUEST FOR SOULS ON ICE

BY CHARLES R PELLEGRINO

With a faint whirring noise, the yard-long robot helicopter descends through the orange haze of Saturn's moon Titan After skimming over the Titan icescape for about ten minutes, it spies a promising patch of tar and ice and gently sets down Its engine off, the heliprobe begins the real work A laboratory of miniaturized sensing equipment switches on Out of the probe's snout glide two telescopic arms At the end of each metal stalk the fingers of a dexterous robotic hand unfurl Over the next few months the robot will repeat this automated ritual as it leapfrogs across the surface of the moon Back on Earth, a small army of scientists follows the machine's progress with an intensity not seen since we landed on Mars The reason They hope to find signs of an immense ocean lurking beneath the frozen crust of Titan And in upwellings from that sea fossils of extraterrestrial life

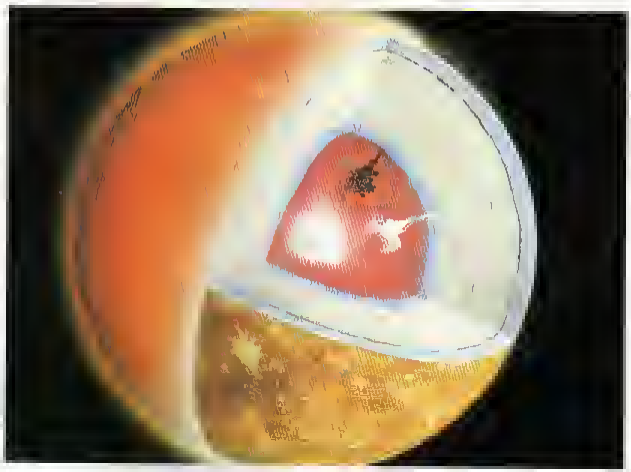
Last August, IRAS the U S - Dutch-British infrared astronomy satellite detected some tantalizing infrared emissions from a bright-blue star called Vega What IRAS found was a spectral sign of a halo of dust that could be a sign of comets asteroids or a system of planets From then on, no matter where IRAS was pointed other candidate solar systems turned up By the time IRAS ran out of gas the number had risen to nearly 50

Within minutes of the announcement the possibility of life near Vega was raised There was good cause for doubt however Besides being much younger than our own sun Vega is at least three times as massive Under the crush of a stronger gravity it burns fiercely, emitting intolerably high levels of ultraviolet and X-radiation The chances that there could be a life-bearing earthlike world anywhere near Vega appeared minimal

Our perennial search for life has already taken us all over our solar system One by one the moon and inner planets have fallen under scrutiny Our moon turned out not unexpectedly to be about as dead as any place could be Mercury was intolerable And Venus? Anyone who landed there and stepped outside would be simultaneously crushed fried and deafened—by the incessant thunderstorms After *Viking* landed on Mars we almost gave up hope But there are alternatives

PAINTING BY CHESLEY BONESTELL

"Titan could be an ice world encircling a sea—a bubble of water locked between two concentric spheres"



Now some intriguing evidence from the robot explorers *Voyager 1* and *2* suggests that maybe we should not have been looking for life only on earthlike worlds. As the two spacecraft raced past Jupiter and Saturn they found that life-bearing oceans can, and probably do, exist in some of the most unlikely places, inside the planets' moons. We now know that eight of these satellites are giant orbiting snowballs more than 50 percent ice and it also appears that four of them—Europa and Ganymede, the second and third moons of Jupiter, and Enceladus and Titan, the second and sixth moons of Saturn—are alive, at least in the geological sense.

Tugged alternately this way by their planets and that way by their sister satellites, some of these ice worlds creaking, snapping, and groaning are kept warm and wet inside by tidal friction. These are worlds whose icy crusts are girdled by continent-size grooves and whose molten lava is water. Having seen these bodies up close, scientists now want to examine these planets' seas of molten ice. Already scientists at NASA have discussed ways of exploring such exotic places. Schemes so far have ranged from sending robot helicopters to the surface of Titan, to launching special spaceship-submarines with dolphin astronauts to explore the liquid interior of Enceladus.

Judging from what we have seen so far in our solar system, the average ocean-bearing ice world has at its center a rocky core roughly the size of our moon. The surface of this core is actually the bottom of a sea hundreds of miles deep and enclosed in a protective shell of ice and slush up to 500 miles thick. We already know from studying meteorites and spectroscopic analyses of volcanic eruptions on Jupiter's moon Io that sulfur is ubiquitous in the solar system and that the floors of these ice-world seas are probably laced with an ample supply of sulfides. We also know from recent exploration of Earth's ocean floor that as long as sulfides are available to make food, entire ecosystems can flourish in worlds without suns.

At least one hidden sea probably circles Saturn inside its little moon, Enceladus. It is possible that cracks in the moon's surface penetrate through to its sea and act as vents. Since Enceladus has no atmosphere, water rising through these vents would erupt as a gas rather than a liquid. Some of the water would freeze and fall back down, which perhaps explains why Enceladus's surface reflects about as much sunlight as does fresh-fallen snow. This, together with the fact that the densest part of Saturn's outermost ring coincides with Enceladus's orbit (implicating a trail of ice crystals from Enceladus as the source of the ring), points to the probable existence of an underground ocean.

Another habitat, an even younger sea, is suspected to exist inside Europa, a Jovian moon only slightly smaller than our own moon. Europa has spent much of its history in the throes of eruptions so violent that only a thin shell of ice remains. The Europa sea, if such exists, would have become habitable only during the last billion years or so. Nevertheless, one of *Voyager 2*'s parting glimpses of Europa gave us a strong case for habitable waters beneath the ice. Looking back over its shoulder, *Voyager 2* made us witness to a faint plume of what appeared to be water vapor rising 75 miles above the crescent moon.

Over the last four or five years I spent a good deal of time playing with numbers: measurements of surface areas and volumes and heat loss from worlds; estimates of the pressure and density of ice miles below the surface of Jupiter's Ganymede or Saturn's Titan. These numbers are anything but boring.

The numbers indicate that if you dig down deep enough into Titan, you will probably find water. To get to it, you must bore through so many miles of ice that the sheer pressure of overlaying crust produces different pressure phases, or densities, of ice. These layers would be real-life variations of Kurt Vonnegut's superdense Ice Nine, a fictional substance in his novel *Cat's Cradle*. The greater the pressure under which ice is formed, the more closely packed are the molecules of water and the lower the ice's melting point. We know of at least ten solid forms of water, from Ice One (ordinary ice cubes) to Ice Ten, suspected to exist inside Neptune.

Around 62 miles below Titan's surface, you should encounter a layer of Ice Three, which melts at −5°F. If salts, ammonia crystalline forms of methane, and other nonwater substances are mixed in with it (and they probably are), its melting point will be still lower. The gravitational pull of Saturn, which Cornell University astronomers Stanley Dermott and Carl Sagan estimate is powerful enough to raise 60-foot tides in a hypothetical

Previous page: A view of Saturn from its moon Titan—minus the permanent haze of its atmosphere. A cutaway view of Titan (above) shows that satellite's thick crust of ice and slush, the ocean suspected of lying beneath the ice, and a rocky core. Painting by Helmut Wimmer.

CONTINUED ON PAGE 96

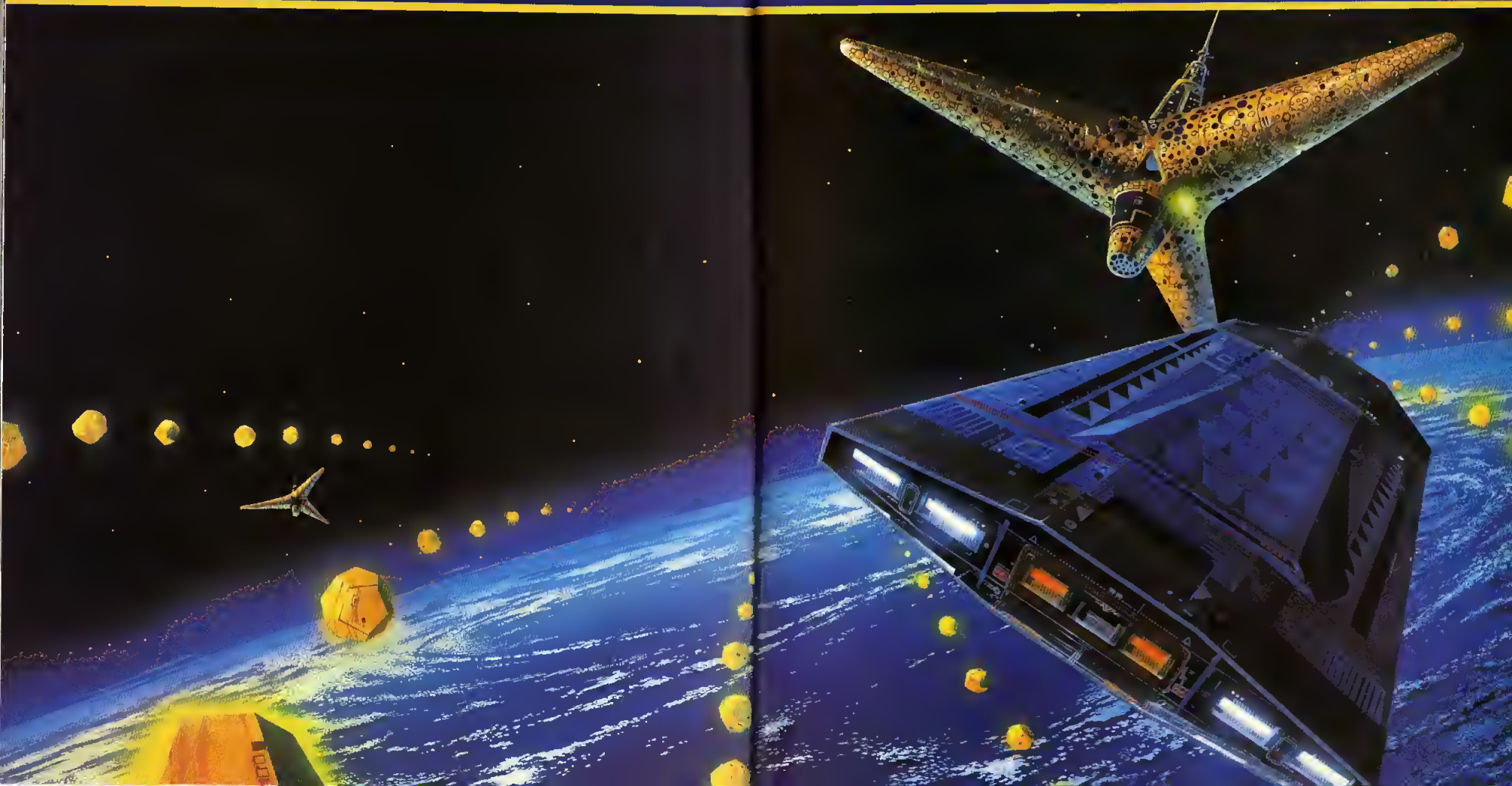
FICTION

ITSELF SURPRISED

BY ROGER ZELAZNY

It's only so much space junk, but its data might be deadly

PAINTING BY TIM WHITE



It was said that a berserker could, if necessity required, assume even a pleasing shape. But there was no such requirement here. Flashing through the billion-starred silence, the berserker was massive and dark and purely functional in design. It was a planet buster of a machine headed for the world called Corlano, where it would pound cities to rubble—eradicate an entire biosphere. It possessed the ability to do this without exceptional difficulty. No subtlety, no guile, no reliance on fallible goodlife were required. It had its directive, it had its weapons. It never wondered why this should be the way of its kind. It never questioned the directive. It never speculated whether it might be, in its own fashion, itself a life form, albeit artificial. It was a single-minded killing machine, and if purpose may be considered a virtue, it was to this extent virtuous.

Almost unnecessarily, its receptors scanned far ahead. It knew that Corlano did not possess extraordinary defenses. It anticipated no difficulties.

Who hath drawn the circuits for the lion?

There was something very distant and considerably off course. A world destroyer on a mission would not normally deviate for anything so tiny, however.

It rushed on toward Corlano, weapon systems ready.

Wade Kelman felt uneasy as soon as he laid eyes on the thing. He shifted his gaze to MacFarland and Dorphy.

"You let me sleep while you chased that junk down, matched orbits, grappled it? You realize how much time that wasted?"

"You needed the rest," the small, dark man named Dorphy replied, looking away.

"Bullshit! You know I'd have said no!"

"It might be worth something, Wade," MacFarland observed.

"This is a smuggling run, not a salvage operation. Time is important."

"Well, we've got the thing now," MacFarland replied. "No sense arguing over what's done."

Wade bit off a nasty rejoinder. He could push things only so far. He wasn't really captain, not in the usual sense. The three of them were in this together—equal investments, equal risk. But he knew how to pilot the small vessel better than either of them. That and their deference to him up to this point had revived command reflexes from both happier and sadder days. Had they awakened him and voted on this bit of salvage, he would obviously have lost. He knew, however, that they would still look to him in an emergency.

He nodded sharply.

"All right, we've got it," he said. "What the hell is it?"

"Damned if I know, Wade," replied MacFarland, a stocky, light-haired man with pale eyes and a crooked mouth. He looked out through the lock and into the innards of the thing, quick-sealed there beside them. "When we spotted it, I thought it was a lifeboat. It's about the right size—"

"And?"

"We signaled, and there was no reply."

"You mean you broke radio silence for that piece of junk?"

"If it was a lifeboat, there could be people aboard in trouble."

"Not too bloody likely, judging from its condition. Still," he sighed, "you're right. Go ahead."

"No signs of any electrical activity either."

"You chased it down just for the hell of it, then?"

Dorphy nodded.

"That's about right," he said.

"So, it's full of treasure?"

"I don't know what it's full of. It's not a lifeboat, though."

"Well, I can see that."

Wade peered through the opened lock into the interior of the thing. He took the flashlight from Dorphy, moved forward, and shone it about. There was no room for passengers amid the strange machinery.

"Let's ditch it," he said. "I don't know what all that crap in there is, and it's damaged anyway. I doubt it's worth its mass to haul anywhere."

"I'll bet the professor could figure it out," Dorphy said.

"Let the poor lady sleep. She's cargo, not crew, anyway. What's it to her what this thing is?"

"Suppose—just suppose—that's a valuable piece of equipment," Dorphy said. "Say, something experimental. Somebody might be willing to pay for it."

"And suppose it's a fancy bomb that never went off?"

Dorphy drew back from the hatch.

"I never thought of that."

"I say deep six it."

"Without even taking a better look?"

"Right. I don't even think you could squeeze very far in there."

"Me? You know a lot more about engineering than either of us."

"That's why you woke me up, huh?"

> *"He held the light before him, moved it from side to side. His uneasiness would not go away. There was something very foreign about all those cubes and knobs."*

"Well, now that you're here—"

Wade sighed. Then he nodded slowly.

"That would be crazy and risky and totally unproductive."

He stared through the lock at the exotic array of equipment inside. "Pass me that trouble light."

He accepted the light and extended it through the lock.

"It's been holding pressure okay?"

"Yeah. We slapped a patch on the hole in its hull."

"Well, what the hell."

He passed through the lock, dropped to his knees, leaned forward. He held the light before him, moved it from side to side. His uneasiness would not go away. There was something very foreign about all those cubes and knobs, their connections.... And that one large housing.... He reached out and tapped upon the hull. Foreign.

"I've got a feeling it's alien," he said.

He entered the small open area before him. Then he had to duck his head and proceed on his hands and knees. He began to touch things—fittings, switches, connectors, small units of unknown potential. Almost everything seemed designed to swivel, rotate, move along tracks. Finally, he lay flat and crawled forward.

"I believe that a number of these units are weapons," he called out, after studying them for some time.

He reached the big housing. A panel slid partway open as he passed his fingertips along its surface. He pressed harder, and it opened farther.

"Damn you!" he said then, as the unit began to tick softly.

"What's wrong?" Dorphy called to him.

"You!" he said, beginning to back away. "And your partner! You're wrong!"

He turned as soon as he could and made his way back through the lock.

"Ditch it!" he said. "Now!"

Then he saw that Juna, a tall study in gray and paleness, stood leaning against a bulkhead, holding a cup of tea.

"And if we've got a bomb, toss it in there before you kick it loose!" he added.

"What did you find?" she asked him in her surprisingly rich voice.

"That's some kind of fancy thinking device in there," he told her. "It tried to kick on when I touched it. And I'm sure a bunch of those gadgets are weapons. Do you know what that means?"

"Tell me," she said.

"Alien design, weapons brain. My partners just salvaged a damaged berserker, that's what. And it's trying to turn itself back on. It's got to go—fast."

"Are you absolutely certain that's what it is?" she asked him.

"Certain, no. Scared, yes."

She nodded and set her cup aside. She raised her hand to her mouth and coughed.

"I'd like to take a look at it myself before you get rid of it," she said softly.

Wade gnawed his lower lip.

"Juna," he said, "I can understand your professional interest in the computer, but

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"Itself Surprised" is an excerpt from a forthcoming novel entitled Berserker Base. *The book's coauthors, all noted science-fiction writers, include the berserkers' creator Fred Saberhagen.*

we're supposed to deliver you to Corlano intact remember?

She smiled for the first time since he'd met her some weeks before

"I really want to see it."

Her smile hardened. He nodded.

"Make it a quick look."

"I'll need my tools. And I want to change into some working clothes."

She turned and passed through the hatch to her right. He glared at his partners, shrugged, and turned away.

Seated on the edge of his bunk and eating breakfast from a small tray while Dvořák's *Slavonic Dances* swirled about him, Wade reflected on berserkers, Dr. Juna Bayel, computers in general, and how they all figured together in the reason for this trip. Berserker scouts had been spotted periodically in this sector during the past few years. By this time the berserkers must be aware that Corlano was not well defended. This made for some nervousness within the segment of Corlano's population made up of refugees from a berserker attack upon distant Djelbar almost a generation before. A great number had chosen Corlano as a world far removed from earlier patterns of berserker activity. Wade snorted at a certain irony this had engendered. It was those same people who had lobbied so long and so successfully for the highly restrictive legislation Corlano now possessed regarding the manufacture and importation of knowledge-processing machines, a species of group paranoia going back to their berserker trauma.

There was a black market, of course. Machines more complicated than those allowed by law were needed by businesses, some individuals, and even the government itself. People like himself and his partners regularly brought in such machines and components. Officials usually looked the other way. He'd seen this same schizophrenia in a number of places.

He sipped his coffee.

And Juna Bayel... knowledge-systems specialists of her caliber were generally *non grata* there, too. She might have gone in as a tourist, but then she would have been subjected to scrutiny, making it more difficult to teach the classes she had been hired to set up.

He sighed. He was used to governmental double-thinking. He had been in the service. In fact... no. Not worth thinking about, all that again. Things had actually been looking up lately. A few more runs like this one and he could make the final payments on his divorce settlement and go into legitimate shipping, get respectable, perhaps even prosper—

The intercom buzzed. "Yes?"

"Dr. Bayel wants permission to do some tests on that brain in the derelict," MacFarland said. "She wants to run some leads and hook it up to the ship's computer. What do you think?"

"Sounds dangerous," Wade replied. "Suppose she activates it? Berserkers

CONTINUED ON PAGE 100

High in the Andes
he slept, a scientific mystery
500 years old

INCA CHILD

BY PATRICK TIERNEY

Two miners, searching for a legendary treasure of the ancient Incas, scrambled up a glacier slope to the 17,700-foot peak of Cerro Plomo, in the Chilean Andes. They headed straight for a rectangular stone wall, with a heap of rocks at its center. Digging three feet into the heap and finally prying up a stone slab, they discovered a genuine archaeological treasure—the body of a young boy dressed in Inca ceremonial regalia.

Curled up on his side, the child wore a

PHOTOGRAPHS BY
TIM McINTYRE

"His face looked peaceful, as if he'd slept through the centuries. Nothing suggested he had been killed."

tunic of bleck llama wool trimmed with red. On his feet were embroidered moccasins. His plaited, shoulder-length hair wes held by a headband. His woolen crown was topped with condor feethers. He wore a heavy silver brecelet end a silver pendant, signaling his high caste. The boy's feet were tucked close to his tunic, scant protection against the eternal cold ebove the permafrost line. But the expression on his fece looked peeceful, as if he'd slept quietly through the centuries. Nothing suggested, at first, that this young child had been killed.

Inadvertently, the two Chilean treasure hunters had stumbled across a 500-year-old pre-Columbian time capsule, providing a starting face-to-fece encounter with e fully clothed inhabitant of the Inca empire. So perfectly preserved was the child's body that he seemed to be merely napping.

The gold seekers found this mountaintop grave in 1954. Chile's National Museum of Netural History in Santiago, immediately bought the body end the tomb's contents: five animal-intestine pouches containing locks of hair, teeth and nail clippings, a purse—richly covered with red and white flamingo feathers—holding still-aromatic coca leaves; two llama stetuettes—one of gold, one of conch; and a silver idol dressed as an Inca princess. Archaeologists examined the treasures with care. But limited by their era's technology they could extract only so much information. Finally, stymied, they put the mummy in a freezer where it rested for nearly three decades, leaving many questions still unanswered. What was the child doing on that hostile peak above the clouds? And why did the Incas make the extraordinary effort of building an open-air temple at nearly 18,000 feet?

Answers are only now coming to light, courtesy of two new disciplines. One is paleopathology, the scientific study of disease in ancient man. Paleopathologists now use CAT scanners, X rays, electron microscopes, and biopsies to study mummified remains. The other is high-altitude archaeology, conducted by edventurer-scientists whose work takes them ebove the timberline of the Andes. Spurred on by the discovery of the Inca boy, archaelogists and anthropologists turned to the skills of the mountain climber to find some more of his pre-Columbian contemporaries.

Archaeologists now report Cerro Plomo is only one of 100 peaks with ceremonial remains some as high es 22,000 feet (7,000 feet shy of Mount Everest). These sites are sprinkled elong a 1,240-mile-long spine of mountains that run through whet was once the Inca empire. The Spaniards, who destroyed the rest of the old Inca civilization in their *conquista* of the 1530s, never knew about these sites. "No other culture in history built at these eltitudes," says Johen Reinhard, en anthropologist who hes climbed most of the major peaks of the Alps, Himalayas, and Andes. "This echievement is one of the greetest we know of in the human past."

In 1982 Canedien anthropologist Patrick Horne reopened the study of the Inca boy, thanks to a UNESCO grant. Horne, a renowned expert who helped found the International Paleopathology Associetion in 1973, has studied hundreds of mummies from several continents. But he has never seen anything like the boy from Cerro Plomo.

"I was awed at its preservation," Horne said during a return visit to Chile mede to complete his examination of the boy. "When I took a tissue sample it was unlike anything I'd seen in mummies from Egypt or the Atacama Desert [in Peru and Chile]. It was still very soft, and the cellular preservation was exquisite. Under the electron microscope, it looked like a biopsy of skin you'd see today at any dermatology clinic. There's no doubt this is the best-preserved natural mummy we have."

Short, bearded, and cherubic, Horne is e cheerful exponent of necroscience. He uses words like *beautiful*, *incredible*, and *spectacular* to describe warts, tumors, and other melignancies. Paleopathologists justify their fescinetion because pathology patterns can indicate what makes e society tick — or stop ticking. For instance, although it is mystifying to the uninitiated, Horne wes delighted to discover lice ova in the Inca

X rays (above) showed a remarkably well-preserved body (overleaf). Artifacts like the doll (above, at right) suggested noble birth.

child's hair. Intraspecies differences between American and Asian Ice. Horne explains, could conceivably confirm man's migration across the Bering Land Bridge, which once linked North America to what is now the Soviet Union.

Horne's main job is to keep the Cerro Plomo mummy from deteriorating, but he and other researchers also want to know how the child died. X rays and dental calcification studies show the boy was eight to nine years old. No disease or injury explains his death. Most revealing are the child's hands, clasped together around his knees, with the unprotected left hand blue and swollen from frostbite. His right hand, protected by the left, is not frostbitten, meaning that the boy was still alive when he assumed his huddled position at Cerro Plomo's snowy apex, Horne's conclusion: The Inca boy froze to death after being buried alive.

His deduction coincides with sixteenth-century Spanish accounts. On special occasions, ten-year-old children, selected for their beauty and nobility, were sacrificed to *huacas*, or sacred places of which majestic, snow-capped peaks like Cerro Plomo were the most powerful. The boy from Cerro Plomo was the right age, and photographs taken just after his exhumation reveal he had lovely, delicate features. He was decorated with silver jewelry, indicating high social status. To the Incas, the boy was a perfect sacrifice, and Cerro Plomo was a perfect place to sacrifice him.

"He was probably sacrificed to the sun god," Horne says, while sipping a glass of Pisco sour during the pre-Christmas rush of Santiago. "In fact, he was probably sacrificed today, December twenty-third, about five hundred years ago, on the great feast of Capac Raemi. So there's something auspicious about this interview."

Whether it was an auspicious day for the victims is another question. "Parents were proud to have their children chosen for sacrifice," claims Silvia Quevedo, an anthropologist at the National Museum of Natural History. A recently discovered document, dated about 1622, gives the best recorded description of the Inca ritual of human sacrifice and hints why parents might have been proud to participate. A leader in the town of Ocros, Peru, was rewarded with the local chieftainship after offering his ten-year-old daughter for sacrifice. The girl, "beautiful beyond exaggeration," went to Cuzco to be royally feted before returning home to Ocros to be buried alive on a high mountain. "You can finish with me now," she told her townspeople at a final celebration. "I could not be more honored than by the feasts that they celebrated for me in Cuzco."

No one knows whether the boy of Cerro Plomo shared her enthusiasm. The Incas had four methods of sacrifice: garroting, breaking the cervical vertebrae with a stone, tearing out the heart, and burying alive. The mountain people from the Incas' southern kingdom, the Collasuyo, preferred live burial. And the boy's dress and hairstyle—woven into hundreds of tiny braids—identify him as a member of this tribe. He was probably given a strong dose of *chicha*, an alcoholic drink, before burial.

"It's a very pleasant way to die—to be intoxicated where it's cold. You simply fall into a coma and don't wake up," Horne says. "The expression on his face, which is very important, is one of great peace. His eyes are closed, very relaxed, and there's no sign of trauma. That's very different from the bodies we've seen that were buried alive in the bogs of Denmark, whose faces are set in grimaces."

A vomit stain on the boy's clothes seems to confirm that he'd been given an unaccustomed drink. But a liver biopsy, helped by a CAT (computerized axial tomography) scanner, failed to produce a good sample of undigested food to test this theory. (CAT, unlike standard X rays, reveals tissues and organs as well as bones.) This CAT study, performed by Dr. Mario Corrales at the Monseigneur Casaneuva Medical Center, in Santiago, indicated that the mummy's internal organs, though contracted considerably, were well preserved. Because of this, the Inca child has proved a storehouse of information for paleopathologists. For example, Horne and Juan Honeyman, of the University of Chile, studied lesions on the child's left leg. They discovered that the boy had a rare, tumorlike pediatric disease never before discovered in antiquity. And while using an electron microscope to examine warts on the child's hand (magnifying them 180,000 times), Horne detected a virus, the first one ever found on a mummy. Since the Inca child was probably sacrificed prior to the arrival of the Spaniards in Chile, in 1540, this discovery helps to explode the myth that the Spaniards brought all viruses with them to the New World from the Old.

"Now at least we know that viruses are preserved in tissues five hundred years old," Horne notes. "One of the Egyptian mummies is thought to have had smallpox. Well, now we can start looking for it and probably find it. It's one of the most exciting things I've ever seen."

The Andes have yielded other equally striking finds. "The boy from Cerro Plomo is nothing compared with our mummy," says Francisco Montes, director of the largest newspaper in the Argentine city of San Juan. In 1964 Montes financed an expedition that brought back the body of a human sacrifice from Inca times, this one of an adolescent boy who had been found buried on the 21,000-foot peak of Cerro Toro, in northwest Argentina. But the expedition had a few problems getting the mummy down the mountain.

"The government opposed our getting the boy," Montes recalls indignantly. "So they sent the police, armed with guns, to take the mummy from us. Well, our reporters and mountaineers had guns, too, and

"Stop blaming your parents. Blame the press."

we were ready to kill for that mummy."

Fortunately, no further human sacrifices occurred on Cerro Toro. The police backed down. Lafer Monfes donated his mummy to the government. Today the boy's fine feafures stare out from a glass refrigerator at a museum built in his honor near San Juan. He looks amazingly lifelike, locked in the fetal position, with his head resfing peacefully on one shoulder. His guanaco-wool cap is typical of the Andean altiplano. But this wasn't a typical *capacocha* or royal sacrifice.

The Cerro Toro corpse is a mystery of another kind. The boy from Cerro Toro sfands out because he's not really a boy; he's an adulf," says Juan Schobinger, a Swiss-born Argentine archaeologist who accompanied the expedition to Cerro Toro and later edited a book on the mummy. Forensic experfs aren't sure whether the victim—a young man of about eighteen, with the muscle tone of a warrior—died of freezing or a neck wound. The circle of stones around him point to a ritual death, though he wasn't buried as carefully as the boy from Cerro Plomo. And no ornaments hint of noble rank. He may have been an enemy warrior, since Spanish chroniclers tell of the Incas sacrificing enemies after making them sing, dance, and repeat a standard speech.

"People from all over fhe world want to examine this mummy," says Mariano Gambier, curator of the Museum of Laja where the mummy is kept. Some think the Cerro Toro boy is in better shape than the Inca child of Cerro Plomo. It's an ongoing competition to determine who is the world's best-preserved natural mummy—an award for which neither candidate has declared himself a nominee.

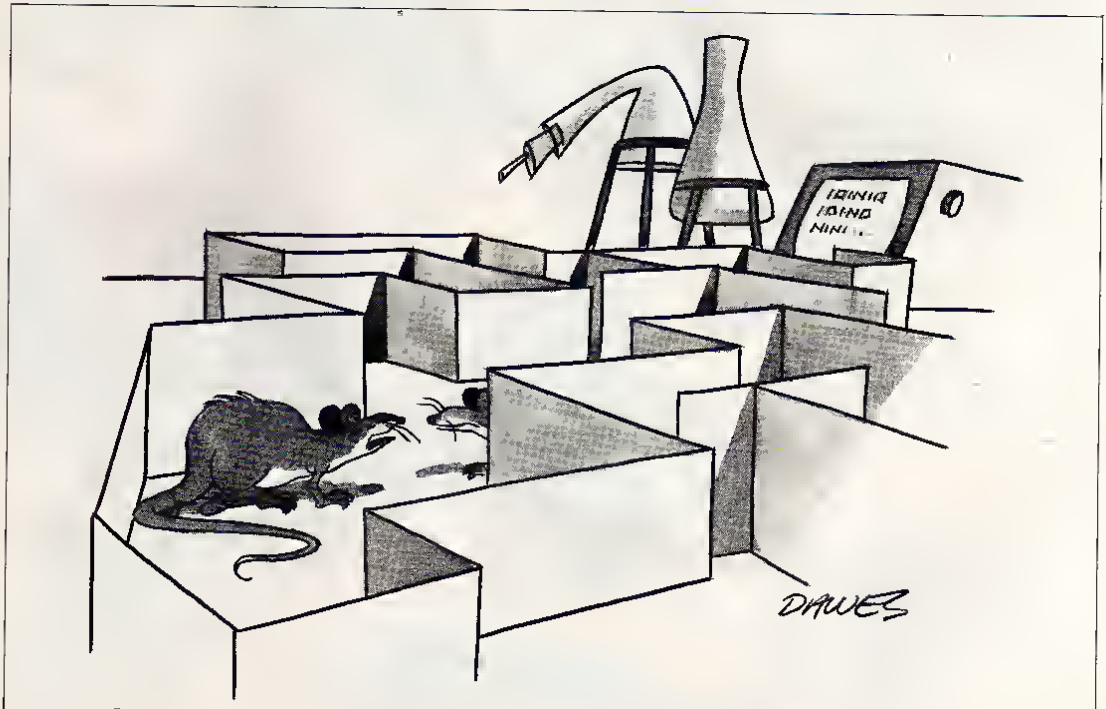
Horne, who hasn't seen the Cerro Toro mummy, would love to resolve the dispute. So would plenty of others. "We've received a lot of crazy ideas," says Gambier, with an air of resignafion. "A great number, the majority, want to prove a relafion existed between the boy and extraterrestrials."

The extraterrestrial connecfion, notwifh-standing, Cerro Toro alerted scienfists that the sacrifice on Cerro Plomo was more than just a local idiosyncrasy. And the almost simultaneous discovery of another mummy at a 20,000-foot peak near Arequipa, Peru, confirmed it. With these discoveries, Schobinger started using the term *high-altitude archaeology*, buf it took Antonio Beorchia, one of the two mountain climb-ers who originally found the boy of Cerro Toro, to get the discipline on its feet.

"The discovery of the boys from Cerro Plomo and Cerro Toro didn't go any further because archaeologists weren't moun-taineers and couldn't reach the sites," Beorchia says. His combined use of sport and science has led to the discovery of new sanctuaries. In 1972 he unearthed two female statues, a llama figure, and a bag of coca leaves at fhe 20,660-foot level of Cerro Mercedario, not far from Cerro Plomo. "I was so excited when I went back to my tent that night. I couldn't sleep," he remem-bers. "That's when it occurred to me to as-semble a team of climbers dedicafed to archaeological work."

Beorchia is an amateur in the literal sense of the word—he loves everything he does, from raising bees as a profession to climb-ing mountains and exploring ruins as an avocation. His silver-gray hair indicates that he is pushing fifty. Still, he remains an in-curable romantic.

High-altitude archaeology boomed after Beorchia founded CIADAM (fhe Center for Archaeological Investigations of High Mountains). Beorchia has written a book that summarizes CIADAM's adventure and describes 100 ruins above 15,000 feef. He found that many peaks near an ancienf road, the Royal Highway of fhe Incas, have circular and rectangular structures—called *tambos*—with dry-stone walls several feet high. There are 150 well-built *tambos* af the base of a volcano, Lincancabur, in north-ern Chile. Another ruin, at 21,075 feet, had walls made with gravel fill hauled up the mountain from 300 feet below. Archaeol-ogists estimate thaf disciplined work teams would have had to make 4,000 trips to move all that gravel to that sife. But Beor-chia's most spectacular find by far was on



"I know how to get out, but I wouldn't give them the satisfaction."

the summit of Volcan Quehuar

We'd heard local people talk about a blond boy, surrounded by a treasure of gold and silver and frozen in ice on the peak of Quehuar," Beorchia says. So in 1974 we mounted an expedition to investigate this legend. We knew the Royal Highway of the Incas ran nearby, and we had a theory that most high-altitude sanctuaries were near this Inca road. Also, Quehuar dominates all the mountains of the salt flats [in northwest Argentina]."

Since the Incas revered peaks like Quehuar, Beorchia had expected to find ruins at the 20,430-foot summit. But even he was amazed at what he found: a staircase leading to an elevated platform and a small "tower." Inside the tower, a child was frozen in ice, just as the legend said. The child's head had already been torn off. Beorchia recalls disappointedly. He was wrapped in a familiar Inca shawl but was frozen so solid that we couldn't move the rest of the body."

In 1981 Beorchia and anthropologist Johan Reinhard struggled through four feet of snow and returned to Quehuar. By then the child was gone—all that remained were some vertebrae, an ear, and pieces of cranium embedded in a wall. Beorchia and Reinhard noticed signs of a nearby explosion, so they think treasure hunters blasted the body with dynamite. The remains belong to a fourteen- or fifteen-year-old, though medical analysis couldn't determine the youth's sex.

It's not surprising that people have assaulted these high-altitude sanctuaries. More than 100 statues, half a dozen mummies, and a treasure trove of Inca garments have been rummaged from Andean ruins, mostly by amateur climbers. Archaeologists are horrified at the way excavations are being done, perhaps some of these scientists are jealous that they're not in good enough shape to do the digging themselves. Climbers at CIADAM also complain that museums present outstretched hands for finds but closed purses for expenses. So lucrative offers from international collectors are all the more tempting. As a result, curators fear this cultural patrimony will wind up in chic living rooms around the world.

They have reason to worry. Half a dozen statues were ransacked from Cerro Plomo before Angel Cabezas, an anthropology student doing a thesis on high-mountain ruins, became the first academic to reach the peak in 1982. A man in the south of Chile boasts of owning a Cerro Plomo statue—a silver idol of an Inca princess. The rest have vanished.

Surprising things also happen to mummies. An American circus acquired a mummy of an Inca miner and took it on tour. After the Inca child was found in 1954, collectors offered sums well into six figures for the boy.

Given the continuing threat of poachers, high-altitude archaeologists and mountain climbers are understandably secretive

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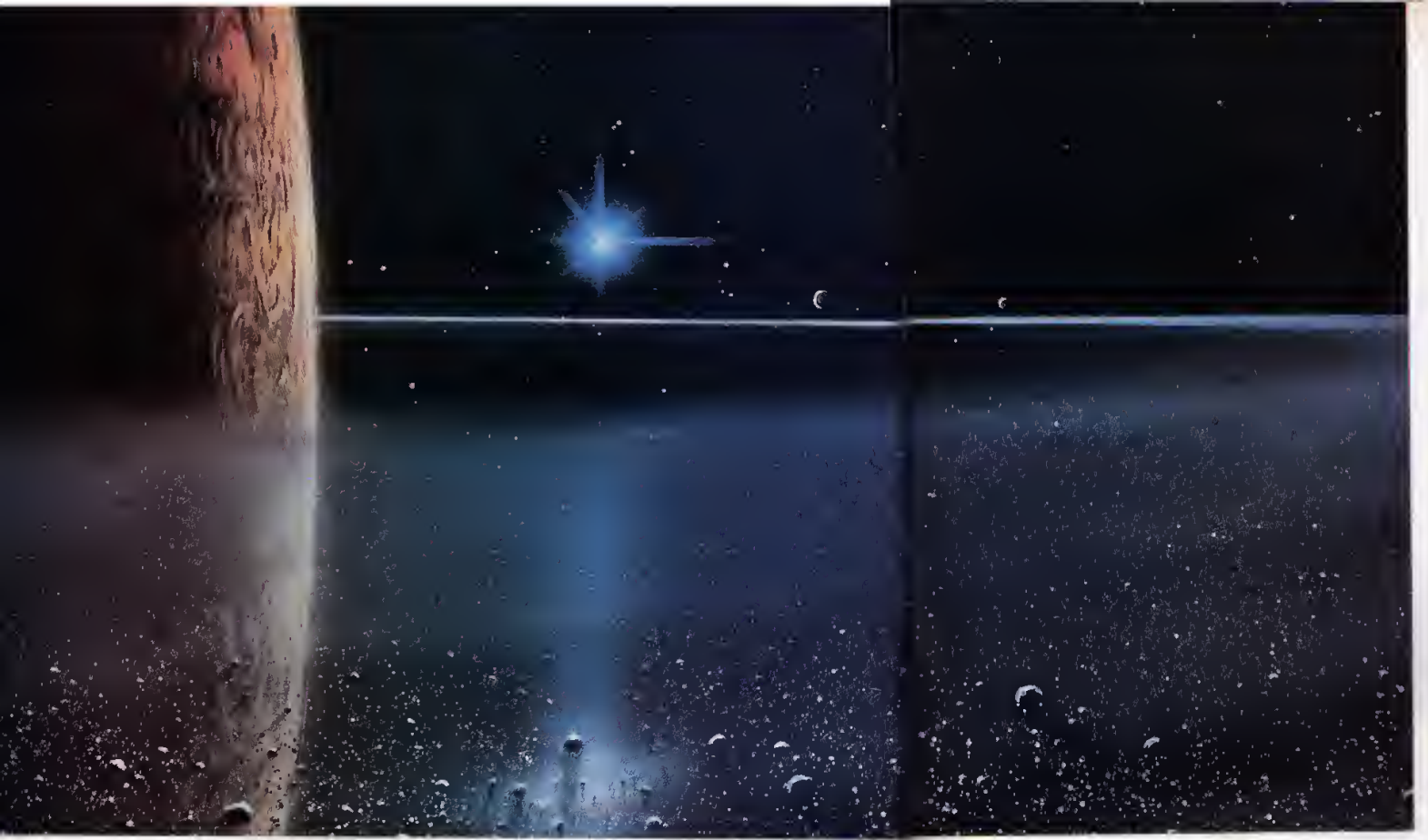
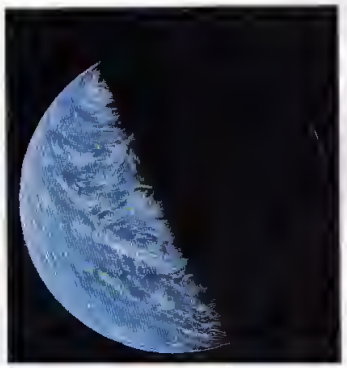




FAR VISIONS

BY OWEN DAVIES

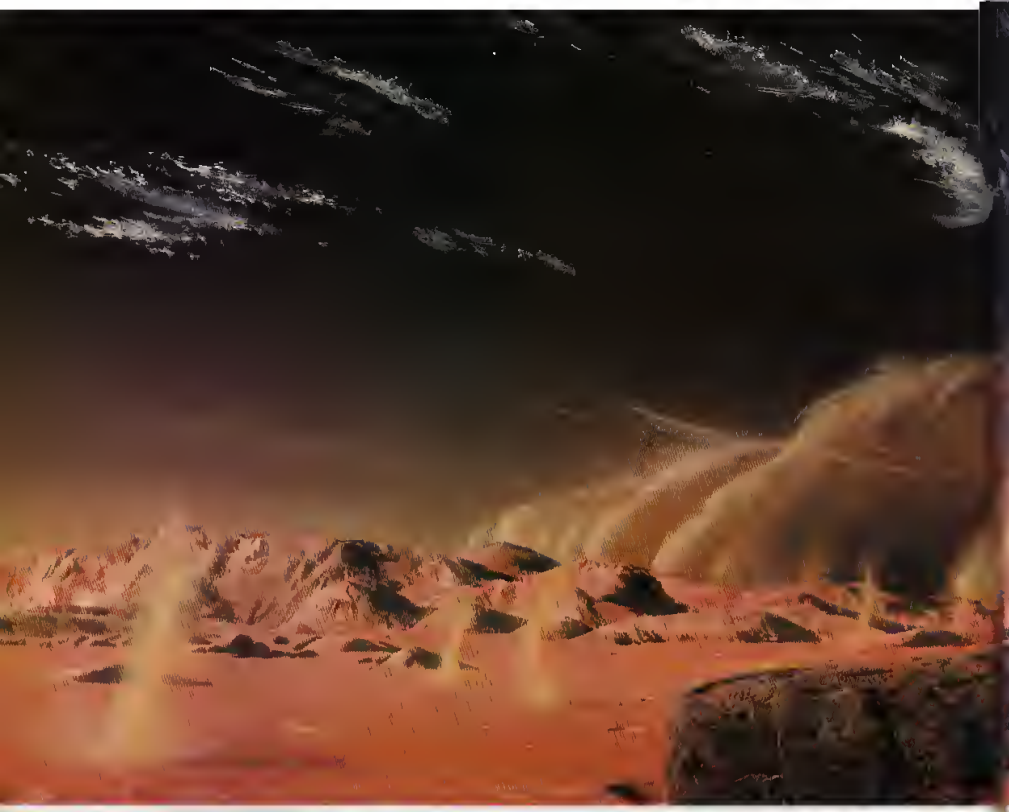
Add science to the artist's imagination, and watch the universe reveal itself

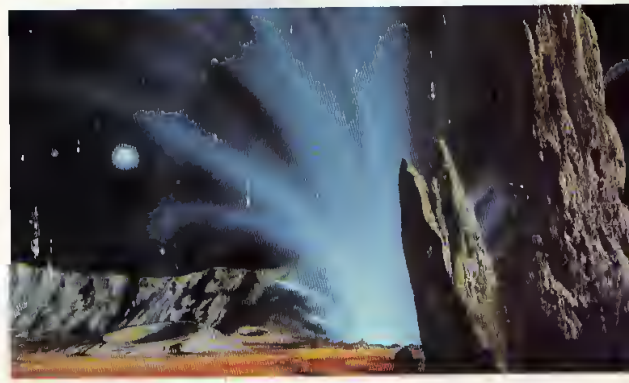
PAINTINGS BY RON MILLER

True frontiers march with those in the mind's eye,' wrote Robert Conquest, in a poem titled *For the 1956 Opposition of Mars* The year wes 1961, the Space Age had barely begun

For e certein breed of artist, this insight has more then poetical significence It is an understanding to which such artists heve dedicated their professionel lives Their concern is for the frontier And their mind's eye—their art—is filled with images sent by the mechanisms of science, from the newest frontier

Ron Miller whose work is seen here, is one such artist To the left e view of Jupiter's rings Below a portrait of Earth These images could not heve been recorded by the space artists of an earlier day Such greets es Chesley Bonestell broadened the horizons of all who sew their work But they painted from imagination their ideas leev-ened by the speculetion of scientists whose telescopes reveeled precious little They could hope only that ert and





intuition had caught the reality of a universe they could never see.

Today's space artists have more than speculation to guide them. NASA's planetary-science program sent orbiters to the moon in the late Sixties, and the Mariner and Pioneer flights to Mars and Venus in the Seventies. And the Voyagers have yet to complete their grand tour of the planets. These two decades of planetary exploration have yielded a wealth of images still being translated to canvas. More photographs will arrive in 1986, when *Voyager 2* passes Uranus.

The results are incomparably more realistic, and therefore more breathtaking, than the technological imaginings of the Forties and Fifties. Informed art reveals more than mere fantasy can.

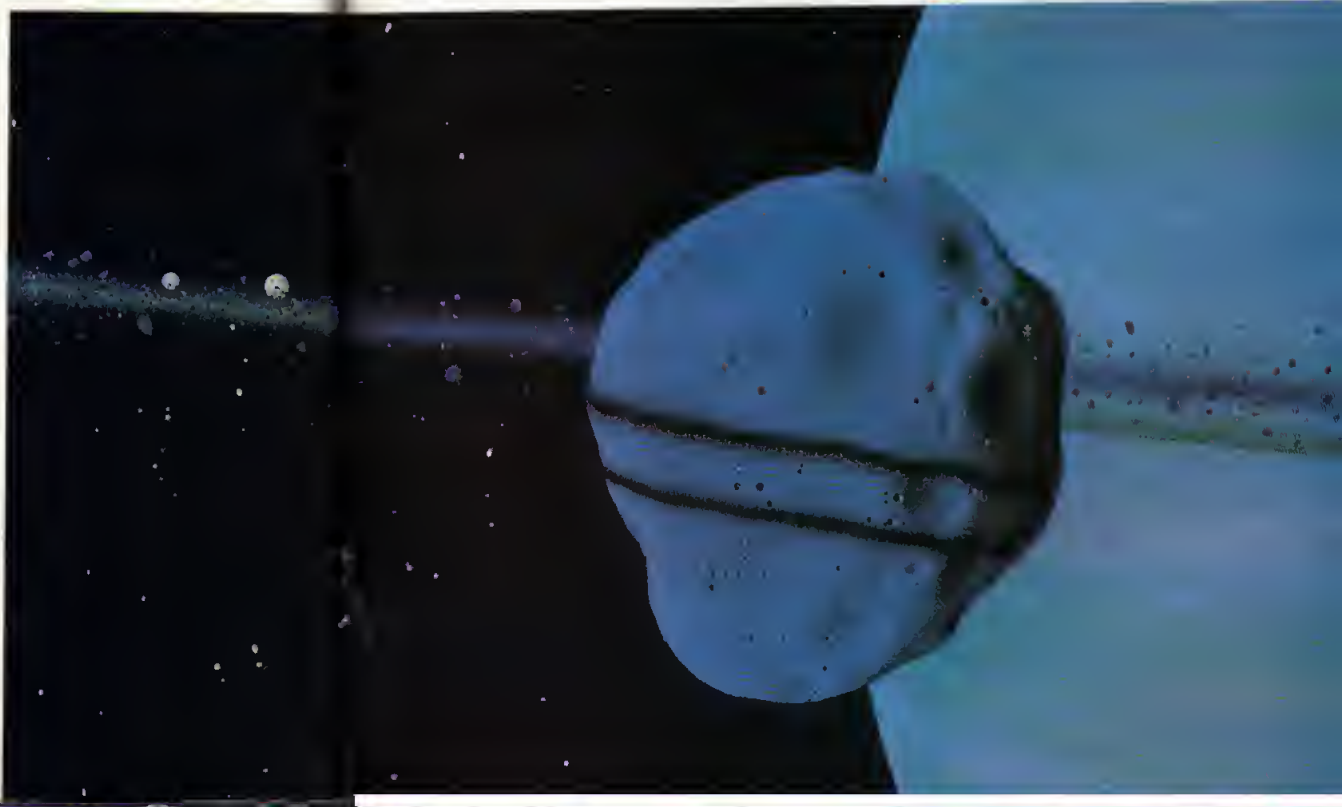
Scenes of a dust storm on Mars (above, left), of Mars from its tiny moon Phobos (above, right), of an aurora on Jupiter (right), and a volcano on Io (far right), are works of knowledge, not speculation. The

"Unlike pioneer artists of the past, today's space artists have more than speculation to guide them."

"The last two decades of planetary exploration have yielded images still being translated to canvas."

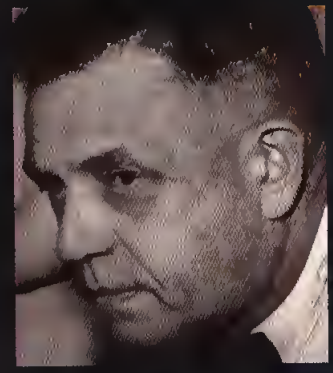
effect of these discoveries is profound. The shadows of dark rings on a Uranian moon (below) were never imagined until *Voyager 1* photographed such a band on S11, a tiny moon of Saturn (below left). Even the familiar aurora of Earth (left) becomes oddly alien when seen with eyes that have gazed on the sterile emptiness of Saturn's moon Rhea (far left). With knowledge gleaned from close contact we are discovering a universe far stranger than our wildest imaginings.

The flow of inspiration has been stemmed now by NASA's small budgets and by the smaller vision of those who vote on them. Sadly, the number of future deep-space probes has been reduced. The grand tour may well be the last of its kind. But such a potential tragedy is tempered by what we have discovered. We have seen the planets, and they have changed us. Our sight no longer fails a few feet over our heads. And artists like Ron Miller are keeping the vision alive. DC



KINSEY '84: THE SCIENCE OF SEX IDENTITY

BY JO DURDEN-SMITH AND DIANE DESIMONE



The Indiana University campus at Bloomington has the fifth largest carillon in the United States. It also has the largest yearly sorority rush and the world's largest collection of books, films, photographs, and other paraphernalia devoted to sex.

The collection, which includes a large number of fancifully decorated condoms—each hermetically sealed with the help of the chemistry department—was founded by one of the United States' first Eagle Scouts, a man who started his scientific career with a paper called "What Do Birds Do When It Rains?" and who spent most of his scientific life passionately accumulating a collection of gall wasps. His collection, nearly 4 million strong, now resides in the Smithsonian Institution, in Washington, DC.

But gall-wasp collecting was just one of this man's scientific passions. Another, perhaps more important, legacy remains among the beeches, maples, and dogwoods of Bloomington, on the top two floors of the campus's biology building. Once in a while a giggling group of

PHOTOGRAPH BY DOUGLAS KIRKLAND

students having had a few rounds at Nick's English Hut down the road will attempt to penetrate its mysteries by taking the elevator to the fourth floor. But sadly for them, there is nothing much to be seen: just a white reception room, a secretary with a steady gaze and a brisk "Can I help you?" and, against the far wall, a four-foot-tall Yoruba ritual figure with a friendly face and a rampant and detachable phallus.

The students take the elevator because the institute that houses the collection of sexual material carries one of the most famous names in post-World War II scientific history: Alfred C. Kinsey, for whom the Kinsey Institute is named, was a professor at Indiana University who, in middle age, suddenly transferred to the taxonomy of human sexuality all the determination he had once reserved for the dogged classification of asexual wasps. In the repressed, Peyton Place environment of the Forties and Fifties, Kinsey was bold enough to ask questions about how, when, and with whom Americans went about it.

With the answers that Kinsey was given he did much to rock, even capsize, the boat of America's sexual innocence and ignorance.

Kinsey was an unlikely revolutionary. He had the brush-cut and bow-tied blandness of a Babbitt-like small-town bank vice president. But after his work was published, sex and sex research were revolutionized. Masters and Johnson later followed in his footsteps. Adultery, homosexuality, and the comparative sexual drives of men and women—topics that had long been considered taboo in American society—were opened up for study.

Kinsey died 28 years ago. And for almost all of those succeeding years, the institute named for him has remained quiet and private, adding to the body of research he initiated and slowly filling out the collection of books and pictures he started. Two years ago, though, the university and the institute's trustees decided to review the status of the institute. The science of sex and gender had undergone a radical transformation since Kinsey's passing, and the priorities of the bodies funding it had also changed profoundly. In studying sexual behavior, scientists were no longer confined only to observation and questionnaires, as Kinsey had been. They were able to go further—past the contributions of environment, learning, and experience—to the biological core of who we are as men and women. A new science, full of ferment, was working on the ways in which the human brain is sexed before birth. And if the institute was to be brought up to date, the trustees decided, it would have to acknowledge the importance of biology and genetics in determining sexual behavior. A new direction and a new director would, as a result, have to be found.

The new director the trustees finally appointed was a controversial choice. She is a woman. She has an instinctive flair for publicity. And since her appointment just two years ago, June Machover Reinisch has indeed revolutionized America's most august sexual-research center with her dramatic ideas, indefatigable energy, and her determination to emphasize the biological nature of human sexuality. The frenetic output that has recently characterized the institute suggests that the future of human-sexuality research is being shaped with a dynamic fervor that reminds old-timers of the bygone era of Kinsey. These are among the most impressive recent findings:

• Reinisch's personal research, begun many years before her appointment to the institute, holds important implications for our understanding of gender behavior. Her early work focused on how hormones like estrogen and progestin, often given to women to help them sustain difficult pregnancies, affect prenatal development. Reinisch has concluded that such personality characteristics as leadership traits and sexual predisposition to homosexuality may in many cases be shaped by hormones to which the unborn child was unwittingly exposed.

"She was fascinated by the idea that sex hormones affected not only sexual characteristics but the brain and body. While others studied the environment, she became interested in nature."

• Along the same lines, Reinisch conducted a pilot study in Scandinavia that examined the effects of barbiturates on unborn children. The results of the study have not yet been released to the press or the public, but the effects of drugs, says Reinisch, are large and far-reaching both on males and on females.

• Dozens of new studies, many exploring the biological foundation of human sexuality, are being developed at the Kinsey Institute today. Other research is still behavioral or statistical in methodology, following the pattern of the landmark sexuality studies pursued by Kinsey and his associates some 40 years ago.

One of the most influential of these new behavioral reports, Reinisch believes, is a teenage-sexuality study that the institute sponsored in 1983. The report, to be released to the public as a book, probes an explosive area of human sexuality that has been virtually ignored in America in the past. Teenage sexual mores, as articulated by a group of teenagers who gathered in Bloomington from all over the country, have undergone an evolution of sorts. Both parents and teenagers have come to accept the inevitability of sexual activity in the adolescent years. But the hot-and-heavy sexual revolution that has been promulgated since the end of the Sixties seems largely passe to today's generation of high-school seniors. Sex for sex's sake is for *junior*-high-school kids. In high school, the emphasis is more on relationships, the teenage participants in last year's study concluded.

The driving force behind these research projects is every bit as unlikely an expert on sex and gender as was Alfred Kinsey himself. Listen:

"When I was booking the acts for the Cafe au Go-Go in New York," Reinisch says, "there was this young guy who'd just recorded his first album on Epic Records/CBS. His name was Van Morrison." Her voice has precisely the same tone and inflections, the same *echt* New York attack, as Joan Rivers's.

Anyway, it was because of him that I ended up getting money for a poster from [CBS president] Clive Davis. It was because of *that* that I went on to manage Peaches and Herb and Sly and the Family Stone. And it was because of *both* of those things that I finally went back to the university to get an M.A. I wanted to be the first and best A&R [artist and repertoire] woman in the United States." She throws up her hands. "And I ended up a scientist."

Sitting in a corner room overlooking the campus, the scientist is surrounded by books on neuropsychology and human sexuality, prints by Matisse and Chagall, photographs, champagne corks, and a collection not of gall wasps but of china pigs. Reinisch's presence in Bloomington, apart from representing a considerable victory for women and the popularizing spirit in science, publicly underscores the dramatic changes that research into human sexuality has seen over the past five years. Reinisch is not a sociologist or psychologist of sex interested, as Kinsey was, only in the acquired behaviors of males and females. She is a psychobiologist fascinated—like an ever-increasing number of scientists, many of them women—in the biological differences between the sexes. Through her own research into hormonal influences on the unborn and through the dozens of studies that she is energetically launching at the Kinsey Institute, Reinisch is taking on a seminal role in a new science that is likely to affect the way we view ourselves as men and women. The story of how she came to the institute then is the story not only of an individual odyssey but of the changing face of sex, sexism, and the study of sexuality in twentieth-century America.

In 1938, five years before Reinisch was born, a respectable professor of biology with four children was asked by the Association of Women Students in Bloomington to give a course on love and marriage.

Photograph of Alfred Kinsey by Dellenback

Being a conscientious man he went to the science library on the Bloomington campus But the professor could find nothing on his prescribed subject that didn't seem inadequate, unreliable, prescientific, and prestatistical

He decided to find out for himself what sex and marriage were all about He began to gather the sexual histories of his colleagues their wives their students, and the campus policemen And he discovered in the process more variation in American sexual attitudes and behaviors than he had imagined possible

By the early Forties, Kinsey's interviews provided research material in 521 separate headings from bestiality to infidelity Soon he and his students were administering sexual questionnaires to individuals all over the country

The results of these 18,000 interviews formed a comprehensive profile of the sexual lives of the American male and the American female and were published in 1948 and 1953, respectively The books immediately became best sellers And Alfred Kinsey became a household name an international and controversial figure Politicians and even scientists attacked him as a communist an underminer of morality and a corrupter of children The Rockefeller Foundation canceled Kinsey's grants U S Customs confiscated materials sent to him from abroad women with placards marched around Indiana University's Wylie Hall In the prurient atmosphere of the postwar era, Kinsey became a favorite bogeyman—the figure who paved the way for the death of the family the growth of the Sexual Freedom League and finally, the difficulties of the Sixties He had let it be known that more than one third of all men had homosexual experiences, that women masturbated and had extramarital affairs and that even children were capable of multiple orgasms In America this was unforgivable

Reinisch was four years old when the Kinsey Institute was founded She was ten when Kinsey's second volume *Sexual Behavior in the Human Female* was published She lived in Manhattan She went to a progressive school on the West Side where she'd been studying algebra since the second grade And she spent the summers in camp, each year obsessively learning a new skill—how to canoe how to survive in the woods

"By rights, I guess I should have grown into a child of that time You know a real *girl*, with a ponytail a hooped skirt with poodles on it and a one-way ticket to marriage and the suburbs But my parents were unusual My mother worked full time She was a librarian and had an M A in library science And my father who was a Jewish lieutenant in the mainly Irish New York City Fire Department had a real respect for women He liked women When I was a child he used to introduce me as the future Supreme Court justice By the time I was eight he let me drive his car Reinisch had one other role model—Pippi Longstocking "Perhaps this sounds foolish today There were very few good role models for girls then But Pippi was perfect for me She was a tomboy a risk taker She lived alone And she could and would do anything"

In 1956 Kinsey died Without his international reputation the institute continued to attract funds, but began a long diminuendo into the present—avoiding controversy keeping a low profile

At about the same time Reinisch's parents moved from the city to the suburbs following a path typical of their generation In the world of suburbia Reinisch began a schizophrenic life

"I was lost somewhere between the Fifties and the Sixties I was a cheerleader I would *die* if I didn't make the cheerleader trials And at the same time I was a beatnik I spent all the time I could in the Village hanging out at the Bitter End seeing Lenny Bruce at the Vanguard And I was also taking dance lessons at Carnegie Hall because I knew *exactly* what I wanted to be the Gwen Verdon of my generation I was going to be a star"

> *"Homosexuality may arise from a biological precursor that parents cannot control, something that alters the hormonal environment of the womb before birth."*

The "schizophrenia" of Reinisch's life—the battle between the expected and the unexpected—continued after high-school graduation She started off in nursing school in Boston, where she performed on the side in some of the same clubs as a young singer named Joan Baez Nursing however, soon lost its attraction "I was no good at being an Indian," Reinisch says And after a year, she was back in New York studying anthropology and biology at New York University, singing and recording with a group called The Seagulls auditioning for Broadway and summer stock and preparing for the year and a half she would eventually spend getting an elementary-school teacher's certificate at the School of Education

One semester Reinisch took off to Florida training dolphins for the movie *Flipper* and for private owners Another semester she spent at UCLA living in a commune in Hollywood

"The best thing about that time was that through a series of amazing accidents, I met Jimmy Cagney He gave me the best piece of advice I ever had He told me a story about the way he had made it the moral of which was *Don't* be content with what you know If you want to *be* somebody, never say that you can't do something.' That and my mother's advice, which was 'Learn how to type but *never* tell anyone you know how' finally got me going."

Armed with a degree a teacher's certificate, two pieces of advice and the realization that she would never make it as a stage star—"I had no talent for rejection"—Reinisch took off for St Thomas to work as a salesgirl and learn skydiving When she returned to New York, she became by turns assistant to the president of a small record company driver photographer and chief assistant to the producer of the first network rock-and-roll show, flyer leaser and seller of airplanes booker for the Cafe au Go-Go in the Village, and finally publicist and on-the-spot manager for Peaches and Herb, and Sly and the Family Stone That as she says, is how she became a scientist

"I was a vice president And I knew about music, you know? I'd booked Paul Butterfield Blood, Sweat & Tears Mike Bloomfield Al Kooper I'd recommended Santana to Columbia Records I'd worked Vegas And I wanted a piece of the action or to get into the record business

"Well I was a woman And there *weren't* any women in the record business then, except for the secretaries and a couple in the art department maybe So there was only one thing to do And that was to get a master's degree in psychology earn myself a little respect get taken on in a record company's personnel division and then be switched with the help of friends to A&R"

At the time Reinisch had a friend who was earning a Ph D in child psychology at Columbia University "I thought *If she can do that and she is no Einstein I can at least go for an M A*" Reinisch applied to Columbia And much to her surprise on April 1, 1969 one year after Columbia's celebrated campus riots, she was accepted with a full-tuition scholarship if she took the degree full-time

The die was cast She flew into the Woodstock Music Festival that August in a helicopter and then flew right out It was her last official act as manager Two weeks later she was in graduate school "walking around with a dictionary and a tape recorder I talked like a rock musician I had no vocabulary at all But I was there"

In the Sixties, when Reinisch went back to school the young were discovering sex, as if for the first time Widespread use of the pill separated sex from reproductive function And sex gradually became a major industry

Sex magazines flourished The Kinsey reports continued to sell in large numbers And the Kinsey Institute, under the directorship of Kinsey colleague Paul Gebhard, quietly went on adding more books, mag

azines films, and photographs to its already impressive collection But despite the sexual liberation associated with the era the Sixties was also a time in which revolutionary Stokeley Carmichael could announce that the position of women in his black-power organization was "prone" Sexual equality remained a mirage until the early Seventies when feminists backed by new doctrines in psychology and sociology, began to insist that differences between males and females were nonexistent Gender was an accident A baby's sex could be surgically switched Sexual behavior was a learned routine that could be unlearned

June Machover Reinisch M A (1970) could have taken this message back into the record industry and fought her way upward Or she could have become the sort of research psychologist who provided the scientific underpinnings for these propositions studying topics like child rearing or cocktail-party behavior She did neither

In 1969 she discovered a book, *The Development of Sex Differences* edited by Eleanor Maccoby which showed that boys and girls exhibited differences in skills, ability, and behavior, and that these differences which appeared from early infancy onward were caused at least in part, by *biological factors*

Reinisch was particularly intrigued by a chapter on a group of women who, as the result of a genetic disorder, had been exposed before birth to abnormally high levels of the male sex hormone These women were born in many cases, with masculinized genitals And their behavior in childhood and adolescence also seemed to have drifted toward some forms of masculine behavior They preferred trucks to dolls, boys' groups to girls' They were not drawn to "feminine" styles of clothing They were tomboys

Reinisch had herself been "a horrendous tomboy I looked like one I behaved like one There was little feminine about me." And she was fascinated by the idea that sex hormones operating on the fetus before birth could permanently affect not only the sexual characteristics of an individual but also the brain and the body At a time when psychologists were studying the effects of the environment, or nurture Reinisch became more interested in nature She hoped to learn the part that nature might have played in the development of her gender and personality She decided to stay on at Columbia for her Ph D She chose to study a group of children who had been exposed to altered levels of hormones in the womb children whose mothers had been given sex hormones to sustain their pregnancies Two New Zealanders, Brian Sutton-Smith the chairman of her department, and John Money of Johns Hopkins University, in Baltimore, encouraged her

"Money had set the agenda for the entire field He threw me in the deep end to see if I was serious When he found I was, he helped me every step of the way"

A comprehensive review paper by Reinisch on the effects of sex hormones on the developing brain appeared in 1974 In early 1977 the results of her Ph D work were published because they were both startling and definitive, in the prestigious British journal *Nature*

Reinisch with the help of Money and others had found and then tested 84 children, half of whom had been exposed in the womb to sex hormones introduced into the mother's body She had made sure that for each child there was a complete record of pregnancy and delivery and that both groups—exposed and unexposed—were comparable in gender and age And she had taken one further step The 84 children came from only 34 families so brothers and sisters acted as controls for one another Genetic differences, then between her two populations could be partly discounted And differences in upbringing could be largely ruled out since the children were from the same families

"Once a Sixties' chick, Reinisch is now at the top of her profession She is writing a new sort of Kinsey report to encourage greater science funding"

The sex hormones that had been prescribed during the mothers pregnancies were of two different kinds Some were estrogens, hormones with feminizing effects And some were progestins hormones with effects similar to those of testosterone a male hormone Reinisch's study showed that the personalities of the exposed children seemed to have been affected in different ways depending on which class of hormones had been used The children who had been exposed mainly to estrogens were more group oriented and group dependent and less self-sufficient than their brothers and sisters The children who had been exposed mainly to progestins were "more independent, sensitive individualistic, self-assured, and self-sufficient"—in short like herself

By the time the paper was published in *Nature* Reinisch had formally taken up a lifetime career as a scientist She had moved to New Brunswick New Jersey as an assistant professor at Rutgers Quickly she became something of a legend on campus known for her hard work her openness and enthusiasm as a teacher and her uncanny ability to attract attention and funding She had applied for and received several large grants for further work on the effects of alterations in the prenatal hormonal environment In the scientific arena she had finally found a home for her considerable gifts as a performer promoter, and businesswoman

Since the late Seventies, Reinisch has made major contributions to our understanding of the effects of hormones on the development of the male and female fetus She showed that exposure to prednisone a hormone commonly prescribed to relieve allergies, arthritis and other ailments reduced the birth weight of both animals and humans And she found that use of progestins produced children boys in particular who were more physically aggressive than what the norm indicated "The results were so shocking that I actually sat on them for a year"

At the same time in Scandinavia Reinisch began to study the ways in which prenatal hormones might affect the different rates at which boys and girls achieve such developmental milestones as walking and talking She speculated about the effects that prenatal exposure to hormone-based drugs and even barbiturates might have

In a landmark review paper written in 1981 with close associate Stephanie Sanders she pointed out that some 22 million mothers between 1950 and 1975 were likely to have taken barbiturates during pregnancy Work on animals she said suggested that the human results might include "learning disabilities decreased I Q increased incidence of psychosocial maladjustment and demasculinization of gender identity and sex-role behavior in males"

The major finding of all her work was that gender was not a hard-and-fast either/or proposition Its gradual development was clearly linked through the sex hormones to the development of certain abilities and personality traits If human beings chose to interfere with the processes by which these things were determined in the womb, then they risked compromising the potentials sexual and otherwise of a future generation—especially perhaps, of males

"Males I think are more sensitive than females to alterations in the hormonal environment before birth, partly because the female is better protected and partly because the road to maleness is more complex It contains more hormonal staging posts than the road to femaleness does This means that the male is perhaps more obviously at risk when the amount of sex hormones is altered in any way at various places along the road Evidence is beginning to emerge that alterations in sex-hormone levels, especially among the male population, can not only produce shifts in personality and aggression but may also influence such things as handedness, immune problems, learning disorders, and adult homosexuality"

The same year that saw the writing of

Reinisch and Sanders's paper witnessed also the coming to power of a Republican administration. The atmosphere in science changed. The amounts of money available to science, especially to the 'soft' sciences of psychology and sociology, began to dwindle. In that year too, Paul Gebhard announced his retirement as director of the Kinsey Institute. A book appeared containing the last major body of research to have been planned for the institute by Kinsey. Based on more than 1 000 in-depth interviews both with male and female homosexuals and with heterosexual controls, the book announced that no detectable environmental or psychological differences could be found between the two groups that might account either for male homosexuality or for lesbianism. Instead, said its three authors, 'homosexuality may arise from a biological precursor that parents cannot control,' something they implied that alters the hormonal environment of the mother's womb.

The wheel had come full circle. Kinsey himself had done as much as any other twentieth-century scientist to free people, especially women, from the imprisoning notion that biology is destiny. People could and did express themselves sexually in a bewildering variety of ways. Now a group of scientists associated with his institute was announcing that biology after all might be significantly more influential than had previously been imagined.

Indiana University began to debate the future of the institute with its inherited bias towards sociological and psychological research. The initiative had passed to a biologically based and rapidly developing science of the human brain. The Kinsey reports were beginning to go out of print for the first time. The distinguished collection of erotica was in disarray, and the prospects for future funding were less than rosy. Should the institute be closed? skeptics wondered.

'They decided no,' says Reinisch, hunched over a diet soda in her fourth-floor office. 'They decided that the institute's collection was far too valuable a resource for scholars and historians for it to be abandoned. And they decided that Kinsey's name and the institute's reputation were assets that had, if anything, been neglected. If was time you know, for the institute to come out of the closet, time for it to play a leading role and become an influence in science again. So,' she says, Joan Rivers deadpan, 'they conducted an international search for a new director, a new sort of director, someone who could and would expand the scope of the place. They came up,' she spreads her hands wide, 'with me.'

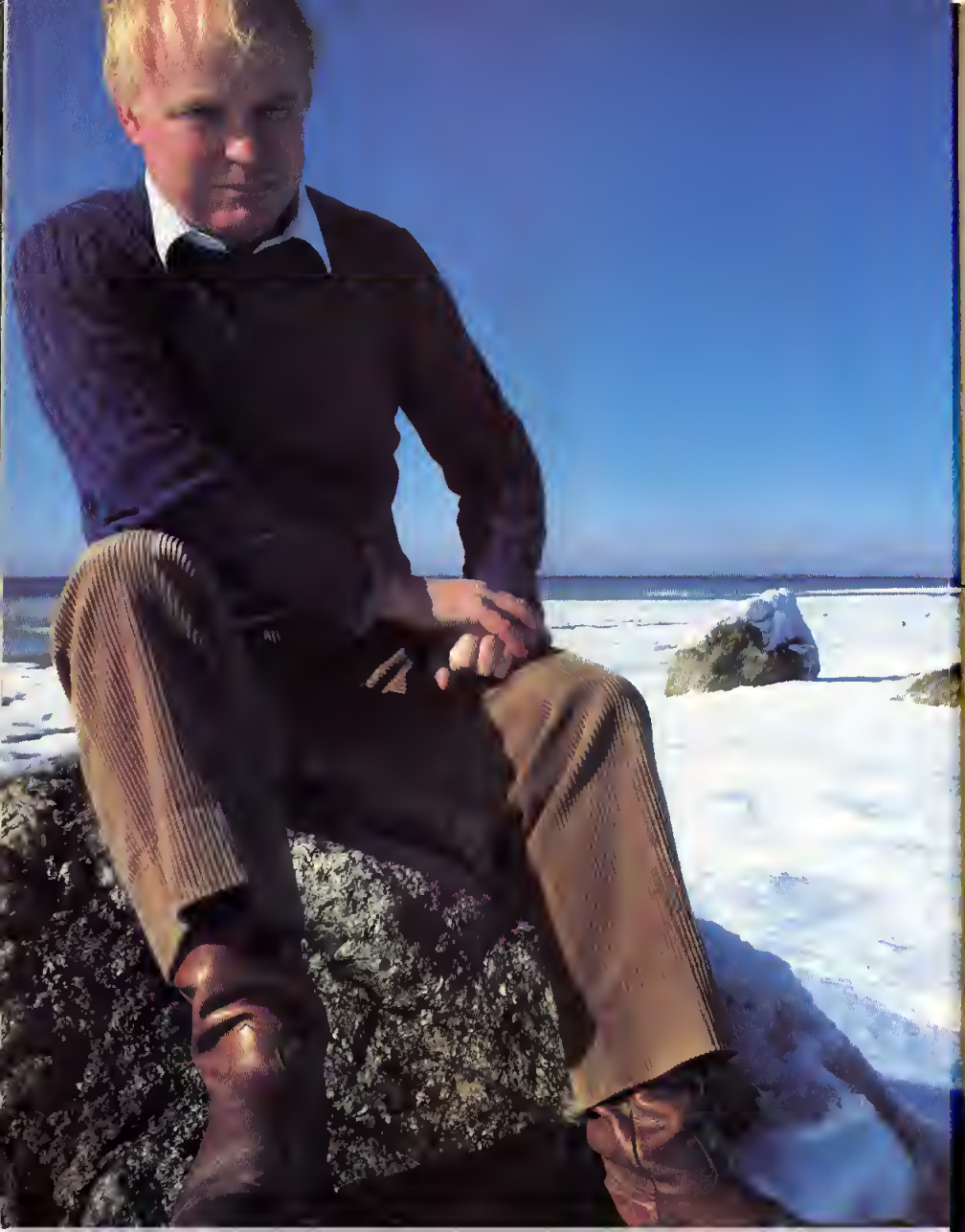
A new sort of director. Like many of the scientists who are currently revolutionizing the way we think about sex and gender, Reinisch is young and female. 'I never expected them to appoint a woman,' Reinisch says. In contrast to the nurturists who dominated the institute for years, she is a psychobiologist who believes that 'there is a biological basis to human behavior.'

She is also that rarity, a scientist who has a flair for business. In the past two years, Reinisch has continued her research on how a fetus is affected by its earliest environment, the womb. And she has put to use everything she learned in the music industry about the connections between image, impact, and performance. She has changed the institute's name to The Kinsey Institute for Research in Sex, Gender and Reproduction. She has appointed a scientific advisory board containing some of the best-known names in the sex and gender field: former mentor Money, Anke A. Ehrhardt, John Bancroft, Frank Beach, Leonard Rosenblum, and Robert Rubin. She has sponsored dozens of studies, ranging from one on male and female parthenogenetic lizards to another on suicide patterns of San Francisco residents. In addition to supporting Kinsey projects, Reinisch has begun to provide seed money for research work done elsewhere. Recently she held two major conferences designed to be the basis of the first of a new line of Kinsey Institute books. One was on masculinity, femininity, and the problems of gender. The other was on teenage sex.

'I invited the experts, kids from communities all over the country. *They* were our anthropologists, our sociologists. It was amazing. Before we started, I wrote on the blackboard every dirty word I could think of, so at least we could get *that* over with. And then we talked. It was as if no one, not even people of their own generation, had ever asked them about their lives before. It was extraordinary.'

Despite her many commitments in the land of the Hoosiers, Reinisch still flies to Scandinavia four or five times a year to continue her long-term study of the biological effects of prenatal hormones. 'It's an important part of my job. I think, to make healthier babies, free of all the stuff mothers are encouraged to take during pregnancy.' Much of Reinisch's time is also spent trying to reach the public with extraordinary new findings in science—findings that call into question our assumptions about nurture, the machinery of our bodies, and our maleness and femaleness. Reinisch has been, by her own admission, 'a Sixties chick—all eyelashes, white boots, two-inch skirts, and long blond hair—you had to be.' She has been helped by male scientists who believe that there are important biological differences between men and women.

Now in the Eighties, at the top of her profession, Reinisch is writing a new sort of Kinsey report, a nationally syndicated newspaper column meant to communicate, educate, and reencourage the science funding that has been vanishing all too quickly. Reinisch may not have become the Gwen Verdon of her generation. But she is more probably a Kinsey for our times: for the good of institute, science, and the public, a different sort of star. ∞



From Polynesian fishing
villages to the streets of Harlem, e
visionary scientist yokes
the greet cycles of Earth end sea into
a timeless garden where
wilderness and humanity intermingle

INTERVIEW

JOHN TODD

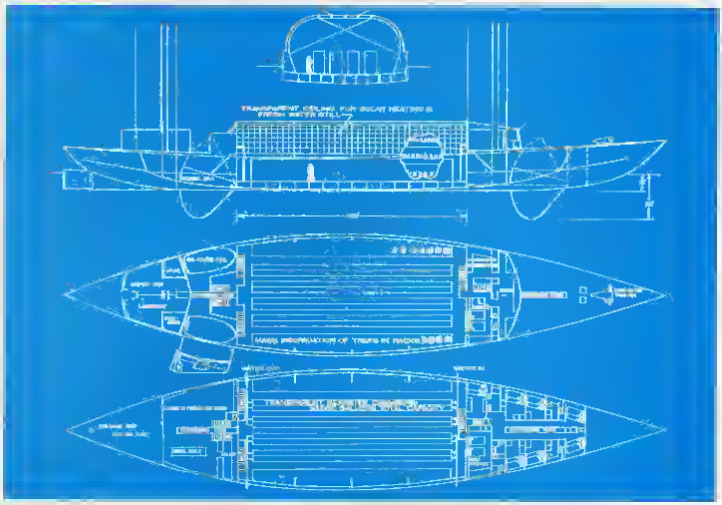
South of the border red is the mark of the devil So when burly, strawberry-haired John Todd went to a festival in Mexico a few years back, a local crowd attacked him "They tried to rip out my hair, and they got quite a bit of it," Todd recalls "My looks were so alien to them But when I saw the red rocks and the cactus all around me, I entered a state of communion with these inanimate objects, which were so benign and passive I've tried to use that sense of being an alien as creatively as possible, it's given me the energy to take risks "

Biologist-ethologist John Todd forty-five has taken risks most of his life Born in Hamilton, Ontario, Canada he studied agriculture, parasitology, and tropical medicine at McGill University, in Montreal, then earned a Ph D in animal behavior from the University of Michigan, in Ann Arbor By the late Sixties, he was a research scientist at the prestigious Woods Hole Oceanographic Institute in Massachusetts Todd was on his way to becoming one of the country's foremost young marine biologists Then he decided to quit "It was the thick of the Vietnam War," he explains "and much of science was being directed toward weaponry We were spewing poisons, pesticides herbicides, defoliants, and insecticides all over the place Yet in all this, there was no institution that would set a different list of values and priorities We decided it was time to make one "

So in 1969, with the grandiose goals of restoring the lands, protecting the seas and informing the earth's stewards (its "healers") scientist-visionary Todd, joined by his wife Nancy Jack Todd and Woods Hole colleague William O McLarney, founded the New Alchemy Institute The name, Todd admits, smacked of mysticism and the psychedelic Sixties But, he insists, it helped him hone his ideas Ancient alchemy, after all,

PHOTOGRAPHS BY DAN McCOY

"Everybody likes to roar around on something, whether it's a motorcycle or an Ocean Pick-up"



demanded a precise knowledge of the natural world. And the natural world was what Todd hoped to emulate.

Working with a dedicated group of colleagues, most of whom were paid little or nothing, he built a series of bioshelters. Structures within geodesic domes, bioshelters house fish and plants and run nearly self-sufficiently on sun and wind, the power of photosynthesis, and the great cycles of land and sea. By studying and varying these domed environments, dubbed *arks*, Todd was able to develop potential agricultural units that could be productive and profitable *without* relying on fossil fuels or costly chemical fertilizer.

Todd had built a number of ark systems when, in the early Seventies, anthropologist Margaret Mead encouraged him to use his methods to transform the town and city as well as the farm. Soon John and Nancy Todd had spawned a plan that included trees to purify the air, water hyacinths to process sewage, aquaculture minifarms at every bus stop, and vast lakes that would modify urban climate.

Todd hopes he can soon begin to implement some of his ideas on the largest Gothic structure in the world: New York's Cathedral of St. John the Divine in Harlem. His plan is to replace the copper sheathing on part of the 600-foot-long roof with glass. This solar greenhouse will at once trap warm air to heat the cathedral and will house hundreds of fruit, nut, and ornamental trees. The hope, according to Todd, is that the church might use these trees to reforest the city en masse. Burnham Wood comes to Harlem.

But Todd is not content to wield the wisdom of biology in the Western world alone. In recent years, spurred by the realization that our profligate, energy-intensive ways will inevitably oppress those in the impoverished Third World, he and Nancy established Ocean Arks International. Their primary purpose: to build sailing ships that would replace the energy-intensive, petroleum-run fishing vessels in use today. Todd, who comes from three generations of naval architects, has already collaborated with designer Richard Newick to create five versions of the Ocean Pick-up, a boat with three parallel hulls connected by crosspieces. This space-age sailing craft—"It's half-bird and half-boat," Todd says—is speedy, sturdy, and reliable. It can be built from local trees with a manufacturing process accessible to low-technology Third World cultures. Should Todd have his way, production will begin in Guyana and Costa Rica sometime soon.

If John Todd has proposed radical designs for people around the world, a visit to his Cape Cod home reveals those concepts implemented with a vengeance. Driving past lush, windswept stretches of Massachusetts coast, one comes to a cul-de-sac without a name. There, just as Todd promises, is a house you can't miss. Its sloping glass face reveals a garden of leaves and eight-foot-tall cylinders filled with iridescent green. Each vat, Todd explains, is an ecosystem all its own. Emerald algae photosynthesize carbon dioxide and water into protein, sustaining fish ranging in species from the ancient tilapia to the Chinese amur. The fish, in turn, often provide dinners for the Todds.

In back of the house, meanwhile, a picture window looks out on the Todds' *other* garden, a natural area complete with wildlife and a pond. "There's a muskrat building his nest," Todd points out. "He really wants a female. Last year his nest wasn't good enough to attract one, but this year he might do better."

The eye, though, is drawn not to the animal but to a rickety shack on stilts in the middle of the pond. Its only approach: planks that emerge out of foot-deep water and seem to miss the door by a yard. "I go in there afternoons to write," Todd explains. But when asked for a tour of the facility, he declines. "It's pretty private and raunchy in there," he says. "Besides, you'd probably fall. I have to wade over with thigh-high boots myself."

"We're going through changes as dramatic as those of the Renaissance," he says, returning to the subject of his life's work. "As a culture, we have not really learned yet to work *with* the planet, with total fascination and respect. We've always superimposed our totally fascinating technology on the natural systems of the planet. And our chemistry is so alluring to us that we impose it in drugs on our own bodies. The exploration of the self and the willingness to work with the planet, not just to use it, are two world views hitched to the same star."

John and Nancy Todd describe their years of research in a new book, *Bioshelters, Ocean Arks, City Farming: Ecology as the Basis of Design* (Sierra Club Books, 1984). Todd was interviewed at their Cape Cod home and at the New Alchemy Institute by *Omni* senior editor Pamela Weintraub. The discussion that follows was added to sections from a previous interview conducted by anthropologist John Grossinger and writer Lindy Hough.

Omni: What convinced you to leave hard-boiled research and an academic career to found the New Alchemy Institute?

Todd: In a way, my path was cyclical. From the time I was a teenager, I was fascinated by the idea of agriculture and farming as the mother of culture. I read the works of Louis Bromfield, Sir Albert Howard, and others studying the relationship between man and Earth. They chronicled the fall of many civilizations that had turned their backs on the natural world, suggesting that agriculture and culture were twin souls. I was inspired and went out to study agri-

A seagoing bioshelter, the ocean ark Margaret Mead *(above) has a solar desalination plant, tree farm, and continuous filtering of seawater.*

culture myself. I soon discovered, though, that as perceived by present-day professionals, it was mostly a technological venture. It wasn't anything like what I had read about. I wanted to understand how the living world worked, and eventually I did a doctorate in ethology, the study of creatures in their natural habitat.

By the Sixties, in fact, I had become an animal behaviorist trying to decode some of the ways creatures in the sea and freshwater lakes communicated. I worked with a species of catfish whose social behavior was so highly organized that two individuals could remember a single conflict four months after it had occurred. For four months I would separate the participants in a conflict situation. Then I would simply place the water from the winner's tank into the loser's tank. The loser would immediately change color, flee, and quiver as if it were about to be clobbered. When I did the opposite, transferring the water from the loser's tank into that of the winner, the unique behavior pattern of aggression and challenge would occur.

Don't forget, in the Sixties, when we founded the New Alchemy, we were in the midst of the flower child era. You turned on the radio and heard Malvina Reynolds singing "Ticky tacky," and everywhere was the sense that society had just become too materialistic and insensitive to deeper aspirations, whatever they might be. We simply wanted science to serve culture in a way that wouldn't lead to atomic bombs. We thought we could best accomplish that goal with an institute of our own. When I told my father that we decided to name it New Alchemy, he said, "You've really blown it there, fella." But the name helped us formulate our ideas. It helped us differentiate between what we perceived as old science as opposed to the new.

Omni: What were some of your goals in those early days?

Todd: The stated goals were to restore the lands, protect the seas, and inform the earth's stewards—those individuals who would help us tend the earth. More specifically, we thought we'd like to create a little food-growing entity that would be highly productive and operate as much as possible on natural cycles, without the need for fossil fuels or a lot of land.

We asked ourselves one basic question: What takes care of itself by itself? There was one obvious answer: The earth. So we said, okay, let's design a miniature earth. Then we set out to learn just how the earth works. Earthly life exists, we realized, because of the atmosphere—a transparent, translucent body of gases that captures solar energy. The architectural form that would simulate the function of the atmosphere best suited to the capture of sunlight we decided, was the geodesic dome, developed by Buckminster Fuller. As the sun marches across the sky, no matter what its position, the dome has facets facing it directly. But the atmosphere alone doesn't cause life to exist. We need another ele-

ment to store the energy that has been captured. Land is a very poor storer of energy, as anyone who's been in the desert at night can attest. Captured sunlight is stored mainly in the oceans, which make up seventy percent of Earth's surface.

So within our artificial atmosphere—a plastic geodesic dome—we placed a pond. Because most of our small farm was water, we thought that most of the foods grown would be based on aquatic cycles. Thus, first we seeded our ocean with a wide variety of tiny plants, the plankton that convert sunlight and carbon dioxide into oxygen and protein. Then we needed to stock our pond with fish that would eat the plankton. The fish we finally chose to play the role of the great blue whale or the sardine—the filter-feeding fish that eat the ocean's green soup—was an African creature called tilapia, or St. Peter's fish. That fish, ironically enough, was the fish associated with the loaves and fishes tale in the Bible and was in the Sea of Galilee at the time of Christ.

The tilapia has been associated with humans for a long time. There are drawings of it on the tombs of the pharaohs, and we liked it because it could be cultured without exploiting the environment. Then there were other aspects of the ocean that we simulated as well. To reproduce currents which cause pond nutrients to roll over and circulate, we introduced the highly muscular and active mirror carp from Israel. And to emulate the nutrition that highly fertile seas get from rivers, we used a Chinese creature called the white amur. These fish are delighted to feed almost exclusively on plant matter from the land, so we gave them hay, marigold leaves and weeds from the garden. They have a rather uncanny digestive ability—what comes out of their rear ends, in short, are things you might find in a river.

Finally we began to design the other thirty percent of our bioshelters. Plants were irrigated and fertilized with pond water enriched by fish waste. The plants, in turn, sent their wastes back to the pond. The whole system was a constant.

Omni: You've built many other enclosed ecosystems—you call them arks—since then, haven't you?

Todd: We have subsequently improved and varied that original strategy, but the thinking still holds. Nature provides the information that will allow us to succeed in our larger goal—creating equality between the world's peoples. As long as things cost money or require a lot of capital, as long as agriculture requires the importation of heavy amounts of petroleum-based fertilizer, you can't have equality because some people can afford it and some people can't. So we were looking for a currency applicable to all peoples, no matter how rich or poor. The one currency available to everyone we found is nature and the information inherent in how it works. There may be more intrinsic resources in any given region. I'm not denying that. Each

area has its own latent possibility learning that is like watching a flower unfold in the spring. Even during periods of scarcity, nature provides enormous potential.

Omni: Could you give an example?

Todd: Well, we were in the Indian Ocean, visiting a beautiful island whose primary crop was coconut. But the fate of the population was threatened because the sole source of fresh water, apart from what people caught on their roofs, was the freshwater lens underneath the island. The lens was nearly depleted, so the island would have to be abandoned in a matter of years. Here was a real tragedy in the making. Well, the one solution to the problem would be to somehow make bowllike basins on the surface, thereby catching the rain during the rainy season. The island's coral soil was as porous as sand, and water poured into it disappeared.

But I remembered the research of a couple of Russian scientists who had discovered a process, little known in nature, whereby, in the absence of oxygen, organic matter could combine with certain kinds of bacteria to form the biological equivalent of plastic. They discovered this process at the bottom of tiny, rubble-filled lakes that wouldn't ordinarily hold water. So I wondered if it would be possible to simulate the process by making a living plastic on an excavated lake. Well, that's just what I did. First we excavated a large pond. Then we went in search of organic matter with a lot of carbon in it. It turned out that husks, which are rejected from the coconut, were appropriate. We ground them up and layered them over this pond floor.

Then we went into the jungle and found a papaya plant with real sexy enzymes, which acted like witches' brew. With that we created another six-inch layer and then pressed sand down over all of it. We added enough water to start the process, waited for the rainy season, and now there's a lake on the island. This was an important experiment, because over-grazing and deforestation have caused most of the soils of the world to lose surface. Those areas of the world where there are seasonal rains can be brought back to life again.

It may sound arrogant to say that I can revive the ecology in wasted places. But I know it can be done. There is a vitality and tough organizing principle to nature. Even when you take a bulldozer and scrape the side of a road, you notice how it reorganizes itself. You see types of organisms that absolutely love a good scraping!

Omni: What part did Margaret Mead play in influencing your thinking, that is, to embrace communities rather than buildings?

Todd: In 1976 we went to the town in Indonesia where she and Gregory Bateson had once observed the balance and connectedness between religious practice and music, art and architecture. We hoped to think on a larger scale about villages and towns. The result was the bioshelter. It has become the main tool within which water can be desalinated passively, inside the structure, trees, plants and soils, as well as water and marine life, are cultivated.

In desert regions, for example, this desalination facility looks like an encampment of tepees, a number of fifty- to eighty-foot-diameter geodesic climatic envelopes. These bioshelters are placed in a large circle. During the day seawater is pumped into a large solar silo within each bioshelter. The evaporation and condensation of the seawater produces fresh water at the silo's base. Marine organisms grow inside the bioshelters. At night, with colder weather outside, the whole building begins to weep, and water runs down its periphery. This enables us to establish the ring of trees immediately beyond the structures. Within two years the trees—their root systems and soils—are established, and the geodesic bioshelters are lifted off and taken to a new site to repeat the cycle. The cluster of trees and vegetation eventually traps its own moisture, preparing the way for permanent agriculture. The whole collective structure acts as a catch basin for wild pollen, leaves and pine needles that fall after the domes have gone on to the next place.

"If we connect a primeval woods from the Hudson River to Manhattan by adding tentacles of soil, we'd create a direct link to all the creatures that don't come into the city."

Omni: Are you more concerned with bioshelters than the technology of land restoration projects?

Todd: We're concerned with different combinations of plants, of predator-prey relationships, soil enhancements—all the ecological elements. There are very few ecologists who have a great interest in technology. On the other hand, we have to bring in biologists who know just what combination of plants will allow a Greek island that is now nothing but rock and sand to flower with springs from the ground and a forest floor. To regenerate an ecology of ten thousand years ago and return a thousand years of its topsoil in a decade, you need people who understand Mediterranean plants and can carry out this symphonic ecology. You can't just plant trees and pray to Pan it'll work.

Omni: How would you evaluate the present state of desert restoration?

Todd: I was fascinated by the early, very sophisticated ecology that grew out of Israel. The rediscovering of the flow of water and of seeds that can germinate with a few days of moisture, get roots down, and survive to produce a crop of trees that can do the same thing. This superb ecology was patterned on the historical methods of the flowering of the desert.

But the pressures from the shadow side, from the militarization of the country, have had their effect. A tremendous amount of walnuts and oranges have to be produced to feed Europe and keep money flowing for weaponry. Israel is no longer adapting trees to the desert. They're adapting the desert to the trees.

They've found primordial aquifers deep within the great organs of the earth, and they're pumping up this water to use on crops in a desert not unlike Death Valley. One effect is the salting up of the surface. Look at the Tigris-Euphrates Valley. It's become one white, glistening desert from salt deposits created by humans trying to grow crops with imported water. That desert's been dead since 2500 B.C. Before it was a lush valley. There is scientific evidence that tampering with these great organs could have untold consequences.

Omni: Does anything remain of those early years of agriculture in Israel?

Todd: I would guess that in the rush for bucks from Europe, the addiction to petroleum has reached nearly everyone. The early ecological agriculture wasn't so involved in oil to fuel every machine. It depended on waterworks and canals to take advantage of the runoff after a flood and allowed that few minutes of rain to produce a whole crop. The Israelis weren't quite as good at it as the Hopi or the Papago, but they were good. Now the bucks are needed because of the weapons. Israel is almost the world in miniature. The moment you develop an addiction to a particular input other than the sun, you start playing by a different set of rules. Israel absolutely must have petroleum.

Omni: So the rules of the game you're playing have to do with technologies that will work indefinitely?

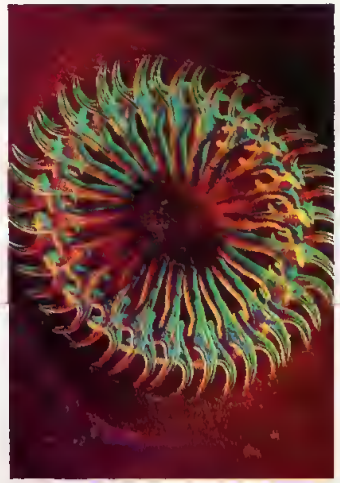
Todd: That's the basic rule. In designing around natural infusions of energy, you soon discover that you're dealing with pulses instead of steady states, such as those of a power station or an electrical generator going twenty-four hours a day. Pulses open your field to a whole variety of interacting relationships.

Ten years ago I designed a wind-powered fish farm: three connecting pools with the bottom pool enclosed by a greenhouse. Water flows from the top to the middle pool and down to the bottom pool, the biggest. The windmill chugs it back up to the top. Everyone said, "The water won't flow all the time. You're going to ruin productivity." I said, 'Perhaps, but I'll see what happens." We put fish in the upper ponds but not in the lower, so that when the wind wasn't blowing, a whole variety of microorganisms were busy proliferating. There were hundreds of rotifers and daphnia. The

CONTINUED ON PAGE 114

MICROZOO

A photomicrographer trains his eye on a colorful menagerie of miniature marvels



"When you look through the eyepiece of a microscope, it's like looking through a porthole into an invisible world. It's much more exciting than any movie or TV program. It's totally captivating," says science photographer Phillip Harrington, whose fascination with microscopes dates back to his early childhood, when he was sometimes allowed to play with the family doctor's instrument. "The complexity of creatures you cannot see with the naked eye is really something to marvel at. Even something the size of a flea can be magnified to reveal intricate portions of the anatomy: muscle structure, the tongue, the nerves, and the eye."

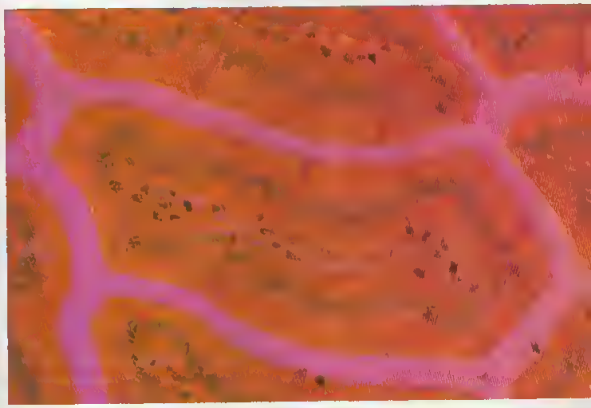
Many of Harrington's techniques for conjuring up visible images of the invisible world are bor-

BY PHOEBE HOBAN

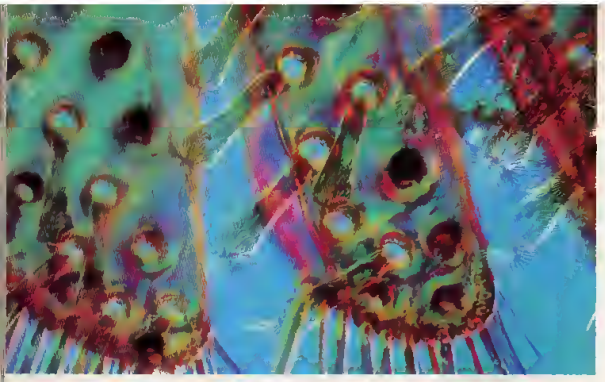
"Most of these microstructures are invisible. They are not just tiny. They are transparent."

rowed from the Victorians. They viewed the microscope as a form of entertainment—something akin to their other optical toy, the magic lantern. "Victorian bachelors actually used to invite their lady friends up to see their slides," Harrington explains. In fact, several of the images pictured here—the sunflower-shaped tapeworm, the strands of human hair, and the flea—were created from authentic Victorian slides. At one point, the photographer owned an entire collection of Victorian brass microscopes; today he uses more modern Olympus scientific equipment for much of his work.

But viewed through even a powerful microscope, most of these microstructures are still invisible. They are not just tiny. They are transparent. So Harrington tints them using several different techniques.



Previous pages: Harrington uses a microscope and special lighting techniques to capture a close-up of the thighs of a flea (large photo) and the flowerlike head of a tapeworm. These pages: A still life photograph of human hairs (top left), a specially tinted blow-up of an original Victorian slide, and a close-up of the cellular structure in a mouse's intestines (lower right). Abstract patterns are revealed in cross sections of a rabbit's tongue (top right and lower left).

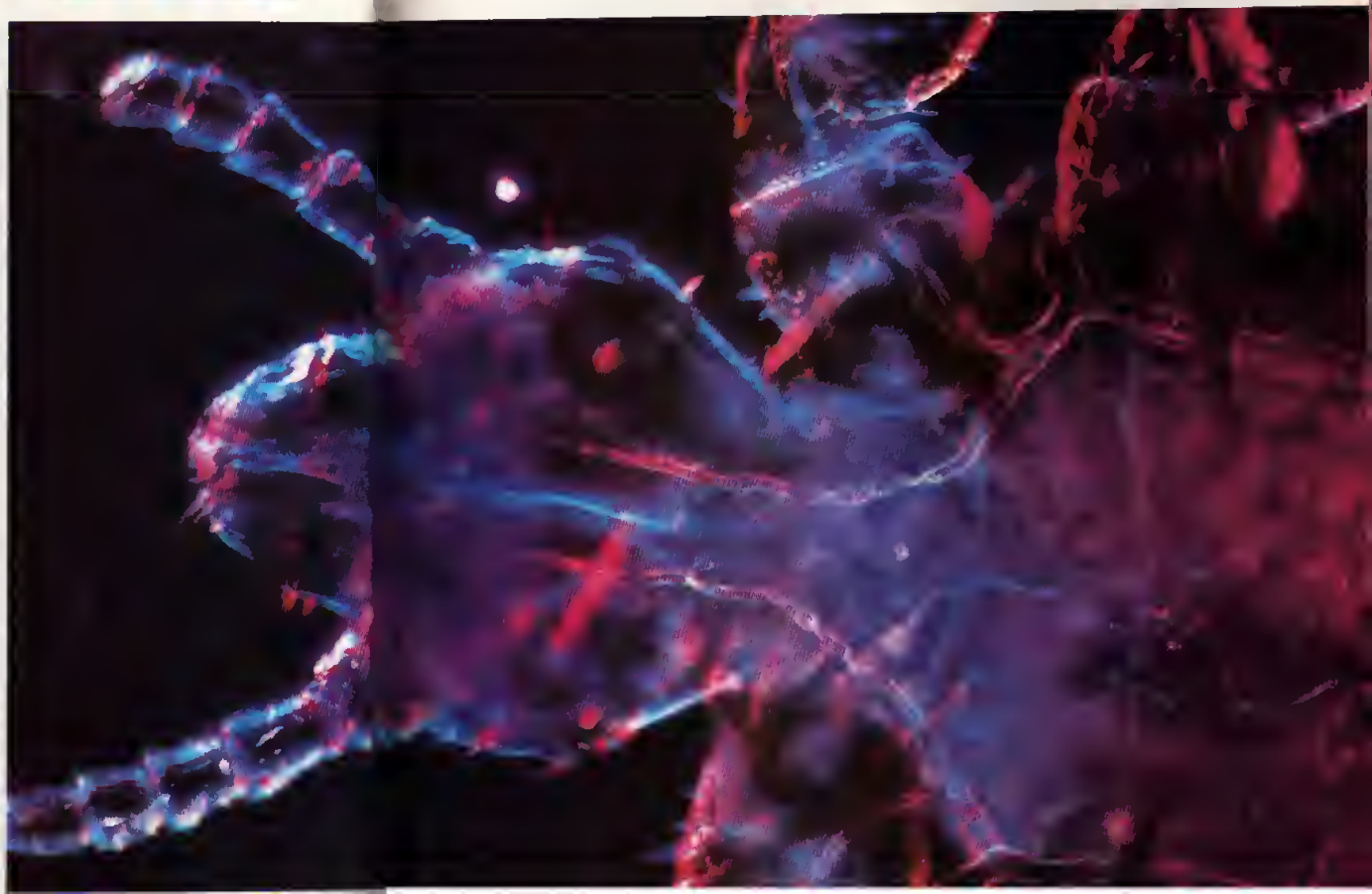


This gallery of common household parasites includes a flea (top and lower left), a mite (top right), and, blown up to monstrous proportions, a louse (lower right). To find his subject matter, Harrington combs laboratories, hospitals, and even antique shops. The flea is from his collection of Victorian slides. After weeks of intensive searching, Harrington finally tracked down the louse in the tropical-disease section of a major New York City hospital.

"Even the lowly louse is vividly illuminated, tinted with Harrington's photographic trickery."

He called on the Victorian-age Rheinberg method—placing different hued gels beneath the slide—to color the images of the rabbit's tongue. The modern Nomarski optical system—an intricate series of prisms that produces a spectrum of brilliant colors—from palest indigo to deepest violet—was used to tint the human hairs. Thanks to special effects, even the lowly louse is vividly illuminated.

Harrington prefers relatively old-fashioned optical instruments to the technologically advanced electron microscope. "Nothing you shoot with the electron microscope offers the same rainbow hues. With the optical microscope, I have one thousand and one tools for creating millions of color combinations and myriad forms so that the image is not only technically correct but visually exciting."



...make ...ome ...
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ANTI MATTER

UFO UPDATE

...n a recent *Omni* in-terview [Nov. 1983] Noam Chomsky expressed his view that humans are unique in their ability to use language. But Earth is, after all, a frighteningly small part of the cosmos, and ... not implausible that other organisms out there somewhere use language. What kinds of ... sy...b... systems might they use? What medium of communication ... telepathy, pulsed radar emissions, or something totally beyond human imagining) do they favor? And how can we bound to this one minuscule planet possibly imagine anything abou...

If we apply the prin... [illegible] ... assump... that in the absence of ... the contrary the same ...les apply throughout the ... linguists can make some plausible claims about what an inhuman language spoken by tool using social intelligences might be like. The enterprise is what ... calling *exolinguistics*.

One claim we can make is that exolanguages will probably use sound as a transmission medium simply because of its special physical properties. Sound propagates well in almost any fluid (liquid or gas), it goes around corners, and it's easily produced by almost any kind of mechanical energy. ... the other hand, we can ... telepathic methods of disclosure. The extremely weak amplitude of neural transmission would make it too unreliable a channel of communication.

The most interesting feature of an exolanguage from the linguistic point of view is that it will probably share a number of ... ral similarities with human language ...

... whether human languages a... ... ass... expl... ... way that ... differen... ... in ... [illegible] ... Chomsky's claim ... this ... [illegible] ... features ... [illegible] ... might be ... they ... learned ... man be ... [illegible] ... language ... Chomsky ... [illegible]

The absence of any actual aliens ... [illegible] ... through this imaginative exercise, however, we ... a ... the central question ... What is language, what does ... know ... does language ... us as human beings ... exolinguistics ... standing questions we ... expand ... the nineteenth ... a ... alive ... [illegible] ... —RICHARD WARNE...

CULTS AND THE PARANORMAL

If your son or daughter starts having psychic experiences and seems confused by them, be careful. Your child might end up being the victim of a religious cult.

That's the opinion of Keith Harary, who was previously director of counseling for the Human Freedom Center which regularly deprograms cult members. Harary, who has harbored a long-lived interest in the paranormal, was surprised to discover how many people are drawn to religious cults because they are psychologically ill equipped to handle psychic experiences. Often these people have failed to get any support from their teachers or clergymen.

We must understand that psychic experiences are real," says Harary, "or people will go to the cults in order to find the answers society refuses to give them. When critics say that belief in psychic phenomena is irrational and unscientific, they scare otherwise reasonable people away. That leaves cult leaders to fill the vacuum."

Cults, Harary continues, embrace psychic phenomena, offering these confused individuals a haven in which they can feel secure and sane about their experiences. But according to the former counselor, this ploy is often no more than psychological exploitation.

Harary discusses the psychic connection and his work with cult defectors in his forthcoming book *The Mind Race* (coauthored with Russell Targ). He feels that a more open attitude about psychic experiences among teachers, scientists and clergymen would prevent people—especially youth—from joining cults. The most important message to impart to those in need of help, emphasizes the San Francisco counselor, "is that psychic experiences are normal."

—D. Scott Rogo

"There are children playing in the street who could solve some of my top problems in physics because they have modes of sensory perception that I lost long ago."
—J. Robert Oppenheimer

BALL OF FIRE

When a Russian passenger plane took off from the town of Sochi recently, it seemed like a routine flight. The sky was blue, and the weather was clear, except for some thunderclouds sighted 60 miles away. According to the Soviet news agency Tass, however, the flight was anything but ordinary. A fireball about four inches in diameter appeared in front of the cockpit on the fuselage. As the amazed pilots looked on, it disappeared with a deafening noise, pierced through the plane's airtight metal walls, and reappeared several seconds later in the plane's lounge where shocked passengers watched the luminous ball fly slowly above their heads.

In the tail section of the airliner, the fireball divided into two glowing crescents which then joined together again and left the plane, almost noiselessly, Tass claimed.

The pilots quickly headed the plane back to Sochi's Adler airport, near the Black Sea, where mechanics discovered damaged radar equipment and holes in the craft's fuselage and tail.

The bizarre incident, according to the Soviet news agency, was caused by ball lightning.

Tales of fireballs zipping through airplanes are not new, says Richard Orville, professor of atmospheric sciences at Albany State University in New York. "There are a couple of cases in the reviewed literature. Something almost identical to the Soviet account was reported about fifteen years ago in the United States," Orville notes. "A military plane was apparently struck by lightning that entered as a bright ball, passed between the pilots, drifted through the plane and went out the tail."

Orville points out that while several scientific theories have attempted to explain ball lightning, little is really understood about it. "It is a very rare and strange phenomenon."

—Sherry Baker

"Only the hand that erases can write the true thing."
Meister Eckhardt

BUILD YOURSELF A GHOST

Psychokinesis the ability to make physical changes the environment by the power of thought alone has long been regarde as one of the most controversial areas of parapsychology Yet one Canadian group the Toronto Society for Psychical Researc laims o have refined this talent to such a fine art that was able t build its own ghost

The key to this reative process ac rding t group eader r A R G Ower and his wife is the northodo to l collective hal ination By channeling their mental nergy to gether the sychic s laim to have begat Phillip noisy poltergeist and former seventeenth century glish obleman

Owen explains that Phillip was able t co municate to hem by generating spirit aps on the table One day he remembers the meditators were sitting around a table when we eard kn

Further experiments showed that Phillip could be directed to tap out answers to questions keep ime ou s and even esp n ewd jokes

But Owen adi onishes "Phil ip has no dependent existence He just sa d what a major f s ers the group tho ght he would say If the questio ad an obvious a er the response ame rapidly and loudly But e embers had t take t e o ndivid ually reason out wha Phil p had to say the res nse was slow and feeble

Skeptics have suggested that the response was little more thar a disp ay o high perfo ance kn le racking But d ring the group's appearanc a local televisior show a table alleged y pped ve W nesses t he udi audience insisted that no one even t ed he surface Phil ip s a so said to have levitated a table completely of he gr und du ng the fi ming of a Canadian documentary But alas the ameraman some how missed the spectacle

Sandr Hansen

The eye you see is ot a eye because see t it an eye because see you

Antor io Machado

FEATHERED SLEUTH

For enturies have been prized be cause thei ability to mimic human speech Recently an Ama zo parr named Baby put her vocal rowess to unusual use she helped reak u a gang o urglars hought to be respon le f es ing the theft of over $60 000 property

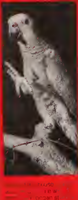
he case of the feathe ed sleut came light whe Bayt wn Texas po detective Reggie Harper interviewed a ber m The woma ad been called e station ident s property that the p e ad ecovered

She said she t a ing tell e e arper S Bab has only a wo word vocab lar B the obbe saving new p me e here Ron ie

Harper a Detec e w had made a case a s pect that two en were nvolve

As the women d me e ames the b was sav ng mmedi ate um ed on Ronnie and ober were he names of two to s spects Harper explains

The man a read s ody soon confessed and his statemen explain d how Baby had learned the names o the other burglars The thieves apparently



he house e w organ st s S de lou voice t he dark glars oke thi d he hor se yell Ronnie! ber s just a d t get the nar pal

We up with a lot o evidence on hese guys nd fingerprints and stolen property So the bir ot going e used nes Har er

Bu have to ad that Baby was a g a informant And we didn't even have to pay her anything e cept a little birdseed

Sherry Baker

PSYCHIC COPS

Hugh Whiteman was a his wits end for several months company thieves had been stealing expensive equipment from Quality Sound Whiteman's stereo store in Denver He'd almost given up hope of nabbing the crooks until someone suggested he call Psychic Enterprises a parapsychology consulting firm based in Los Angeles

According to Leslie Lewis a founder of Psychic Enterprises the company normally specializes in such business forecasts as the next generation of junk food But a client has a security problem the psychics will do a full investigative report detailing all suspects for twenty three hundred dollars

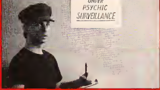
When Whiteman contacted Psychic Enterprises the ... asked ... to send them all ... personnel records including samples of his employees handwriting and a list of their astrological signs A few weeks ... the psychics pooled their ...

... impress ... de alle ... identifie ... ag ... ar ... name ... tion ... one ... as ... surprise ... aught him ... records ... fts We eve ... plice

... signs ... usual ... employees ... thieves ... ble an way ... this psych ... can ... Whiteman ... friend ... Psychic Enterprises ... hope ... helps ... him ...

—Mar... ...es

... hardly know ... present—at least know ... when ... morning ... have ... since then



MYSTERY MISSILE

... World War ended more than 30 years ago So how did a missile from that era end up crashing into the backyard of a suburban house in Lakewood California recently? That's a question the Federal Aviation Administration (FAA) and the Los Angeles County sheriff's department would like answered

The ...-pound shell whistled through a sunny afternoon sky and then plummeted onto the patio of Fred S...'s home smashing a layer of concrete before coming to rest in a four-foot-deep crater After digging up the missile the local bomb squad declared it a dud that contained no explosives

Because Lakewood is in the flight path of aircraft using Long Beach Airport FAA investigators at first theorized that a prankster had probably dropped the shell out of a passing plane

We monitored all tapes from around the time the missile hit to see if any aircraft flying over could have opened a door and thrown something out We would have heard a screaming sound on the tape if that had happened explains Ben Harris of the FAA But we didn't come up with anything

The Los Angeles County sheriff's department launched a probe to look into other possible explanations We never found any source Deputy Wes Slider comments although we determined that the shell could not have been fired from some kind of tube or a cannon

Lacking any clues at all both the FAA and the sheriff's department have dropped their investigations of the mystery missile Harris concludes We just have no idea where the thing came from To tell you the truth I don't think we'll ever know what happened

—Sherry Baker

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have not the smallest molecule of faith in aerial navigation other than ballooning

—William Thomson Kelvin

SOULS ON ICE

CONTINUED FROM PAGE 46

sea on Titan is more than sufficient to melt the Ice Three layer.

About 100 or 200 miles farther down you might pass through slush and then run into a solid wall of Ice Six. At one time beneath this wall there was probably a warm, shallow sea surrounding Titan's rocky core. The sea almost certainly existed during the first 2 billion years of Titan's existence. Then, like our own moon, Titan's rocky core was heated by the decay of radioactive elements to temperatures hot enough to liquefy rock. Lava welled up from its interior and the surrounding ice absorbed its heat and melted. As the radioactive elements continued to decay and their abundance dwindled, the internal heat failed to keep pace with the seafloor cooling. The innermost of Titan's seas began to freeze except for a few oases located around dying volcanoes. Over the past 2 billion years the radioactive glow has probably gone out, and whatever life started down there may now be nothing more than fossils.

Still, today there is that upper level between the Ice Six mantle and Titan's surface, where ice can liquefy somewhere below −5°F. And the result could be an ice world encircling a sea—a bubble of water perhaps 124 miles deep, locked between two concentric spheres of frozen water. Rocks and dust that would normally be mixed in with the ice would have settled on top of the inner sphere of Ice Six, littering the seafloor with clays, sulfides, and other life-sustaining ingredients. This sea, if it still exists, would be as old as Earth, old enough for living cells, and perhaps even full-fledged creatures, to have evolved.

What would such alien life forms look like? My bet is that they'll be eerily familiar, fast-swimming, torpedo-shaped fishlike creatures with fins and gills—but no eyes. Conceivably they would share the subsurface waters with other beings resembling such earthly sea life as crabs, worms, and clams. But familiar as they might seem, their genetic roots would be of another world. A fish swimming in the mantle of Titan would, in terms of ancestry, be no more related to a barracuda than an earthly barracuda is to a Venus's-flytrap.

Titan's surface is another possible habitat for life. To an earthly visitor, conditions would seem intolerable. At ground level the pressure is 60 percent greater than at sea level on Earth, and the smoggy atmosphere is mostly nitrogen. The air is cold. At −293°F, human hands would undergo an instant transformation from flesh to something resembling glass. The humidity ranges from 70 to 100 percent. But it is not water humidity; it is methane humidity. If the mountains of Titan are sufficiently high, they may well be capped with methane snow. Glaciers of methane flowing groundward would become rivers of methane. On Titan, methane would take the same forms that water assumes on Earth: vapor, rain, snow, slush, and ice.

There is more than methane on the wind. The Voyagers detected other organic compounds: ethane, acetylene, propane, formaldehyde, and hydrogen cyanide. These toxic molecules are the first chemical steps toward life. But Titan's lakes and seas are too cold to support the life-building processes that could knit them into more elaborate entities, such as viruses and cells. The lakes, if such exist, are so frigid that carbon dioxide and water—substances we breathe and drink—are present everywhere as rocks and sand.

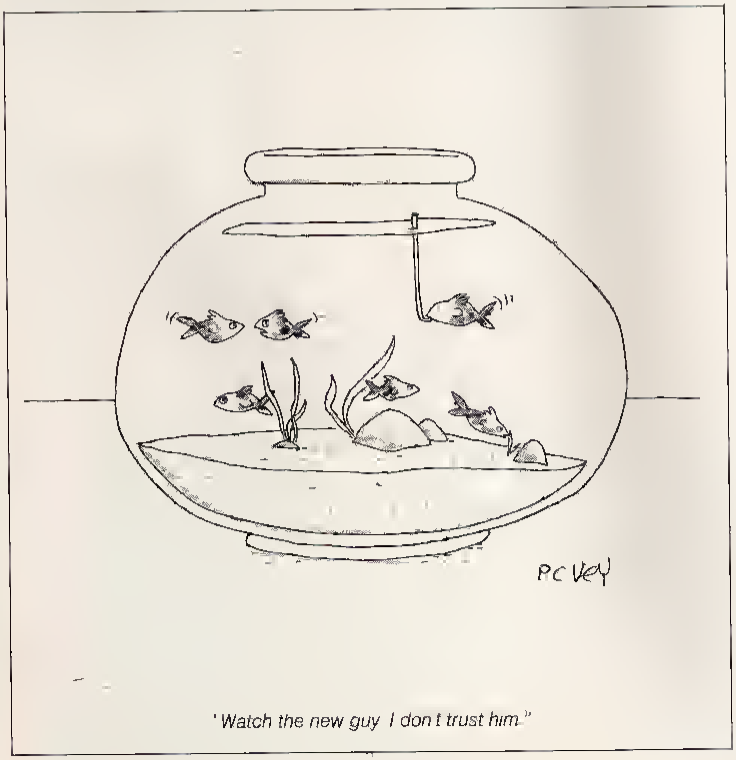
In the face of such conditions, life would appear to have no chance. But researchers have recently begun to believe that chemicals can become animate even in apparently hellish environments. Scientists believe that the upper atmosphere of Titan, irradiated by ultraviolet light from the sun and bombarded by charged particles from Saturn's magnetic field, could synthesize organic molecules, the building blocks of life. Swept by a sleet of frozen hydrocarbons, Titan's lakes would gather organic debris—amino acids and sugars among them—from the heavens. Some of the debris would be kept afloat by surface tension. Some would sink to the bottom and become a sticky, lifeless caramel.

University of Hawaii microbiologist and exobiologist Clair E. Folsome has shown that it is easy to put these molecules on the road to life. Simply apply shock waves. You could even put the chemicals in a flask and let a monkey bounce them off a wall for a few minutes. Invariably the sticky caramel will become protocells—microscopic rods and spheres and long, hollow tubes with membranous divisions running down their lengths. But there are no monkeys with flasks on Titan.

There is, however, rain. And where there are tributaries—methane rivers charting meandering courses over beds of hydrocarbon snow—there must be waterfalls, or rather methane falls. And where there are methane falls, there are shock waves.

In one room-temperature experiment, Folsome sent an amino-acid-producing electrical charge through a flask of methane, ammonia, and water. After shaking the flask vigorously, more than 60 percent of the carbon in the methane became protocells. They resembled clumps of 20-micron-wide spheres and tubes (1,000 microns equals about one twenty-fifth of an inch) and smaller, bacterialike objects.

In 1980, when meteoriticist Jesse A. Stoff and I began studying the atmospheres of ice worlds, we estimated that Titan-size worlds 600 million miles beyond the orbit of Saturn must be so cold that gaseous nitrogen would liquefy into a worldwide ocean. Our attention turned to Neptune's moon Triton. In September 1983, radio waves that researchers from the University of Hawaii had bounced off Triton confirmed there was liquid covering Triton's



"Watch the new guy. I don't trust him."

surface. It is beginning to look as if there is an ocean out there, near Neptune, whose water is nitrogen, whose icebergs are methane, and whose continents are ice. It rains nitrogen on the land, and there are rivers, "waterfalls," shock waves and possibly life, too.

Whole new worlds full of unsolved questions and puzzles, unimagined only four years ago, lie in every direction. All of them are fun to think about. Titan, for example, with its possible methane lakes and underground seas of water, might be able to generate life both above and below its surface. What if liquid water leaked to the surface through a wrinkle in the skin? Any Titan "fish" that came up with it would die violently, its blood fizzing from decompression and then freezing solid within a few seconds.

What would happen if a world like Titan fostered intelligent life in both environments? If representatives of each were to meet and shake hands (tentacles?), one would fry, the other would freeze. If, before it died, the fish were to embrace an inhabitant of Titan's surface, the embrace would feel like the touch of molten lead to a surface dweller. The "fish" would seem a bizarre creation—deadly to the touch, living in lava, and turning to stone almost the instant it was exposed to the atmosphere.

Few questions are likely to be answered by the first generation of space probes to land on the ice worlds. And even before the first expeditions, another question looms. What kind of probe do you send to an ice world? The answer depends, in part, on which world you want to explore first. I'm something of a Titan lover. But brainstorming sessions at the Jet Propulsion Laboratory in Pasadena, California, have focused on Europa, mainly because there are places in its crust where the ice looks thin enough to cut through. One session generated close to 110 hypothetical mission proposals. One of the more interesting was idea number 59, dropping dolphin astronauts into Europa's seas to search for the local versions of seaweed, fish, or any other life forms—and bringing specimens back to the spaceship. Dolphins would be ideal because of their intelligence and because their sophisticated sonar would let them move with ease through the sunless Europa oceans. It's a good idea in theory. But in practice?

Well, there are difficulties that put the idea at least 40 years beyond our present technological ability. Dolphins must come up for air, of course. Europa, surrounded by a vacuum, has none. Unless there are air pockets under the ice (and we have no way of knowing this until we get there), the dolphins would die. Also we would have to send them in a ship capable of finding a weak spot in the ice. It would have to drill through the crust and, once through, double as a submarine/camper for the dolphins, which would likely be accompanied by humans.

This would all be far from easy. A major

consideration in spacecraft design has always been fuel economy. Yet dolphins need lots of water simply for exercise. You cannot simply keep a dolphin in a bathtub for a three-year space trip. This means we would need at least a dozen of today's shuttle flights just to ferry seawater into space. Then there's the tens of metric tons of extra fuel needed to nudge that mass of water out of Earth orbit and toward Jupiter. Even with nuclear fuels, the ship's enormous mass would present an almost intractable problem.

It would be almost as difficult, however, to send, say, a skeleton crew of four humans. They would also require living space, bulky life support equipment, and roomfuls of food to sustain them for years.

If launching submarines into space sounds a bit odd, how about helicopters for Titan? It is not as crazy as it may seem. Titan, with a favorable combination of low gravity and dense atmosphere, is one of the most accessible bodies in the solar system for exploration by robot spacecraft. A robot helicopter could enter Titan's atmosphere in a protective shell or capsule. With parachutes blooming behind it, the capsule would release a heliprobe within a mile of the ground. Powered by batteries (charged by a small fission reactor) and equipped with stubbier rotor blades than terrestrial helicopters, the heliprobe could have up to half an hour to find a safe landing site. It would remain set in one place for at least a month, performing chemical tests and seismic searches for underground seas. Later we could have the Titan probe take off and do what the Viking was unable to do on Mars: perform a gadabout exploration of the world.

Heliprobes may not be the best approach. In *Science* magazine, planetary scientist Jonathan Lunine and his colleagues at the California Institute of Technology suggested that Titan's seas have evolved slowly from a methane-rich mixture to an ethane-rich one. They envision a cycle in which methane evaporates from the surface, rises into the upper atmosphere, where it is converted by sunlight into ethane, and falls back to the surface—a surface that might be an ocean of liquid natural gas more than a half-mile deep.

Cornell astronomers Dermott and Sagan predict that as Titan orbits Saturn, the tidal bulge of such an ocean, sweeping across the satellite's icy body, has an enormous erosive power. Rising in frightful majesty, sloshing and dragging over headlands and coastal plains with amplitudes as high as a three-story building, the tides of Titan could be powerful enough to wash away whole continents until all that would remain would be a world-encircling ocean of uniform depth. If this is true, then heliprobes are about the most useless things we could send there.

Titan "buoyant stations," proposed by the Jet Propulsion Laboratory Advanced Projects Group, would be far more practical. Group Supervisor Kerry T. Nock explains, "We are studying both hot-air- and gas-filled balloons. Some would carry electric engines to power propellers and would look more like the Goodyear blimp than a balloon. Surface samplers could be lowered from and raised to these stations on tethers."

But if Titan should turn out to be mostly dry land, helicopters would become more adaptable than blimps. Currently, nobody knows how extensive Titan's lakes or seas or oceans are, and there is little point in carrying helicopters or blimps much farther than the preliminary design stage until we know. We must first send an imaging-radar mapper to peer through the orange haze of cloud cover that completely hides Titan's surface. Such a mapping mission could be launched by 1992, making use of off-the-shelf, flight-qualified spare parts from the upcoming *Galileo* probe to Jupiter and from the Venus radar missions.

An atmospheric entry canister might also be included, courtesy of the European Space Agency. Then, some years later, follow-up probes (blimps or helicopters) would arrive. The cost? Spread out over several years, we can know Titan for $3 billion to $5 billion, a fraction of what Americans have been dropping into arcade video games every year.

It would be money well spent. If our own solar system is any indication, ice worlds must be at least five times more common than rocky, earthlike or Mars-like planets. And because rocky worlds seem to be outnumbered by globes of rock and ice, the gravitational resonances, or tugs-of-war, felt by Jupiter's Europa and Saturn's Enceladus may be far more likely to produce earthlike oceans than are rocky planets, which would have to be just the right distance from just the right kind of star and with just the right mass to hold just the right kind of atmosphere.

By contrast, an ice world need not be located any specified distance from a star in order to develop a suitable habitat. Neptune is just as likely a candidate for life as Jupiter is. Even Pluto and its icy moon Charon can no longer be ruled out as sites for life. And if planet formation is a normal by-product of star formation (as seems to be the case), a quick look around the solar system suggests that life could have gotten a start at one time or another near almost any star in the sky.

This being the case, most life in the universe may exist inside ice worlds. We surface dwellers may have become members of a galactic, if not downright freakish, minority. And still, when the question of life off Earth comes up, most of us think of sunlike stars, look for the nearest ones, and then calculate how far away an earthlike world would have to orbit to be neither fried nor frozen, but cooked slowly. We have adopted the patterns of our own world as the standard for all worlds. Now, with the new perspectives Europa and Titan add to our view of the universe, we may have to change our minds. ∞

FILM

CONTINUED FROM PAGE 32

part, vanquishing the foe. Unfortunately, some viruses escape the body's blood-borne defenses by entering nerve cells and finding refuge in nerve endings, or ganglia, where they remain dormant until reactivated by stress, menses, sunlight or fever. Traveling back to the original infection site via the nerve cells, the herpes viruses once again do battle with an immune system that now recognizes and dispatches them even more quickly than before.

Although *The Evasive Invader* reports that herpes is incurable, it does end on an upbeat note. It suggests that recent advances in the field of immunotherapy—the treatment of disease by means of enhancing or stimulating the immune system—may someday produce a medicine that can treat and control the disease and perhaps even reduce the number and severity of recurrences. Coincidentally, NPI has been marketing such a drug abroad for the past 13 years, although the company has yet to gain U.S. Food and Drug Administration (FDA) approval to sell or even advertise it in this country. The drug is isoprinosine, discovered in 1968 by NPI president Dr. Alvin Glasky and Dr. Paul Gordon of the University of Chicago Medical School. Isoprinosine—a combination of inosine, one of the natural purines that helps to build nucleic acid, and a salt, Dip-PAcBA—stimulates the body's immune system to ward off a variety of viral infections, including herpes. Because NPI is prohibited by law from mentioning the drug in the United States, it has instead produced a series of films, including *The Evasive Invader*, to promote the field in which isoprinosine may well be a future star. The films, which cost an average of $175,000 apiece, are financed by NPI public stock and by overseas sales of isoprinosine.

Isoprinosine, under a variety of brand names, is available in 60 countries. More than 250 million doses have been administered with no side effects, save for a harmless and temporary rise in serum uric acid. Although isoprinosine was once facetiously referred to as a drug in search of a disease, it is now being tested in the United States to see whether herpes, as well as AIDS (acquired immune deficiency syndrome), will respond to it. But FDA approval for its use against even one disease is time-consuming and expensive. Glasky estimates that the requisite tests could take up to 15 years and cost $50 million.

In the meantime, those who suffer from herpes will have to wait for the medical field to catch up with them. But they shouldn't fret. As the next installment in its Disease Theater series, NPI is releasing a movie on AIDS. With all this attention focused on AIDS and herpes (as well as recent breakthroughs in the understanding of these diseases), drugs like isoprinosine might be here very soon indeed. These films, then, will take their place on the shelf beside *Mr. Tooth Decay*. ∞

ITSELF SURPRISED

CONTINUED FROM PAGE 51

aren't very nice in case you've never—"

She says she can isolate the brain from the weapons systems," MacFarland replied. "Besides, she says she doesn't think it's a berserker."

"Why not?"

"First, it doesn't conform to any berserker design configurations in our computer's records—"

"Hell! That doesn't prove anything. You know they can customize themselves for different jobs."

Second, she's been on teams that examined wrecked berserkers. She says that this brain is different."

"Well, it's her line of work, and I'm sure she's damned curious, but I don't know. What do you think?"

"We know she's good. That's why they want her on Corlano. Dorphy still thinks that thing could be valuable, and we've got salvage rights. It might be worthwhile to let her dig a little. I'm sure she knows what she's doing."

"Is she handy now?"

"No. She's inside the thing."

"Sounds as if you've got me outvoted already. Tell her to go ahead."

"Okay."

Maybe it was good that he'd resigned his commission, he mused. Decisions were always a problem. Dvorak's dance filled his head, and he pushed everything else away while he finished his coffee.

A long-dormant, deep-buried system was activated within the giant berserker's brain. A flood of data suddenly pulsed through its processing unit. It began preparations to deviate from its course toward Corlano. This was not a fall from virtue but rather a response to a higher purpose.

Who laid the measure of the prey?

With sensitive equipment, Juna tested the compatibilities. She played with transformers and converters to adjust the power levels and cycling, to permit the hookup with the ship's computer. She had blocked every circuit leading from that peculiar brain to the rest of the strange vessel—except for the one leading to its failed power source. The brain's power unit was an extremely simple affair, seemingly designed to function on any radioactive material placed within its small chamber. This chamber contained only heavy, inert elements now. She emptied it and cleaned it, then refilled it from the ship's own stores. She had expected an argument from Wade on this point, but he had only shrugged.

"Just get it over with," he said, "so we can ditch it."

"We won't be ditching it," she said. "It's unique."

"We'll see."

"You're really afraid of it?"

"Yes."

"I've rendered it harmless."

"I don't trust alien artifacts!" he snapped.

She brushed back her frosty hair. "Look. I heard how you lost your commission—taking a berserker-booby-trapped lifeboat aboard ship," she said. "Probably anyone would have done it. You thought you were saving lives."

"I didn't play it by the book," he said, "and it cost lives. I'd been warned, but I did it anyway. This reminds me—"

"This is not a combat zone," she interrupted, "and that thing cannot hurt us. So get on with it!"

She closed a circuit and seated herself before a console.

"This will probably take quite a while," she stated.

"Want some coffee?"

"That would be nice."

The cup went cold, and he brought her another. She ran query after query, probing in a great variety of ways. There was no response. Finally, she sighed, leaned back, and raised the cup.

"It's badly damaged, isn't it?" he said.

She nodded.

"I'm afraid so, but I was hoping that I could still get something out of it—some clue, any clue."

She sipped the coffee.

"Clue?" he said. "To what?"

"What it is, and where it came from. The thing's incredibly old. Any information at all that might have been preserved would be an archaeological treasure."

"I'm sorry," he said. "I wish you had found something."

She had swiveled her chair and was looking down into her cup. He saw the movement first.

"Juna! The screen!"

She turned, spilling coffee in her lap.

"Damn!"

Row after row of incomprehensible symbols were flowing onto the screen.

"What is it?" he asked.

"I don't know," she said.

She leaned forward, forgetting him.

He must have stood there, his back against the bulkhead, watching, for over an hour, fascinated by the configurations upon the screen, by the movements of her long-fingered hands working unsuccessful combinations upon the keyboard. Then he noticed something that she had not, with her attention riveted upon the symbols.

A small, telltale light was burning at the left of the console. He had no idea how long it had been lit.

He moved forward. It was the voice mode indicator. The thing was trying to communicate at more than one level.

"Let's try this," he said.

He reached forward and threw the switch beneath the light.

"What—?"

A genderless voice, talking in clicks and moans, emerged from the speaker. The language was obviously exotic.

"God!" he said. "It is!"

"What is it?" She turned to stare at him. "You understand that language?"

He shook his head.

"I don't understand it, but I think that I recognize it."

"What is it?" she repeated.

"I have to be sure. I'm going to need another console to check this out," he said. "I'm going next door. I'll be back as soon as I have something."

"Well, what do you think it is?"

"I think we are violating a tougher law than the smuggling statutes."

"What?"

"Possession of, and experimentation with, a berserker brain."

"You're wrong," she said.

"We'll see."

She watched him depart. She chewed a thumbnail, a thing she had not done in years. If he were right, it would have to be shut down, sealed off, and turned over to military authorities. On the other hand, she did not believe that he was right.

She reached forward and silenced the distracting voice. She had to hurry now to try something different, to press for a breakthrough before he returned. He seemed too sure of himself. She felt that he might return with something persuasive, even if it were not correct.

So she instructed the ship's computer to teach the captive brain to communicate in a Solarian tongue. Then she fetched herself a fresh cup of coffee and drank it.

More of its alarm systems came on as it advanced. The giant killing machine activated jets to slow its course. The first order to pass through its processor, once the tentative identification had been made, was *Advance warily.*

It maintained the fix on the distant vessel and its smaller companion, but if executed the approach pattern its battle-logic bank indicated. It readied more weapons.

"All right," Wade said later, entering and taking a seat. "I was wrong. It wasn't what I thought."

"Would you at least tell me what you'd suspected?" Juna asked.

He nodded. "I'm no great linguist," he

"The berserker fired its maneuvering jets. How close was too close when you were being wary? It continued to adjust its course. This had to be done just right."

began but I love music I have a very good memory for sounds of all sorts I carry symphonies around in my head I even play several instruments, though it's been a while But memory played a trick on me this time I would have sworn that those sounds were similar to ones I'd heard on those copies of the Carmpan recordings—the fragmentary records we got from them concerning the Builders the nasty race that made the berserkers There are copies in the ship's library and I just listened to some again It'd been years But I was wrong They sound different I'm sure it's not Builder-talk "

"It was my understanding that the berserkers never had the Builders' language code anyhow" she said

"I didn't know that But for some reason I was sure I'd heard something like it on those tapes Funny I wonder what language it does talk?"

"Well, now I've given it the ability to talk to us But it's not too successful at it"

"You instructed it in a Solarian language code?" he asked

"Yes but it just babbles Sounds like Faulkner on a bad day

She threw the voice switch

Prothector vincit damn the torpedoes and flaring suns like eyes three starboard two at zenith—"

She turned it off

"Does it do that in response to queries too?" he asked

"Yes Still I've got some ideas—"

The intercom buzzed He rose and thumbed an acknowledgment "It was Dorphy "Wade we're picking up something odd coming this way" the man said "I think you'd better have a look

"Right," he answered "I'm on my way Excuse me Juna

She did not reply She was studying new combinations on the screen

"Moving to intersect our course Coming fast" Dorphy said

Wade studied the screen punched up data which appeared as a legend to the lower right

"Lots of mass there" he observed

"What do you think it is?"

"You say it changed course?"

"Yes

"I don't like that

"Too big to be any regular vessel"

"Yes" Wade observed "All of this talk about berserkers might have made me jumpy, but—"

"Yeah That's what I was thinking too "

"Looks big enough to grill a continent"

"Or fry a whole planet I've heard of them in that league "

"But Dorphy, if that's what it is it just doesn't make any sense Something like that, on its way to do a job like that— I can't see it taking time out to chase after us Must be something else "

"What?"

"Don't know "

Dorphy turned away from the screen and licked his lips frown lines appearing between his brows

"I think it is one," he said "If it is what should we do?"

Wade laughed briefly harshly

"Nothing" he said then There is absolutely nothing we could do against a thing like that We can't outrun it and we can't outgun it We're dead it that's what it really is and we're what it wants If that's the case though, I hope it tells us why it's taking the trouble before it destroys us "

"There's nothing at all that I should do?"

"You can send a message to Corlano If it gets through they'll at least have a chance to put whatever they've got on the line This close to their system it can't have any other destination If you've got religion now might be a good time to go into it a little more deeply "

"You defeatist son of a bitch! There must be something else! "

"If you think of it, let me know I'll be up talking to Juna In the meantime, get that

"Wade was shocked at his own answers In his imagined dialogues with death, he'd never seen himself so reckless It's all in not having anything to lose."

message sent"

The berserker fired its maneuvering jets again How close was too close when you were being wary? It continued to adjust its course This had to be done just right New directions kept running through its processor the nearer it got to its goal It had never encountered a situation such as this before But then this was an ancient program that had never before been activated Ordered to train its weapons on the target but forbidden to fire them all because of a little electrical activity

" Probably come for its little buddy " Wade finished

"Berserkers don't have buddies" Juna replied

"I know I'm just being cynical You find anything new?"

"I've been trying various scans to determine the extent of the damage I believe that something like nearly half of its memory has been destroyed "

"Then you'll never get much out of it."

"Maybe Maybe not," she said, and she snitted once

Wade turned toward her and saw that her eyes were moist

"Juna—"

"I'm sorry, damn it It's not like me But to be so close to something like this—and then be blasted by an idiot killing machine right before you find some answers It just isn't fair You got a tissue?"

"Yeah Just a sec "

The intercom buzzed as he was fumbling with a wall dispenser

"Patching in transmission " Dorphy stated

There was a pause and then an unfamiliar voice said "Hello You are the captain of this vessel?"

"Yes I am " Wade replied "And you are a berserker?"

"You may call me that

"What do you want?"

"What are you doing?

"I am conducting a shipping run to Corlano What do you want? "

"I observe that you are conveying an unusual piece of equipment What is it?"

"An air-conditioning unit "

"Do not lie to me captain What is your name?"

"Wade Kelman"

"Do not lie to me Captain Wade Kelman The unit you bear in tandem is not a processor of atmospheric gases How did you acquire it? "

"Bought it at a flea market" Wade stated

"You are lying again, Captain Kelman

"Yes I am Why not? If you are going to kill us, why should I give you the benefit of a straight answer to anything?"

"I have said nothing about killing you

"But that is the only thing you are noted for Why else would you have come by?"

Wade was surprised at his responses In any imagined conversation with death he had never seen himself as being so reckless It's all in not having anything more to lose he decided

"I detect that the unit is in operation," the berserker stated

"So it is

"And what function does the unit perform for you? "

"It performs a variety of functions we find useful" he stated

"I want you to abandon that piece of equipment" the berserker said

"Why should I?" he asked

"I require it "

"I take it that this is a threat?"

"Take it as you would"

"I am not going to abandon it I repeat, why should I?"

"You are placing yourself in a dangerous situation"

"I did not create this situation "

"In a way you did But I can understand your fear It is not without justification "

"If you were simply going to attack us and take it from us, you would already have done so, wouldn't you?"

"That is correct I carry only very heavy armaments for the work in which I am engaged If I were to turn them upon you, you would be reduced to dust This of course

includes the piece of equipment I require

"All the more reason for us to hang onto it as I see it"

"This is logical but you possess an incomplete pattern of facts

What am I missing?"

I have already sent a message requesting the dispatch of smaller units capable of dealing with you

"Then why are you even bothering to tell us all this?

"I tell you this because it will take them some time to reach this place and I would rather be on my way to complete my mission than wait here for them"

"Thank you. But we would rather die later than die now. We'll wait"

You do not understand. I am offering you a chance to live

'What do you propose?

"I want you to abandon that piece of equipment now. You may then depart"

And you will just let us go unmolested?'

"I have the option of categorizing you as goodlife if you will serve me. Abandon the unit and you will be serving me. I will categorize you as goodlife. I will then let you go unmolested

"We have no way of knowing whether you will keep that promise

"That is true. But the alternative is certain death, and if you will but consider my size and the obvious nature of my mission you will realize that your few lives are insignificant beside it."

"You've made your point. But I cannot give you an instant answer. We must consider your proposal at some length

Understandable. I will talk to you again in an hour

The transmission ended. Wade realized he was shaking. He sought a chair and collapsed into it. Juna was staring at him

"Know any good voodoo curses?

She shook her head and smiled fleetingly at him

You handled that very well

'No. It was like following a script. There was nothing else to do. There still isn't"

'At least you got us some time. I wonder why it wants the thing so badly?' Her eyes narrowed then. Her mouth tightened. 'Can you get me the scan on that berserker?' she asked suddenly

"Sure."

He rose and crossed to the console

"I'll just cut over to the other computer and bring it in on this screen"

Moments later a view of the killing machine hovered before them. He punched up the legend, displaying all the specs his ship's scanning equipment had been able to ascertain

She studied the display for perhaps a minute, scrolling the legend. 'It lied.'

"In what respects?" he asked

"Here, here and here," she stated, pointing at features on the face of the berserker. "And here—" She indicated a part of the legend covering arms estimations.

Dorphy and MacFarland entered the cabin while she was talking.

"It lied when it said that it possesses only superior weapons and is in an overkill situation with respect to us. Those look like small weapon mountings."

I don't understand what you're saying."

"It is probably capable of very selective firing—highly accurate, minimally destructive. It should be capable of destroying us with a high probability of leaving the artifact intact."

'Why should it lie?' he asked

"I wonder—' she said, gnawing her thumbnail again.

MacFarland cleared his throat.

"We heard the whole exchange," he began, "and we've been talking it over."

Wade turned his head and regarded him.

'Yes?'

"We think we ought to give it what it wants and run for it."

'You believe that goodlife crap? It'll blast us as we go."

'I don't think so," he said. 'There're plenty of precedents. They do have the option of classifying you that way, and they will make a deal if there's something they really want."

Dorphy," Wade asked, 'did you get that message off to Corlano?

The smaller man nodded.

"Good. If for no other reason, Corlano is why we're going to wait here. It could take a while for those smaller units it was talking about to get here. Every hour we gain in waiting is another hour for them to bolster their defenses."

I can see that—" Dorphy began.

"But there's sure death for us at the end of the waiting," MacFarland continued for him, "and this looks like a genuine way out. I sympathize with Corlano as much as you do, but us dying isn't going to help. You know the place is not strongly defended. Whether we buy them a little extra time or not, they'll still go under."

You don't really know that," Wade said. "Some seemingly weak worlds have beaten off some very heavy attacks in the past. And even the berserker said it—our few lives are insignificant next to an entire inhabited world."

"Well, I'm talking probabilities, and I didn't come in on this venture to be a martyr. I was willing to take my chances with criminal justice, but not with death."

"How do you feel about it, Dorphy?" Wade asked.

Dorphy licked his lips and looked away.

"I'm with MacFarland," he said softly.

Wade turned to Juna.

"I say we wait," she said.

"Well, then that makes two of us," Wade observed.

"She doesn't have a vote," MacFarland stated. "She's just a passenger."

"It's her life, too," Wade answered. 'She has a say."

'She doesn't want to give it that damned machine!" MacFarland shot back. "She wants to sit here and play with it while everything goes up in flames! What's she got to lose? She's dying anyway and—"

Wade snarled and rose to his feet.

"The discussion is ended. We stay.

The vote was a tie—at most."

"I am assuming full command here and I say that's the way it's going to be."

MacFarland laughed.

"Full command!' This is a lousy smuggling run, not the service you got busted out of. Wade. You can't command any—"

Wade hit him, twice in the stomach and a left cross to the jaw.

MacFarland went down, doubled forward and began gasping. Wade regarded him, considered his size. If he gets up within the next ten seconds this is going to be rough, he decided.

But MacFarland raised a hand only to rub his jaw. He said, "Damn!" softly and shook his head to clear it. "You didn't have to do that, Wade."

"I thought I did."

MacFarland shrugged and rose to one knee.

"Okay, you've got your command," he said. "But I still think that you're making a big mistake."

"I'll call you the next time there's something to discuss," Wade told him.

Dorphy reached to help him to his feet, but the larger man shook off his hand.

Wade glanced at Juna. She looked paler than usual, her eyes brighter. She stood before the hatchway to the opened lock as if to defend the passage.

"I'm going to take a shower and lie down," MacFarland said.

'Good."

Juna moved forward as the two men left the room. She took hold of Wade's arm.

"It lied," she said again softly. "Do you understand? It *could* blast us and recover the machine, but it doesn't want to."

No," Wade said. "I don't understand.

It's almost as if it's afraid of the thing.

Berserkers do not know fear."

All right. I was anthropomorphizing. It's as if it were under some constraint regarding it. I think we've got something very special here, something that creates an unusual problem for the berserker."

What could it be?

"I don't know. But there may be some way to find out, if you can just get me

Moments later the killing machine hovered before them. He punched up the legend, displaying all the specs that his scanning equipment had been able to ascertain.

enough time. Stall for as long as you can."

He nodded slowly and seated himself. His heart was racing.

"You said that about half of its memory was shot."

"It's a guess, but yes. And I'm going to try to reconstruct it from what's there."

"How?"

She crossed to the computer.

"I'm going to program this thing for an ultrahigh-speed form of Wiener analysis of what's left in there. It's a powerful nonlinear method for dealing with the very high noise levels we're facing. But it's going to have to make some astronomical computations for a system like this. We'll have to patch in the others, maybe even pull some of the cargo. I don't know how long this is going to take or even if it will really work." She began to sound out of breath. "But we might be able to reconstruct what's missing and restore it. That's why I need all the time you can get me," she finished.

"I'll try. You go ahead. And—"

"I know," she said, coughing. "Thanks."

"I'll bring you something to eat while you work."

"In my cabin," she said, "in the top drawer, bedside table—there are three small bottles of pills. Bring them and some water, instead."

"Right."

He departed. On the way, he stopped in his cabin to fetch a handgun he kept in his dresser, the only weapon aboard the ship. He searched the drawers several times but could not locate it. He cursed softly and went to Juna's cabin for her medicine.

The berserker maintained its distance and speculated while it waited. It had conceded some information in order to explain the proposed tradeoff. Still, it could do no harm to remind Captain Kelman of the seriousness of his position. It might even produce a faster decision. Accordingly, the hydraulics hummed, and surface hatches were opened to extrude additional weapon mounts. Firing pieces were shifted to occupy these and were targeted upon the small vessel. Most were too heavy to take out the ship without damaging its companion. Their mere display, though, might be sufficiently demoralizing.

Wade watched Juna work. While the hatch could be secured, there were several other locations within the ship from which it could be opened remotely. So he had tucked a pry bar behind his belt and kept an eye on the open hatch. It had seemed the most that he could do, short of forcing a confrontation that might go either way.

Periodically, he would throw the voice-mode switch and listen to that thing ramble, sometimes in Solarian, sometimes in the odd alien tongue that still sounded somehow familiar. He mused upon it. Something was trying to surface. She had been right about it, but—

The intercom buzzed. "Dorphy."

"Our hour is up. It wants to talk to you.

again," he said. "Wade. It's pointing more weapons at us."

"Switch it in," he replied. He paused then, "Hello?" he said.

"Captain Kelman. the hour has run out," came the now-familiar voice. "Tell me your decision."

"We have not reached one yet," he answered. "We are divided on this matter. We need more time to discuss it further."

"How much time?"

"I don't know. Several hours at least."

"Very well. I will communicate with you every hour for the next three hours. If you have not reached a decision during that time, I will have to reconsider my offer to categorize you as goodlife."

"We are hurrying," Wade said.

"I will call you in an hour."

"Wade," Dorphy said at transmission's end, "all those new weapons are pointed right at us. I think it's getting ready to blast us if you don't give it what it wants."

"I don't think so," Wade said. "Anyhow, we've got some time now."

"For what? A few hours isn't going to change anything."

"I'll tell you in a few hours," Wade said. "How's MacFarland?"

"He's okay."

"Good."

He broke the connection.

"Hell," he said then.

He wanted a drink, but he didn't want to muddy his thinking. He had been close to something.

He returned to Juna and the console.

"How's it going?" he asked.

"Everything's in place, and I'm running it now," she said.

"How soon till you know whether it's working?"

"Hard to tell."

He threw the voice-mode switch again.

"Qwibbian-qwibbian-kel," it said. "Qwibbian-qwibbian-kel maks qwibbian-qwibbian-kel."

"I wonder what that could mean," he said.

"It's a recurring phrase or word—or whole sentence. A pattern analysis I ran a while back made me think that it might be its name for itself."

"It has a certain lilt to it."

He began humming. Then whistling and tapping his fingers on the side of the console in accompaniment.

"That's it!" he announced suddenly. "It was the right place, but it was the wrong place."

"What?" she asked.

"I have to check to be sure," he said. "Hold the fort. I'll be back."

He hurried off.

"The right place, but the wrong place," emerged from the speaker. "How can that be? Contradiction."

"You're coming together again!" she said.

"I—regain," came the reply after a time.

"Let us talk while the process goes on," she suggested.

"Yes," it answered, and then it lapsed again into rambling amid bursts of static.

Dr. Juna Bayel crouched in the lavatory cubicle and vomited. Afterward, she ground the heels of her hands into her eye sockets and tried to breathe deeply to overcome the dizziness and the shaking. When her stomach had settled sufficiently she took a double dose of her medicine. It was a risk, but she had no real choice. She could not afford one of her spells now. A heavy dose might head it off. She clenched her teeth and her fists and waited.

Wade Kelman received the berserker's call at the end of the hour and talked it into another hour's grace. The killing machine was much more belligerent this time.

Dorphy radioed the berserker after he heard the latest transmission and offered to make a deal. The berserker accepted immediately.

The berserker retracted all but the four original gun mounts facing the ship. It did not wish to back down even to this extent,

"Wade Kelman received the berserker's call at the end of the hour and talked it into another hour's grace. The killing machine was much more belligerent this time."

but Dorphy's call had given it an appropriate-seeming reason. Actually, it could not dismiss the possibility that showing the additional weapons might have been responsible for the increased electrical activity it now detected. The directive still cautioned wariness and was now indicating nonprovocation as well.

Who hath drawn the circuit for the lion?

"Qwibbian," said the artifact.

Juna sat pale before the console. The past hour had added years to her face. There was fresh grime on her coveralls. When Wade entered he halted and stared.

"What's wrong?" he said. "You look—"

"It's okay."

"No, it isn't. I know you're sick. We're going to have to—"

"It's really okay," she said. "It's passing. Let it be. I'll be all right."

He nodded and advanced again, displaying a small recorder in his left hand.

"I've got it," he said then. "Listen to this."

He turned on the recorder. A series of clicks and moans emerged. It ran for about a quarter-minute and stopped.

"Play it again, Wade," she said, and she smiled at him weakly as she threw the voice-mode switch.

He complied.

"Translate," she said when it was over.

"Take the—untranslatable—to the—untranslatable—and transform it upward," came the voice of the artifact through the speaker.

"Thanks," she said. "You were right."

"You know where I found it?" he asked.

"On the Carmpan tapes."

"Yes, but it's not Builder talk."

"I know that."

"And you also know what it is?"

She nodded. "It is the language spoken by the Builders' enemies—the Red Race—against whom the berserkers were unleashed. There is a little segment showing the round red people shouting a slogan or a prayer or something. Maybe it's even a Builder propaganda tape. It came from that, didn't it?"

"Yes. How did you know?"

She patted the console.

"Qwib qwib here is getting back on his mental feet. He's even helping now. He's very good at self-repair now that the process has been initiated. We have been talking for a while, and I'm finally beginning to understand."

She coughed, a deep, racking thing that brought tears to her eyes. "Would you get me a glass of water?"

"Sure."

He crossed the cabin and fetched it.

"We have made an enormously important find," she said as she sipped it. "It was good that the others kept you from cutting it loose."

MacFarland and Dorphy entered the cabin. MacFarland held Wade's pistol and pointed it at him.

"Cut it loose," he said.

"No," Wade answered.

"Then Dorphy will do it while I keep you covered. Suit up, Dorphy, and get a torch."

"You don't know what you're doing," Wade said. "Juna was just telling me—"

MacFarland fired. The projectile ricocheted about the cabin, finally dropping to the floor in the far corner.

"Mac, you're crazy!" Wade said. "You could just as easily hit yourself if you do that again."

"Don't move! Okay. That was stupid, but now I know better. The next one goes into your shoulder or your leg. I mean it. You understand?"

"Yes, damn it! But we can't just cut that thing loose now. It's almost repaired, and we know where it's from," Juna says—

"I don't care about any of that. Two-thirds of it belong to Dorphy and me, and we're jettisoning our share right now. If your third goes along, that's tough. The berserker assures us that's all it wants. It'll let us go then. I believe it."

"Look, Mac. Anything a berserker wants that badly is something we shouldn't give it. I think I can talk it into giving us even more time."

MacFarland shook his head.

Dorphy finished suiting up and took a cutting torch from a rack. As he headed for the open lock, Juna said, "Wait. If you cycle the lock you'll cut the cable. It'll sever the connection to Qwib-qwib's brain."

"I'm sorry, doctor," MacFarland said. "But we're in a hurry."

From the console then came the words "Our association is to be terminated?"

"I'm afraid so," she answered. "I am sorry that I could not finish."

"Do not. The process continues. I have assimilated the program and now use it myself. A most useful process."

Dorphy entered the lock.

"I have one question, Juna, before good-bye," it said.

"Yes? What is it?" she asked.

The lock began cycling closed and Dorphy was already raising the torch to burn through the welds.

"My vocabulary is still incomplete. What does *qwibbian* mean in your language?"

The cycling lock struck the cable and severed it as she spoke, so she did not know whether it heard her say the word *berserker*.

Wade and MacFarland both turned.

"What did you say?" Wade asked.

She repeated it.

"You're not making sense," he said. "First you said that it wasn't. Now—"

"Do you want to talk about words or machines?" she asked.

"Go ahead. You talk. I'll listen."

She sighed deeply and took another drink of water.

"I got the story from Qwib-qwib in pieces," she began. "I had to fill in some gaps with conjectures, but everything seemed to follow. Ages ago, the Builders apparently fought a war with the Red Race, who proved tougher than expected. So the Builders hit them with their ultimate weapon—the self-replicating killing machines we call berserkers."

That seems the standard story."

"The Red Race went under," she continued. "They were totally destroyed—but only after a terrific struggle. In the final days of the war, they tried all sorts of things, but by then it was a case of too little, too late. They were overwhelmed. They actually even tried something I had always wondered about—something no Solarian world would now dare to attempt, with all the restrictions on research along those lines, with all the paranoia."

She paused for another sip.

"They built their own berserkers," she went on then, "but not like the originals. They developed a killing machine that would attack only berserkers—an antiberserker berserker—for the defense of their home planet. But there were too few of them. They put them all on the line, around their world, and apparently they did a creditable job—they had something involving short jumps into and out of other spaces going for them. But they were vastly outnumbered in that last great mass attack. Ultimately, all of them fell."

The ship gave a shudder. They turned toward the lock.

"He's cut it loose, whatever it was," MacFarland stated.

"It shouldn't shake the whole ship that way," Wade said.

"It would if it accelerated away the instant it was freed," said Juna.

"But how could it, with all of its control circuits sealed?" Wade asked.

She glanced at the greasy smears on her coveralls.

"I reestablished its circuits when I learned the truth," she told him. "I don't know what percentage of its old efficiency it possesses, but I am certain that it is about to attack the berserker."

The lock cycled open, and Dorphy emerged, began unfastening his suit as it cycled closed behind him.

"We've got to get the hell out of here!" MacFarland cried. "This area is about to become a war zone!"

"You care to do the piloting?" Wade asked him.

Of course not.

"Then give me my gun and get out of my way." He accepted the weapon and headed for the bridge.

For so long as the screens permitted resolution, they watched—the ponderous movements of the giant berserker, the flashes of its energy blasts, the dartings and sudden disappearances and reappearances of its tiny attacker.

Later, some time after the images were lost, a fireball sprang into being against the starry black.

"He got it! He got it! Qwib-qwib got it!" Dorphy cried.

And it probably got him, too," MacFarland remarked. "What do you think, Wade?"

"What I think," Wade replied, "is that I will never have anything to do with either of you ever again."

He rose and left to go and sit with Juna. He took along his recorder and some music. She turned from watching the view on her own screen and smiled weakly as he seated himself beside her bed.

"I'm going to take care of you," he told her, "until you don't need me."

"That would be nice," she said.

Tracking. Tracking. They were coming. Five of them. The big one must have sent for them. Jump behind them and take out the two rear ones before the others realize what is happening. Another jump, hit the port flank and jump again. They've never seen these tactics. Dodge. Fire. Jump. Jump again. Fire. The last one is spinning like a top, trying to anticipate. Hit it. Charge right in. There.

The last qwibbian-qwibbian-kel in the universe departed the battle scene, seeking the raw materials for some fresh repair work. Then, of course, it would need still more for the replications. Who hath drawn the circuits for the lion? ∞

FORUM

CONTINUED FROM PAGE 14

Montclair, New Jersey, and they could make them there, too! I wish that I had patented my design in the third grade.

Gregory Szabo
Monmouth Beach, NJ

Floyd Fogleman and Richard Kline respond: *We were very upset to learn of injuries sustained by David Butz. When a mechanical pilot broke its arms landing a model, it clearly indicated that any full-scale testing should not have been done. We did not recommend that anyone test the wing himself. The article suggested just the opposite. Until NASA evaluates wind-tunnel testing of the wing design, nonprofessional testing is unsafe.*

Stalls are a very important lesson in flight. After all, a landing is nothing more than a controlled stall. Stalls occurring at a reasonable altitude will give the pilot a chance to recover, but if a stall occurs at too low an altitude, the aircraft will most probably crash. Airplanes have been designed to minimize stalls. Aircraft can spin in either direction, but most do have a preferred direction. Some were designed not to spin at all. Some aircraft spin nicely in one direction and go into a flat spin in another. A flat spin is nearly always fatal.

It was not stated that Bernoulli's principle was the only theorem explaining lift. Newton's law of action and reaction is another of the many laws that apply.

We do not believe that there was any intention to imply a cover-up. If Ronald Burt were to examine a recent NASA configuration called the natural laminar flow airfoil, however, he would discover that it has a "hook" on the underside just before the trailing edge. It comes extremely close to resembling our airfoil. Admittedly, it does not have a sharp steplike discontinuity, but it does begin to define a delinite cavity. We are pretty sure that NASA did not put it there for aesthetic reasons.

As Gregory Szabo suggests, it is entirely possible that many people have made paper planes with a steplike discontinuity. Until the introduction of the Kline-Fogleman airplane, however, no one had ever studied the effects of such a discontinuity. In more than 70 years of aviation, no patent had ever been granted on this concept until we applied for ours. ∞

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CONTINUED FROM PAGE 22

scientists have been testing the effects of NER on animals and finding some disturbing results. In the early Seventies Alan Frey, technical director of Randomline Associates in Pennsylvania, found that microwaves somehow made rats uncomfortable. When exposed to the rays, the rats consistently moved to the shielded side of their box. Dr. Rochelle Medici found a more baffling effect. She trained monkeys to press a lever every five seconds, then exposed one group to low levels of nonionizing radiation. After several hours of exposure, the monkeys pressed the bar on the average of about 10 percent too soon. "We saw small, systematic changes," says Medici, who was in charge of the work at UCLA. Something had sped up the monkey's biological clocks.

Since then, scientists have shown more fundamental ways in which NER affects the brain. Researchers have shown that NER temporarily increases the "leakiness" of the membrane that separates the bloodstream from the brain. Others found it reduces the ability of brain cells to hold calcium, a crucial element in the action of nerves. What's strange, says Blackman, is that the effect appears only at certain intensities. Cranking up the power does not automatically increase the effect. "We still don't understand the mechanism or know what the significance is," he says.

Other studies add to the NER mystery. Frey found that by tiddling with the adjustments on a microwave machine, he could stop a frog heart from beating. Swedish researchers found that rabbits raised in NER fields grew to half the size of their nonexposed counterparts. Czerski, of the FDA, recently irradiated hundreds of male mice and then mated them with nonirradiated females. "There was a ninety percent reduction in pregnancy," he says. An electron microscope helped him see why. "We saw chromosomal damage. At higher levels, it led to cell death and sterility."

Some scientists theorize that the shaking of molecules caused by NER changes the way molecules in cell membranes react with those around them. Dr. G. Ross Adey and his colleagues at Loma Linda University, in California, hypothesize that NER interferes with the way calcium binds to the cell surface. Calcium mediates almost all cell communications; the change thus affects the cell's ability to receive chemical messages from other cells. A second change occurs when ripples of energy travel across the cell membrane to the inner surface, where they release enzymes lodged there, disrupting normal cellular functions. So fundamental are these effects, argues Adey, that they explain everything from the ability of NER to promote the healing of broken bones to changes in the biological clock. "There's a private communication going on between cells. We're jamming the way cells send and receive signals."

Another study recently conducted by scientists at the FDA exposed DNA to microwaves. The molecules acted like tiny antennas and absorbed several wavelengths of radiation, depending on the length of the DNA chain. Longer chains absorbed longer wavelengths. Although it's too early to draw conclusions from these results, they could explain how such genetic effects as sterility occur.

Although not all scientists are convinced NER poses a threat to the health of the nation, a growing number do believe that current regulations must be tightened and that new standards should address a wide variety of frequencies, since no two seem to cause exactly the same result.

The proliferation of computers has made the problem even stickier. For several years, office workers have been concerned about apparently high rates of birth defects and miscarriages among some women who work with video-display terminals (VDTs). The National Institute for Occupational Safety and Health (NIOSH) has studied some of these cases, however, and has found no tie-in to nonionizing radiation. In fact, they contend, the radiation from the terminals is almost too low to measure.

Janice Blood, spokesperson for 9 to 5, The National Association for Working Women, contends that this radiation can't be ruled out as a potential risk. "We do know that short-term exposure may not be damaging," she says. "But no one knows what the long-term effects are. The questions should be studied until we have conclusive results." She says manufacturers should be required to shield the back and sides of VDTs and that pregnant women should be allowed to work at other jobs—precautions that several companies and provincial agencies in Canada have adopted. Seven states are now considering bills to authorize new safety standards or studies on VDTs.

More disturbing, however, is the plight of people working with radiation levels known to be hazardous. More than 200,000 workers use radio-frequency heat sealers to bind food packages and other plastics, and they have little or no protection from the rays. Tests with the same radio frequencies have produced alarming results in lab rats. "We produced some pretty extensive birth defects," says Joseph Lary of NIOSH. Lary says the rays are powerful enough to heat the fetus and deform it. Yet there are no mandatory requirements for shielding the machines.

And then there are the hundreds of radar workers who charge that they have contracted cataracts or even cancer from unmonitored levels of nonionizing radiation. What can recent studies tell them? "I don't know," says Zorach Glaser, a senior radiation scientist at the FDA. "The whole situation troubles me."

INCA CHILD

CONTINUED FROM PAGE 59

about their latest discoveries One claims to have found immense ruins almost a city at 14 000 feet Another talks about a fort built on a 17 000 foot peak Not all the ruins are as spectacular as these Nevertheless the Incas chain of open-air sanctuaries was a major feat of mountaineering and organization

If you climb to thirteen hundred feet in the Andes you appreciate the physical stamina needed to climb higher says Reinhard looking a little tired himself after three months of nonstop climbing And then there is the difficulty of building walls staircases and elevated platforms above twenty thousand feet Westerners thought it was a great achievement when climbers in the mid-nineteenth century simply *reached* those heights

To build their Andean adoratories the Incas solved logistical problems that baffled Europeans until 400 years later The Incas built base camps at intervals up the mountains with the final camp only a few hundred meters below the summit Priests probably slept on these peaks worshiping the mountains at night or just before sunrise Thus they mastered complex logistics for food firewood and straw bedding Climbers say Inca routes were invariably intelligent and probably mapped out by expert mountaineers

The Incas must have had specialists in mountain climbing as they did in other walks of life Reinhard says Many mountains they climbed were nice volcanoes but even there it s still easy to get into trouble Often you re on incredibly treacherous rocks which are constantly sliding I was recently in an ice fall where there was a fifty fifty chance of getting killed

Reinhard a sinewy man lean and tough from climbing 100 Andean peaks where he has discovered 20 high-altitude ruins in the past three and a half years says that Andean peoples believe he risks a curse by violating their sacred peaks The Incas he points out surmounted a formidable psychological barrier when they scaled those mountains to build their altars and temples They believed the peaks were inhabited by powerful spirits To this day the Incas descendants still believe the peaks will destroy any human interlopers And Reinhard who has been caught on the high peaks in unseasonal blizzards and electrical storms sometimes wonders whether the curse might not be real

Despite the superstitions and difficulties, Andean peoples still climb 16 660 feet to worship mountains In parts of Argentina and Bolivia mountains are still adored as residences of Pacha Mama the Earth Mother Until the Forties all the inhabitants of one Bolivian town routinely climbed to 18 300 feet There with an accompanying band they sang and danced to Pacha Mama and the Virgin Mary indiscriminately A few died of heart attacks but the traditional sacrifice of llamas continued

The real reason for mountain worship is always related to fertility Reinhard explains Fertility means the maintenance and increase of production the main thing is that crops aren t destroyed

The arid Andean ecosystem is terribly fragile for farmers who eke out an existence in irrigated valleys subject to drought floods hail and earthquakes—phenomena they believe are controlled by mountain gods Reinhard saw evidence of countless offerings to hills and mountains in the drought-stricken area of Peru Since snow covered mountains are the best Andean water reservoirs the devotion they inspire isn t surprising

Even today human sacrifice is suspected to continue In 1945 one set of Peruvian parents were taken to court for sacrificing their child They basically told the authorities Why the fuss? We ve always done this Over the past few years long lists of missing children have been published in Peruvian newspapers I think a lot of human sacrifice is still going on in the altiplano Reinhard says

I really hate to talk about mountain worship Reinhard continues after talking about it for six hours *Mountain worship* really means traditional Andean worship practiced everywhere from Tierra del Fuego on up It also has a worldwide basis going back some four thousand years to the Rig Veda in India

Maybe it s inevitable that someone like Reinhard who has been scaling mountains for 20 years would interpret everything in terms of mountains just as a paleopathologist sees disease everywhere A broad consensus of scholars however now accepts mountain worship as the fundamental principle of Andean culture

Thirty years work by scientists and CIADAM climbers confirms that high-altitude adoratories are the most spectacular manifestations of this ancient culture But these findings originally inspired by the mummies of Cerro Plomo and Cerro Toro may be secondary to explorers like Beorchia and Reinhard Even if there were no Inca ruins they would find some excuse to keep climbing

I guess I m addicted Reinhard admits When you climb alone at first you don t particularly care for it But after a while you begin to feel—I don t know exactly how to explain this—that things get clarified There s a particularly exciting feeling that you re going back in time You can almost visualize the ceremonies It s strange walking through a door at twenty-two thousand feet You get a weird feeling that you ve climbed up only a few hours after the last Inca priest came down

Like other climbers Reinhard has sensed an invisible presence at high altitudes Unable to explain the sensation scientifically he simply repeats what a man in northern Chile once told him You should know our mountains are alive ∞

EARTH

CONTINUED FROM PAGE 18

breeding animal. That's the risk you take."

Six weeks later, though, Zeya scaled a 15-foot gate to attack Wilson and two other keepers who were cleaning her enclosure. Aspinall shot her that time, with Wilson's body still in her jaws.

Aspinall has had to run for his own life on several occasions, like the time he set off to wrestle with his Himalayan black bears. He had forgotten the keys to their enclosure, so he entered it by jumping over a fence into its dry moat, and he assumed that someone would come along to let him out when he was ready. Unfortunately, the male bear, Esau, was at that moment attempting to mount his mate, Ayesha, who was refusing his advances. Enraged, the frustrated Esau turned and charged the human interloper.

For what seemed like hours to Aspinall (but was probably about 15 minutes), he managed to fend off the bear. First he slipped out of his leather jacket and tossed it to Esau, who ripped it apart. He managed to hide for a while among some trees, and when the animal's attentions were temporarily diverted, Aspinall tried to climb up a concrete wall, but failed. Finally, with Esau about to settle matters, friends heard Aspinall's cries and came to the rescue, making a racket with pans and trash-can lids and scaring away the rampaging bear.

"I had given myself twenty-to-one odds against surviving," Aspinall recalls. But he is willing to take the risk because he feels that his animals are in far worse danger. "In gambler's terms, wildlife has almost no chance," Aspinall says.

A gambler by nature, he attended Oxford but never graduated, served in the Royal Marines for three years, and never held a job in business.

When he launched his gambling career at Oxford in the Forties, he was already a "plunger"—the sort of gambler who bets all or even more than he has. But that penchant rewarded him when two of his race-horse picks came in 20-to-1 and 126-to-1.

In 1952 Aspinall began to buy animals with his winnings from private gambling parties and poker games. In a two-story London garden apartment, he set up house with a tiger, two bears and a black-capped capuchin monkey named Dhedd. In 1956 he paid cash for the eighteenth-century Howlett mansion and its magnificent surrounding estate, with its giant chestnuts, sequoias, cedars, gingkos and oaks, some of them more than 500 years old. There Aspinall made a home for his first gorillas, purchased in 1958, and for a chimpanzee he bought the following year.

In those start-up days, the animals were as likely to be found in the mansion as around the grounds, much to the dismay of two workmen who arrived at Howletts to put up new wallpaper one afternoon. They were directed upstairs but warned not to disturb the sleeping gorillas. "Sure thing," the men laughed. But soon they heard funny noises coming from an adjoining room. Peering in, they found two gorillas staring up at them from under a sheet covered bed. Terrified, the workmen fled, the wallpapering unfinished.

To support his growing menagerie, which soon included wild boars, American bison and Indian deer and antelope, Aspinall opened the Clermont Club, his first casino, in 1962. He sold it ten years later when he bought Port Lympne, but various stock-market losses and the continually rising cost of maintaining a zoo forced Aspinall back into the casino business in 1978.

"I couldn't afford not to own a club," Aspinall says ruefully. The zoos attract only 200,000 visitors a year, enough to pay just half of their $2 million annual operating costs. ("We are a cut above the public taste," he explains. "We attract only the discriminating zoo public.") So Aspinall divides his time among his disparate enterprises, spending four days a week at the casino and long weekends at the zoos. And at the entrance to Aspinall's club in the fashionable Knightsbridge section of London, two carved tigers heads with red eyes ablaze stand as a reminder of why the casino exists.

Expenses run as high as the quality of care the animals receive. Aspinall once sent his brother to London to buy fruit for Howletts's apes. The dealer, on learning that the fruit was going to a zoo, offered bruised and spoiled produce at a cut rate. But Aspinall wanted the same quality fruit that the Queen gets at Buckingham Palace. The gorilla's menu includes more than 90 food items, from chocolate bars and custard apples to fresh strawberries and beer. Says Lady Osborne, Aspinall's eighty one-year old mother, "I have often wished that I were a gorilla."

Aspinall swears he would not hesitate to spend $3,000 to send Dhedd, the monkey (his very first acquisition), to the United States for a specialized operation if need be, and he has written odes to well-loved animals that died. The walls of Aspinall's private study are lined with pictures of the deceased Gugis, a dominant male gorilla that turned out to be infertile.

Aspinall does not view his lavish attentions on wildlife as excessive. He hopes to do more to help endangered species and plans to buy perhaps 1,000 acres in the American west to carry on the work begun in England, where both of his zoos are now crammed beyond capacity.

"We are willing to spend millions of pounds to save great art or other artifacts of man," Aspinall says, "but we give nothing at all for nature. We need a reversal of our current value structure in order to see these majestic animals as masterpieces that are worth preserving."

CONTINUED FROM PAGE 82

windmill started after a few days and pumped these organisms up to the fish which ate them, but without destroying the population that was growing exponentially in one compartment. So our fish had a source of tree food that wouldn't have existed if water constantly circulated. Then there would have been continual predation. The pulsing of the wind and the segregating of elements of the ecosystems functioned as two interacting principles.

Omni: How can your ideas help us revamp the center of industry, the city itself?

Todd: Okay, let's start with an existing city. First, I'd like to see greater use of living processes within the city itself. Cities have always tended to be exclusive to humans and pets. Other than parks, there's been a real rejection of nature. The biological knowledge gathered at New Alchemy, on the other hand, shows that while nature can be miniaturized, it has to be whole. To make the city whole so that it can take care of itself, much as the earth does, you've got to link it up to the essential cycles of nature. The first cycle to consider would be the purification cycle. The secret agenda behind this scheme is to purify the water by reinstating the original marsh plants that once flourished where buildings have now displaced them. There are plants that extract toxic materials from the air. Such plants could be used everywhere—inside buildings, on the streets, in workplaces. Another cycle is the food cycle. Foods can be grown in cities and should be grown in cities, because people who grow food in the city just won't tolerate pollution.

Perhaps the most orthodox city agriculture would be greenhouse gardens on the rooftops. But equally challenging is a funny idea I call bus-stop aquaculture. It is possible and cost-effective to grow fish and shellfish in small spaces, using relatively little water. Translucent cylinders of fiberglass seeded with algae and filter-feeding fish could be placed in almost any spot that receives direct sun, from bus stops to street corners. People could make good livings selling the fish.

A third extremely important area is the whole question of wastes. I propose the very radical idea of building a solar sewage wall right through the heart of the neighborhood. The wall—a long, thin, greenhouselike structure filled with a beautiful display of water hyacinths—would run parallel to the sidewalk, shielding pedestrians from cars and the street. Human waste would enter the system, and as it traveled through the chambers, hyacinth roots would filter out all particulate matter. By the time the water had passed through, it would be crystal clear. At the very end of the process, you would zap it with ozone to kill any remaining viruses or pathogens. The result would be the purest drinking water you could find. Finally, you could compost the hyacinths to make fertilizer!

One of our ideas for the Cathedral of St. John the Divine was to produce literally millions of fruit trees, which would be made available to parishioners and would also be used for the reforestation of urban areas. There is no question that everything planted on the street would get vandalized initially. But in their minds, people would start to own the trees and take care of them. And the trees might lead to the protection of the neighborhoods. It might take several waves of trees out in the streets. It would be nice to give or sell peach trees so that the street would accept them when they are bearing fruit. It's harder to violate a peach tree when it has a big peach on it. Steal the peach but not the tree.

Omni: You have another scheme—building lakes throughout the city.

Todd: To set up these lakes, you excavate an area eight feet deep and one block long. I'd like to see one lake about every four blocks, staggered in a pattern that wouldn't screw up the movement of the city. Cafe societies could spring up along the banks. The lakes would serve as gigantic swimming pools; the only life they'd contain would be human. Since the lakes would be heated with solar energy, they'd be warm enough for swimming in the late spring and throughout the fall. In the winter, the lakes would be drained to a few inches in depth. Whenever there was a cooler-than-frost night, a fine mist of water would freeze over it, and you'd have a beautiful rink for ice skating. It would be like Elizabethan England on the Thames.

> *"To regenerate an environment of 10,000 years ago, you need people who can carry out this symphonic ecology. You can't just plant trees and pray to Pan it'll work."*

On the side of the lake exposed to the southern sun would be a channel, perhaps three feet deep. The water would leave one end of the block and be pumped through the channel, which would be covered by a transparent vault. As the water comes through the channel, it gets warmer and warmer, so that by the time it goes out the other end, you've got warmish water. That would give you swimming temperatures in the later spring and throughout the fall. And in the lake there would simply be a wall of photovoltaic cells for solar heating. Every time the sun would shine, the water would pass through the channel, getting warm and being purified.

On cloudy and gloomy days, people are less prone to swim, so there are going to be fewer kids peeing in the water. So it's a perfect connection between the sun and the purifying cycle and the fact that all kids pee in swimming pools. During the summer, the lakes would absorb excess heat, cooling the city. In late fall, they would release that heat to the air, thus warming the surrounding area.

Omni: Any other schemes for the biologically based city of the future?

Todd: Yes. I think it would be good to have fingers of true, unbroken wilderness from the country—say, from the Hudson River Valley—permeating all the way down into the very center of the city, right down to lower Manhattan. These would be like tentacles, so the wildness that makes up our cells, that makes up us, would be reflected in the wildness inherent in nature. The word *wildness* makes most people think of creatures like tarantulas. They don't realize that *wildness* simply means *without domestication*. If we connect, say, a primeval woods from the Hudson to Manhattan by adding strips of soil, we'd create a direct link to all of the creatures that don't come into the city.

Another thing I would do in the city is rethink light from the ground up. Future generations are going to see our notions of light in the twentieth century as savage and cruel. There is nothing in our architecture that allows us to be conscious of the sun's position in the sky or the degree of cloud cover. Yet all other things in nature respond to those elements, as do we whenever we're out in the environment. This is one reason why so many people seek out the wilderness experience. They know deep down they're missing something that the architecture of the city prevents them from getting at. But buildings could be designed with shapes and structures that would reflect some of this, and I know the effect would be powerful, since I myself have slept out under the sky.

Finally, I would design the city to change our notion of school. I didn't like going to school. None of my kids did, either. My youngest daughter, who is now fourteen, hasn't been to school for two years. Our oldest daughter and our son didn't go to school until they went to university. They get a bunch of books, and there were always knowledgeable people coming in and out of this house, and we gave them advice when they needed it.

Omni: Do they feel at a loss because they're not with a peer group?

Todd: No. Susannah, our youngest, is a dancer; she spends three or four hours a day with other people. Anyway, what I'm driving at is light. I cannot be in a building without being sick. That was true in high school, and it's true with my son Jonathan, and it's true with Rebecca, the oldest daughter. Ordinary commercial light makes us sick and gives us headaches. And I feel

funny in department stores. I think we need to have rooms with many different grades of light to reflect different states of being, different environments, and I can apply the concept to education as well.

In the ideal city you might enter, say, a medical center for some kind of checkup. But at that point you may also find yourself in the middle of a farm. The medical center would be inside the farm, and inside the farm, you would have a school. Right now, schools are prisons that reinforce the distinctions between indoor and outdoor, between wildness and domestic. My ideal school within the ideal society is quite a bit different from what exists. I'm putting together millions of known elements that have never been put together, postulating radical combinations and constellations. It's like cooking, you start out with a dish and a few things and end up with a bouillabaisse. A hell of a lot takes place between one and the other.

Omni: Getting back to the schools, theory has it that if you put people in a well-lighted room and eliminate distractions, they'll think and learn more easily.

Todd: Maybe it's just the opposite. If you're in the most natural environment with that bird winking at you, you'll feel so totally comfortable and natural you'll learn more. Moreover, how can you know about old age if there isn't somebody very old on the corner, which may also be your school or the senator's office. Why shouldn't a senator look out from his office and see not another senator but a child? And a bum?

It could be that the story of man's expulsion from the Garden of Eden has deep roots in his relationship to nature. As we weave all the large cycles of the earth back into human culture, Eden will rise up around us again. The need for this deep connection is evident in something as simple as having a pet. The blueprint for human life is so similar to the instructions that compel the rest of earthly life that we are in many ways linked to all the other species. Our need for a dog may actually be the result of an ancient biological memory.

I have the feeling that wherever the forests were protected, wherever peoples were able to live within the complete constellation of light, there were gods. Wherever there was massive environmental destruction and loss of habitat, you start having the monotheistic religions like Islam, Judaism, and Christianity. The seat of monotheism, the Middle East, is a place where the gods have disappeared. As the elements of nature are destroyed, the gods become silent, one by one. For the ancients, the world was alive in a spiritual sense, it still is in places like Bali.

Omni: This connection to nature brings to mind the Gaia hypothesis, which suggests that the earth is a single, thinking being.

Todd: Although the myriad life forms, processes and natural cycles of the earth have been thoroughly studied and documented, the question of a pattern of patterns, or metapattern, that would make the entirety of life comprehensible continues to elude us. The most far-reaching yet credible theory to date comes from the brilliant research of Lynn Margulis, of Boston University, and James Lovelock, an independent British researcher. In their Gaia hypothesis, named after the Greek goddess of the earth, they say that the entire range of living matter on the planet, from whales to viruses and from oaks to algae, could be regarded as a single living being. Earth hangs in the blackness of space like a great, luminous, pulsating cell endowed with powers of maintenance, regulation, and intelligence far beyond those of its constituent parts.

If this hypothesis is proved true, it will erode man's sense that he's separate from and more important than the rest of the world. If we accept Gaia, then destroying the environment would be like cutting a wrist. In a Gaia culture, we would honor the earth just as the early Americans did when they placed rocks on the ground.

"A greenhouse filled with water hyacinths will run parallel to the sidewalk and shield pedestrians from cars. Human wastes will enter the system, the hyacinths will filter out the particulates."

Omni: How do you think that people born and bred on Western culture will come to accept this hypothesis?

Todd: They may have to. Already there's significant evidence to support the idea. For instance, the earth's oxygen level has always provided a habitable environment, despite the odds against it. The sun's output of radiation has increased enormously over the aeons, and such an increase should have altered the level of oxygen. Yet the current oxygen atmosphere has altered very little since the beginning of life. The oxygen level is twenty-one percent right now. If it went down to sixteen percent, combustion couldn't occur, and there would be no fires.

If it went up to twenty-four percent, just three or four percent above where it is now, the planet would spontaneously burst into flame and burn itself out. We've stayed within the habitable range, despite the increase in radiation, because myriad other factors—some might say the forces of Gaia—have come into play. Analysis of atmospheric carbon dioxide and nitrogen reveal planetary self-regulation as well.

Omni: Speaking of stewardship, you've changed the direction of yours. After years of designing model farms and bioshelters at New Alchemy, you've founded an organization called Ocean Arks International, which designs ships for the Third World. Why?

Todd: Whether I liked it or not, I was becoming an entrenched old alchemist, still going into areas that were beautiful but also basically my own. It was time to take greater and more mature risks. I have always felt obliged to test myself in ways I wouldn't think of testing other people. I sensed this many years ago at that festival in Mexico. In Mexico red hair is considered the sign of the devil. Maybe red is a sign of the devil, but another devil, one who has been long enough in exile from a false heaven. Now it's time for him to break the idols and show us ourselves and our planet. Anyway, that sense of being an alien in a culture, yet part of a larger culture, gives me energy to do work that entails risk.

Omni: And you took this sort of risk with Ocean Arks?

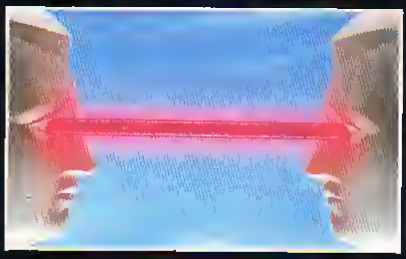
Todd: I saw a tremendous need to help Third World peoples with growing technological problems. What we call a recession in the United States is total tragedy in many parts of the world. The spinoff from First World economies into the backwaters is really devastating.

We have elected to design commercial fishing craft that are sail powered rather than diesel powered. Why? Because throughout the world there are millions of watercraft people who use small boats to get around and do their work, the way we use cars and pickup trucks. Formerly their boats were built of slow-growing, noble woods like mahogany and teak. But most of those trees have been cut down; so in the Fifties, Sixties, and Seventies, these watercraft people began buying steel, and aluminum, and fiberglass boats. They threw their sails away and put outboards or diesels in. That worked all right for a time, but they had to cut the forest down like crazy to pay for the spare parts and the fuel. This forest was their birthright and their only living resource. During the next few years, country after country went bankrupt—a Guyanan dollar buys nothing outside Guyana. Because the debts exceed the gross national product, many countries can't get hard currency. So the boat people have no way to buy fuel or spare parts. Their networks are breaking down.

I knew I couldn't go back to traditional methods. But through my association with marine engineers and naval architects, I realized we could put together three technologies that are just emerging and build high-performance sailing craft using fast-growing, scrubby trees that could be replanted quickly. Ocean Arks is now doing the replanting experiments in Costa Rica and Central America. We plan to take the most advanced epoxy materials and mass-production techniques, deindustrializing as much as possible for a Third World village. We can make high-performance

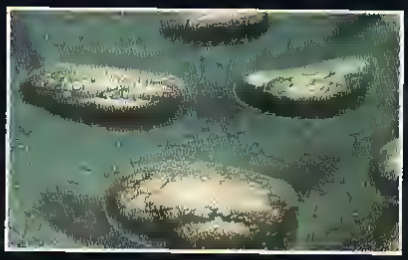
COMING IN THE SEPTEMBER OMNI

TACHYON TALK



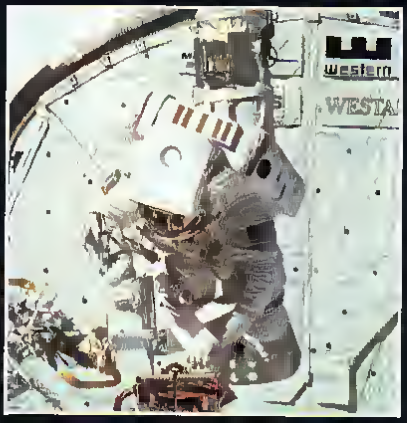
If E.T. had consulted with Earth's leading physicists, he might have discovered a faster, more efficient way to call home. Presently, interstellar communication seems light-years away for human beings, but a new theory has emerged that proposes to attach messages to particles called tachyons. These particles, as yet unseen, are thought to move faster than the speed of light, thus making them, theoretically at least, the perfect medium for communication. Read the September issue of *Omni* to see how tachyons may one day let us phone anywhere in the universe.

FICTION



Adagio, a novelette by Barry Longyear, tells of five people marooned on an asteroid, awaiting a rescue that may never come. *Adagio* demonstrates Longyear's keen perception of the human psyche under stress. On the lighter side, a psychiatrist helps his unusual patient overcome some alarming obsessions in Carol Carr's entertaining short story "Tooth Fairy." And long-time favorite Howard Waldrop returns to the pages of *Omni* with "Flying Saucer Rock and Roll," a tale about the Kool-Tones, an a cappella singing group on their way to making it big, back in the summer of '65.

WALKING IN SPACE



Racing through the blue-black void of space, carried by a $10 million jet-powered backpack, Captain Bruce McCandless soared into history on February 7, 1984, by taking the first untethered walk through space. "That may have been one small step for Neil [Armstrong], but it was a heck of a big leap for me," said the forty-six-year-old astronaut of his heroic stride into the future. Wearing Hamilton Standard/ILC space suits, McCandless and his partner, Lieutenant Colonel Robert Stewart, traveled unrestrained at 4.8 miles per second. These two spacewalks marked the beginning of a new era of extravehicular activity, in which future astronauts could be considered living space stations in orbit. McCandless and Stewart have shown that astronauts can perform tasks without being tied to their vehicles. Don't miss *Omni*'s pictorial in September, displaying NASA's photographs of these adventurous men and their step into the future of space travel.

THREE-MILE CLEANUP

Remote cameras lowered into the interior revealed the awesome truth. The core of the 800-megawatt nuclear reactor was totally destroyed. "We were stunned. It took our breath away," admitted one engineer. Now, after years of scanning and probing the radioactive innards of Three Mile Island, technicians are finally getting ready to start cleaning up the worst mess in the short history of nuclear power. In the September issue of *Omni*, find out how they'll attempt to do this—from assembling a cleanup task force of 10,000 nuclear workers to sending in Red, the Robot.

lightweight, sail-powered working craft that are as fast as the motor boats they're supposed to replace. And they don't require spare parts. We call them Ocean Pick-ups. They are relatively inexpensive, and only ten percent of the materials must be imported. They're analogous to four-wheel-drive pickups. The aerodynamics and hydrodynamics engineered into the Ocean Pick-up are of the caliber of a Concorde or the most advanced jet. The exciting thing is that you can use high-tech information in a rural setting and come up with a really exquisite, usable, nonexploitative solution.

That first Ocean Pick-up was able to carry one and a half tons of fish. Now though, a smaller model has been designed for fishermen who catch less. And larger pickups can go out to sea. In fact, we've already created four and produced some ideas on a fifth, and we hope to start production in places like Costa Rica and Guyana as soon as possible.

Omni: How would you distribute them?

Todd: We're trying to change the rules of the big multinational corporations. Instead of making something somewhere to sell to somebody, we're trying to send the *information* to develop the manufacturing capability. We'd like Ocean Pick-up factories to be indigenously owned. We're also trying to set it up so that boat people begin to see the relationship between these boats, which give them economic freedom, and the need for reforestation. After all, they'll be building the boats with wood that they grow from scratch.

Our Western technology is fascinating to everyone. I'm hoping we can develop as sexy a technology for the Third World as the Western one that doesn't work for them. Everybody likes to roar around on something, whether that means riding a racehorse, a motorcycle or a one ton Ocean Pick-up.

Omni: How do you come by funding?

Todd: Whatever we get comes primarily from small U.S. foundations and the Canadian National Development Agency.

Omni: The government isn't interested?

Todd: The United States Agency for International Development would rather invest in a big industrial process that employs Southern U.S. shipyards that can sell products to the Third World at a profit. A lot of pioneering is very hard. The orthodox channels of support are closed to you.

Omni: Speaking of support, what was your work with Marlon Brando?

Todd: In the winter of 1980, I spent four weeks with him on his island, designing gardens, a waste-treatment plant, a fish farm, and aquaculture networks. The island was to be an example for the rest of the Pacific. We tried not to impose engineering solutions on top of creatures, but to find subtle ecological solutions. Brando had been tracking my work for a number of years, but he hasn't yet decided to get further involved. He is absolutely fascinated by the ideas, but he is frightened of pioneering—of technical failure and its attendant ridicule. In the end, Marlon turned his back on it, despite the fact that one of the Ocean Pick-ups on his atoll could pay for itself in a year. It saddened me, but the project certainly wasn't a waste.

I loved the whole notion of a tropical island, where the scale is so reduced. The alkalinity of the soil doesn't allow vegetables to grow. Islands don't have surface water in most cases. So you change a few things, and you begin to attract pollen, birds, dust. In the Seychelles I built a lake, using a biological seal on porous coral soils. Now birds that have never been seen there before are landing on the islands. It was a real breakthrough in biotechnical restoration. When you get a sense of what could be done, you have to make a start. It's like putting a seed in the ground and seeing it grow.

Omni: What about planting your ideas? Does your radical approach make publication in scientific journals difficult?

Todd: I've never had problems publishing. I've published in all the prestigious journals. But these days, I don't even try to publish scientific papers. The idea of writing a scientific paper that reaches an audience of only a thousand is something I don't have time for. It would be misplaced concreteness. I'm not against it. It's just that there isn't time. I'd much rather produce a sequence of books. Right now I'm thinking about the *Ecological Cookbook*. Turn to page seventeen, put in so many sprinkles of this and dots of that, and end up with a forest. I also want to do one on the Ocean Pick-up that will be equal parts adventure, Third World development and, for want of a better word, *quest*.

Omni: Do you think there is an overriding symbol that pervades our culture?

Todd: Yes: the notion of a rocket leaving the earth and moving into outer space as some kind of transcendence. I would like to propose another kind of symbol—the biological hope ship—in an attempt to bring the power of symbolism back to Earth. We would see the great sailing ships, beautiful things that are also greenhouses and that also function like whales, bringing the sea into them and through them supporting millions of life forms that are also extraordinarily beautiful.

It really doesn't matter whether your work is interstellar communication or trying to restore the ecology of a hillside. The attitude behind the practice is what's important. To view space exploration as the only possible next frontier, with its funding and societal weight being greater, is wrong. Every civilization has a kind of rip-roaring next-frontier sensibility, a sort of what's-next mentality that might be easier for humans than standing in a desert and thinking how to bend the forces of the world to care about restoring land here and now. While this language turns off technologists, most great scientists harbor a sense of the divine. That implies getting your cues from the natural world and not imposing short-term desires on a natural cycle. ☒

CONTINUED FROM PAGE 20

serial killers have been abused as children. But many people warped by childhood abuse simply become criminals, not repeat murderers.

One hypothesis is that at some point in the killer's life, something known as *pairing* occurred, when sexual urges became tied to violent feelings. Burgess is looking for the moment when those violent urges and fantasies turn into a pattern of murder.

"We want to find out: Was there a time when they thought it was *not* okay to murder? And what made them cross the line?" she asks. She feels that once serial killers get away with murder the first time, it becomes easier. "It could be like speeding," she offers. "If you go over fifty-five and don't get caught, you drive at sixty-five until you get a ticket."

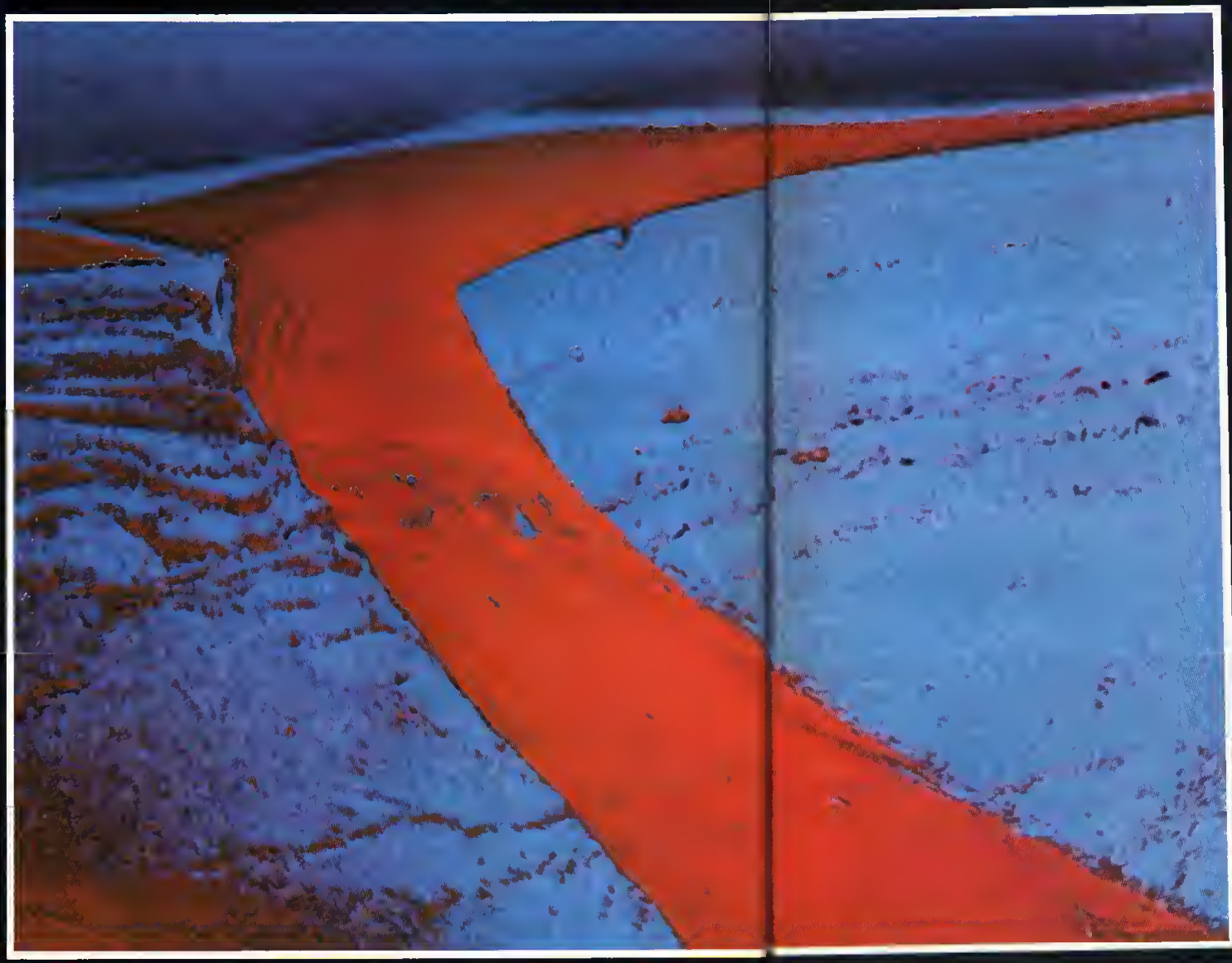
Burgess's team is also studying a factor known as *attributional style*—the way people perceive why things happen to them. "If you have a car accident," Burgess says, "your belief about why it happened tells a lot about you." And among serial killers, one pattern emerges. They often blame the victim. "They will sometimes say, 'If she hadn't screamed....' This puts the final responsibility for death on the victims, as if they somehow deserved it."

These killers, notes Burgess, are unable to put limits on their own homicidal behavior. And it is here that the true compulsive nature of serial murder emerges. Repeating the compulsive behavior gives the individual a sense of relief. And, in a counterintuitive twist, the killer sees the act of murder as the ultimate means of control. Committing a murder may give a serial killer the sensation that he is conquering his murderous drive.

In time the source of gratification may shift from the reward of committing the crime to the reward of getting away with it and playing a game with the authorities. "My hunch is that the thrill of beating the police and the FBI becomes a source of excitement for them," says Burgess.

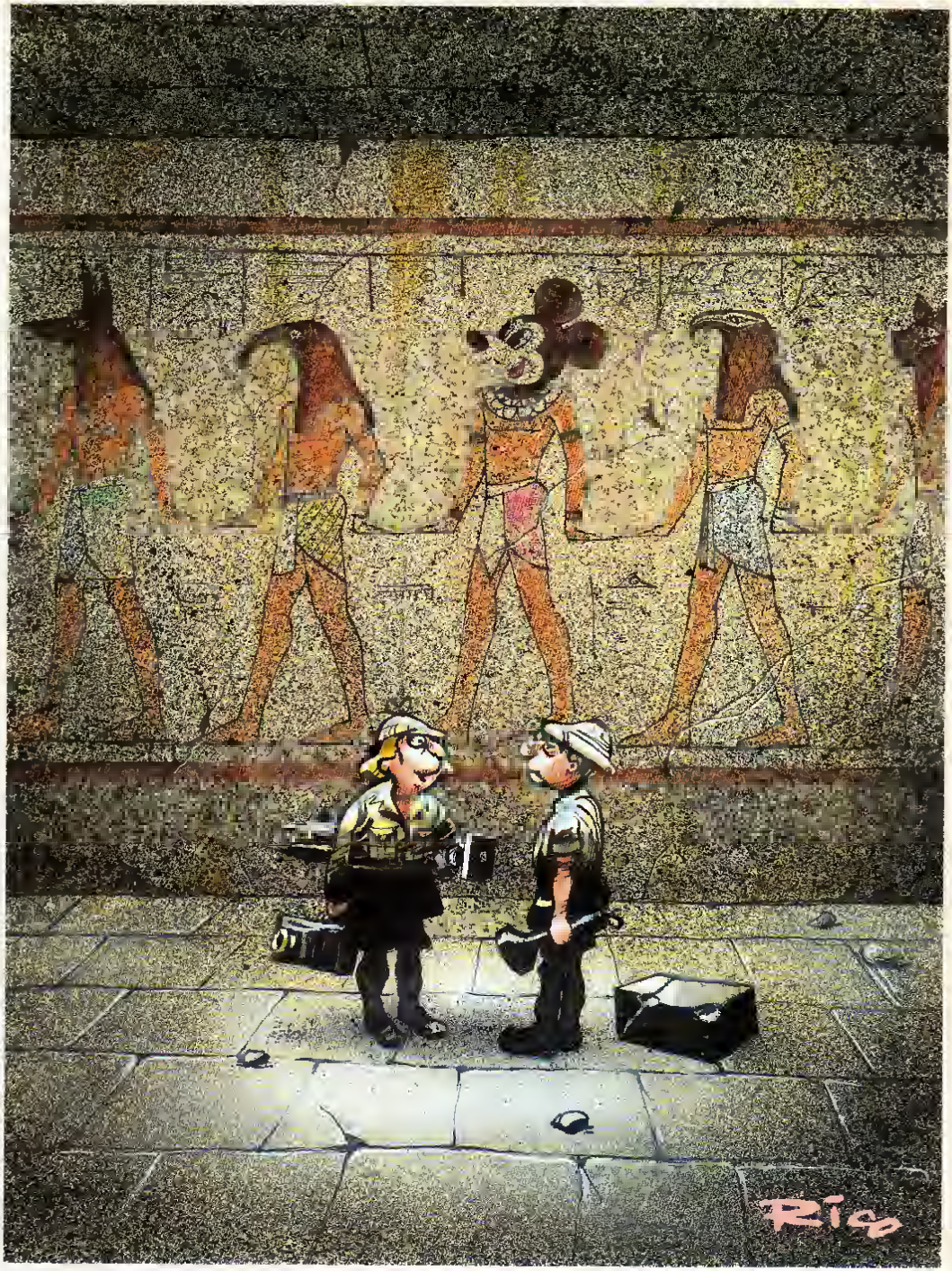
All serial killers have certain lines or routines that they use to lure victims. A serial killer's greatest skill is often his ability to spot someone who will be vulnerable to his kind of manipulation.

Bundy usually chose middle-class educated women as victims. Hillside strangler Bianchi has been described, even by psychiatrists, as "charming." Child murderers may be holding a puppy or kitten and ask the child to help nurse it back to health. "The ones that prey on children are really good," Burgess says. "They know what kids like. It's all premeditated and calculating, very well planned." In the end, serial killers seem to *like* what they do. They choose a goal and systematically pursue it. More than anything else, it is their workaday approach to killing that makes these people so terrifying. ☒



PHENOMENA

A blood-red road no wider than a few microns arches off to a glowing horizon in this photomicrograph of the surface of an amorphous selenium crystal. It was taken by photographer Manfred Kage, who specializes in finding the spectacular in the mundane. Using microscope and camera, he moves across infinitesimal landscapes of organic and inorganic material and records scenes of surreal beauty. In the practical world, amorphous selenium is usually of no particular aesthetic interest. But magnified 80 times, as it is here, it becomes a richly textured microscape with an almost prismatic ability to fracture light into different hues and patterns. Fascinated with the material, Kage did a series of photographic surveys of the material's surface. Each time the image resembled an interplanetary vista. This picture was taken through a scanning microscope with Agfachrome 50L film.



"You're sure Professor? This is really it, the tomb of the loony pharaoh?"

Gyrotoys
Playing with spin

GAMES

By Scot Morris

Frisbees, yo yos diabolos tops—they are all spinning toys that give pleasure while illustrating the curious properties of the gyroscope In the laboratory a gyroscope is serious business But outside in parks and playgrounds all sorts of variations on this scientific tool are found at play

Gyroscopes have two fundamental properties—inertia and precession—that are direct consequences of Newton's laws of motion

Inertia keeps a rotating body turning in a fixed plane so long as no outside force or torque acts upon it A top stays upright while it is spinning until gravity and friction slow it down and cause it to topple over The inertia of gyroscopes has made them indispensable navigational tools for everything from ocean liners to jet planes to guided missiles

When torque is applied to a rotating body the resulting motion is called precession As a child's top spins (in a clockwise direction, say), its axis of spin slowly swings around (also clockwise), defining the surface of a cone This precession results from the torque due to the force of gravity

A motorcycle offers another illustration A rider turns not by rotating the handlebars as on a bicycle, but by leaning in the direction of the turn Leaning to the right not only *tilts* the wheels' axles to the right it makes them precess around their axes of spin, and the wheels *turn* to the right

Inertia and precession in combination can produce some weird effects as in a classic practical joke played by Robert Wood Wood was the Johns Hopkins physicist responsible for exposing the illusory nature of N rays, those imaginary emanations 'discovered' in France shortly after the world learned of the mysterious things called X rays He also produced the clever and timeless children's book *How to Tell the Birds From the Flowers* The story goes that Wood hid a spinning flywheel in a suitcase which he gave to a hotel porter to carry down a corridor to his room Since the wheel was spinning in the same plane as the corridor the porter noticed nothing unusual at first But as he turned to enter the room the bag seemingly possessed remained in the hallway and twisted itself out of the porter's hands The man is said to have run off in fright abandoning the bag any thought of a tip and perhaps some portion of his mental health

Diabolos (top), gyroscope and yo yos (bottom) spinning toys with curious properties

THE FLIGHT OF THE FRISBEE

Frisbees are part wing, part parachute and part gyroscope Their eerily stable flight fascinates most who see it, especially physicists and aerodynamics experts From the moment it leaves a thrower's hand a Frisbee's rate of rotation and forward momentum begins to decrease Why doesn't one or the other of these factors cause the disc to tilt and fall, out of control to the ground?

The discs have been tested countless times in wind tunnels but their aerodynamics still remains mysterious We spoke recently with Ed Headrick, former president of the Frisbee division of Wham-O As far as I can tell," Headrick said "the disc has a center of lift (CL) that changes throughout the flight It seems that the CL starts toward the front then follows an S curve that passes through the disc's center of gravity and ends toward the back, at the very end of the flight Something like that must be happening it seems otherwise the disc wouldn't fly level

Frisbee players develop a gyroscopic intuition in learning the *nail delay* which involves balancing a spinning disc on the end of one fingernail and delaying the moment of final catch The point of contact between nail and disc must move in just the right way to keep the disc level For example if the disc is spinning clockwise as seen from above (a backhand throw from a right-hander), and you touch the underside of the disc at the six o'clock position, it tilts up not at six o'clock but at nine o'clock Precession rotates the disc's axis in the direction of its spin Mastering the nail delay means learning the principles of gyroscopic motion at a muscular level

THE WORLD ON A STRING

During childhood most people played with one form of gyroscope the yo yo

A yo-yo is a toy flywheel—it stores kinetic energy in a rotating mass The looped string that allows a yo-yo to "sleep" is a twentieth century invention but the classic version, with the string fastened to the axle is millennia old Pictures of them from ancient Greece are dated at almost 500 B C Natives of the Philippines claim that the yo-yo originated as a Filipino weapon A hunter holding a heavy flint tied to a long leather strap would sit in a tree and wait for prey If he missed his target the flint would return to his hand for another try But as physicist Wolfgang Bürger points out in a recent issue of *American Scientist* an understanding of yo yo mechanics 'casts serious doubt on this widespread story That's because the thickness of the string causes the radius of the spool to get smaller as the string unwinds A yo-yo reaches its maximum downward velocity about halfway down the string and then its

descent slows A missile that slows down just before it hits its target doesn t do much damage and can t be much of a weapon Burger surmises that the hunters simply tied a stone to a string They could retrieve it by pulling on the string, but the object had no yo yo effect.

Inertia keeps a yo-yo stable, but if it isn't spinning fast enough, the yo-yo begins to tilt to one side of the contact point of the string, and precession causes it to rotate around the vertical axis That ruins the yo yo effect because the toy won't return smoothly to the hand Several methods have been tried to reduce precession, including reducing the size of the axle so the yo-yo spins faster and making the axle more slippery to reduce friction Patrick MacCarthy, of the Colorado School of Mines, has invented a yo-yo that unrolls on a ribbon instead of a string This keeps the axle from tilting, which avoids precession This kind of yo-yo won t 'sleep " but it is very easy to handle MacCarthy tells me he can operate four at a time—two in each hand He also has a patent on a two string yo-yo, on which the two halves spin in opposite directions Precession forces on one side cancel out those on the other and the yo-yo stays stable

The diabolo—or so-called Chinese yo-yo—is a more complicated form of the toy The spinning piece, which often looks like two cones joined at their points is separate from the string, which runs between two sticks held in the hands This makes possible a variety of spectacular tricks in which the diabolo is thrown into the air and caught on the string

TOPSY-TURVY A TOY TO MAKE YOUR HEAD SPIN

The most famous spinning toy of all is the top and the most perplexing version of it is the Tippe Top (upper right) Niels Bohr, the famous nuclear physicist who developed the first quantum model of the hydrogen atom, was entranced by it Its behavior is so paradoxical that whole treatises about it have appeared in *Physica The American Journal of Physics* and other scientific periodicals Physicists are still not in agreement as to how it works

The Tippe Top has a spherical bottom and a stem on its top The surprising thing is that when you spin it on its spherical surface it stays on this side for only a few seconds then turns upside down and spins on its stem This raises the top s center of gravity which would seem to violate the principle of the conservation of energy

You can demonstrate this paradox to yourself with any Tippe Top (they're often given away as advertising premiums) or with any typical high-school or college class ring that has a smooth stone Spin the ring on its stone and in a few seconds the ring will invert itself and spin with the stone facing upward A hard-boiled egg that is spun flat will rise to spin on one end (Spinning an egg is a good way to tell whether it is hard-boiled a fresh egg won't spin because the liquid inside sloshes around too much)

This inversion isn t easy to explain, but various theories—some contradictory some unintelligible and some complete nonsense—have appeared in the journals Jearl Walker, in *Scientific American*, says that the simplest explanation is that the flipover ' arises from friction between the top and the surface on which it spins That is whenever the spin axis tilts away from the vertical the top slides on part of its spherical surface The friction creates a torque that precesses the top to an inversion Even with that explanation this simple toy nevertheless seems to violate common sense

The Tippe Top raises a second paradox that isn t often discussed If the top is spinning clockwise at first as seen from the stem side (above), it will spin *counter-clockwise* as seen from the stem side (below), after the inversion At what point in the whole process does it change direction?

If you could continuously view the flat part of the stem, the top's rotation would be seen to slow down and stop at some point during the inversion and then to start up again in the other direction! It may seem incredible, but it s true

The Tippe Top raises its heavy side up Why?

NO CHEQUE, MATE

As announced in May, the first official attempt to win the *Omni* Levy Prize—a $5 000 cash award for the first computer chess program to beat international chess master David Levy—was held in London in April The prize is still unclaimed In four matches, Levy handily beat the Cray *Blitz* program every time

The Cray can execute 210 million instructions per second (and perform over 1 billion arithmetic operations per second) which makes it the fastest computer on the planet The *Blitz* chess program earned its crown by winning the fourth World Computer Chess Championships in New York last October It has a U S Chess Federation rating of 2158

"We were plagued by mechanical and procedural problems," *Blitz* programmer Robert Hyatt told *Omni* 'We had one person in the room with Levy entering his moves on a terminal I relayed these by telephone to a man at our computer in Mendota, Minnesota, who would then enter the move and tell me the Cray s response With three humans in the loop we were losing over one minute per move In our best games, we played fairly well, but we just ran out of time We had to forfeit two of the matches because we couldn't get the computer working correctly at the appointed hour "

Levy says he is nonetheless impressed with the power of the *Blitz* when it is working and expects that when it expands from 2-processor to 16-processor hardware (as it is supposed to do in about a year), ' theres quite a fair chance that I ll lose The odds will definitely be in the machine's favor ' The *Blitz* people hope that this climactic match will take place in Minnesota with Levy and the machine going head-to-head

LAST WORD

By Randy Cohen

"Why not include a question on fish preference for the Democratic presidential nomination? You know the old saying: As trout go, so goes the nation."

Editors' note: Randy Cohen is a compulsive letter writer and a whimsical seeker of truth. These are actual letters he has written and received.

Margaret M. Heckler
Department of Health and Human Services
Washington, DC 20201

Dear Secretary Heckler:
Is there an official medical term describing that dismal condition when you have a song running through your head all day long and you can't shake it, no matter what you do? It's not *musicosis*, is it? Whatever the technical term for it is, it can drive you crazy, let me tell you. Has this sort of thing ever happened to you?

I'm particularly anxious to learn if your agency knows of a recommended treatment, something like that Heimlich maneuver, for dislodging a melody in your mind. I've had "Rainy Days and Mondays" playing over and over again in my head for the last six weeks, and I can't shake it. I've tried everything I could. I even forced myself to sing "I've Got a Lovely Bunch of Coconuts" about 100 times. It didn't work.

I'm eager to know if your agency can suggest a method of dealing with this mental-health problem. Is there some sort of federal program that might aid me?

Randy Cohen

Dear Mr. Cohen:
Your letter to Secretary Heckler concerning *musicosis* has been referred to the National Institute of Mental Health.

While the problem you describe can be very distressing, it is not at all uncommon. Many of us, at one time or another in our lives, have had the experience of a repetitive phrase, word, scene, or song playing over and over in our minds. The majority of sufferers are able to break the cycle by not focusing on it; they find that it just goes away naturally. Perhaps you are prolonging the problem by consciously forcing yourself to try various remedies to shake it. You may be able to get rid of the melody by not paying it any attention and continuing with your life.

The problem in its most distressing and incapacitating form falls under the category of a personality type that tends to be obsessive-compulsive in nature. There is no simple way, such as the Heimlich maneuver, to deal with the problem except to consult a health or mental-health professional. If you should continue to experience the discomfort of the repetitive melody for a prolonged period of time, we suggest that you see your family physician, who is usually the first health contact for a problem of this sort and can provide references for further assistance. Should you not have a family physician, I am enclosing a listing of mental-health facilities in your state to help you locate a clinic near you. I hope that the suggestions I have provided will lead you to them.

Carrie Lee Rothgeb
Deputy Director
Division of Communications

Henry G. Williams
Commissioner
New York State Department of Environmental Conservation
Albany, New York

Dear Commissioner Williams:
I'm elated with the news that your agency will be conducting the first statewide fish census since 1939. Long overdue! According to some reports, this project will be modeled on the national census and will discover how many fish own TV sets, how many drive to work . . . that sort of thing. Is this true? It sounds a little frivolous to me, but I guess you know what you're up to.

One suggestion: Why not include a question on fish preference for the Democratic presidential nomination? You know the old saying: As trout go, so goes the nation.

Some questions: Will your study be limited to wild fish or will it include domesticated fish? Will I be required to fill out forms with all sorts of minute info on the habits of my tropical fish?

What about privacy? Doesn't that count for anything these days, what with computer crime and all that sort of thing not to mention a rogue FBI on the rampage? I assure you, sir, that when congress established a Federal Bureau of Investigation, it was not their intention that it devote its time to prying into the lives of honest fish.

Randy Cohen

Dear Mr. Cohen:
Commissioner Williams has asked the Division of Fish and Wildlife to respond to your letter about the "fish census".

We assume that what you are referring to is the commissioner's announcement that "Return a Gift to Wildlife" funds would be used to fund the comprehensive biological resurvey of New York's aquatic resources. This will provide comparison with the original New York biological surveys compiled from 1926 to 1939.

While many waters have been resurveyed since 1939, there has not been a complete reassessment of New York's resources.

The first phase of the program will begin in 1983, with the hiring of a project supervisor and staff. It is very likely the survey will continue beyond 1990 to include all the New York watersheds.

Incidentally, your pet tropical fish will not be bothered.

Kenneth F. Wich
Director
Division of Fish and Wildlife