

OMNIBUS

AUGUST 1979 \$2.00

ROBERT A. HEINLEIN:

REFLECTIONS ON
LOVE, RELIGION,
SPACE TRAVEL, AND
HUMAN POTENTIAL

WEEKEND ASTRONAUTS:

THE SLOWEST,
CHEAPEST, AND
MOST BEAUTIFUL
WAY TO FLY

CARL SAGAN:

WHITE DWARFS, LITTLE
GREEN MEN, AND
TALES OF THE ANCIENT
ASTRONAUTS

PLUS:

SILICON VALLEY •
JAWS 2 • UFOs
OVER IRAN • THE
LITTLE SPACE PROBE
THAT COULD

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Cover art for this month's *Omni* is a painting by the English artist Peter Goodfellow, entitled *The Illustrated Man Goodfellow*, who was born in 1950, studied at the Central School of Art in London. His art reflects elements of the surrealist and symbolist schools

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JERRY GREY

Again we've compromised one of mankind's most impressive and most useful advancements in order to save a few bucks up front.

Whatever happened to the Grand Tour of the solar system? Why was Skylab, the only U.S. space station, lost in a fiery descent to Earth? Why are the Canadians, the French, the Germans, the Japanese, and the Russians developing more advanced communications satellites than the Americans, who pioneered space-communication technology? Why is the space shuttle having so many problems?

Because the U.S. space program operates on a shoestring, that's why.

Back in the days of the race to the moon there were virtually no limits on space spending. National prestige was at stake.

But times are different now. The Vietnam War, double-digit inflation, and burgeoning social concerns have generated a major change in public attitudes. Proposition 13 hauls the halls of Congress and the White House. The result? Whatever does get done gets done literally on a shoestring.

Item: The Grand Tour, a remarkable opportunity to swing scientific spacecraft past all the outer planets of the solar system—an opportunity that presents itself only once in centuries—was deemed "too expensive." The recent Voyager flyby of Jupiter, spectacularly successful though it was, could have been the forerunner of equally successful visits to the outer planets; but the Grand Tour mission was delayed out of existence, its "window" foreclosed by the inexorable movement of the planets around the sun.

Item: Skylab plummeted to Earth. There was much furor about the prospective danger of that reentry, but few persons recognized the real tragedy of Skylab's plunge. It signified the loss of the only U.S. space station. What was the reason for failure? In 1969 NASA's recommendation for a permanent manned orbiting station surfaced during the post-Apollo mood of national parsimony. We launched Skylab instead—a lash-up literally thrown together out of hardware left over from the canceled final Apollo missions (albeit with almost wondrous skill and success). The crux of this penny pinching, however, was that it could have been placed in a higher orbit, which would have kept it in space for decades, at a cost (in 1972-73) of only a few hundred thousand dollars.

Item: The United States decided in 1973 that communications-satellite technology was sufficiently well developed to be turned over to industry. Now there's nothing basically wrong with that philosophy. But U.S. industry did not pick up the long-term, high-economic-risk research and development, which is classically the government's role. Foreign

governments, however, jumped in with lots of francs, marks, yen, and rubles. The Carter administration finally recognized the signs—six years late. America is now playing catch-up ball in the only profitable, tax-revenue-producing business in space (item). The much-hyped space shuttle whose first orbital test was originally scheduled for March 1979, will be lucky to get off the ground by March 1980. The same old shoestring philosophy did NASA's again. In 1971 the Office of Management and Budget said, in effect, "You get five billion dollars. That's it. Not a penny more. Go do the best you can."

The result is an ungainly, only partly reusable camel (a horse designed by a committee), lacking the reusable orbital transfer vehicle ("space tug") so critically needed for many of its projected missions. We'll have a shuttle—which is great—but it will be at least a year late (and mission "customers" are already stacked up solid for the first two or three years); it won't be as efficient, reliable, cost-effective, or flexible as it might have been, and it will still cost a billion dollars more than the original shoestring estimate.

Again we've compromised one of mankind's most impressive and most useful advancements in order to save a few bucks up front.

Perhaps the most graphic denunciation of this shortsighted budgetary attitude was offered by Norman Cousins in an address to the American Institute of Aeronautics and Astronautics' annual meeting in Washington last February.

"The world will end neither with a bang nor a whimper, but with the slender cries of little men devoted to cost-benefit ratios. If cost-benefit ratios had governed our history, Socrates would have become a baby-sitter, Newton an apple polisher, Galileo and Giordano Bruno court jesters, Columbus would have taken out a gondola concession in Venice, Thomas Jefferson would have become a tax collector, John Milton would have written *Americus*, and Albert Einstein would have changed his name and stayed in Germany."

Space technology is so valuable—no, too valuable—to our national and global well-being to be developed on a shoestring. The lessons are there to be learned. Let's do it right from now on! **DD**

*Jerry Grey, the administrator of public policy for the American Institute of Aeronautics and Astronautics, is the author of *Enterprise*, a new book that focuses on the space shuttle.*

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OMNIBUS



BYLINSKY



SAGAN



HEINLEIN



LONG

They're calling it the new mecca of high technology, and nothing like it exists anywhere else in the world. Birthplace of electronic games and home computers, of some of the world's most advanced supercomputers, of impressive laser technology, and of machines that can understand human speech and can talk back, Santa Clara Valley has become home to the twentieth century's most daring and innovative explorers. Known familiarly as Silicon Valley, this stretch of land between the Santa Cruz Mountains and San Francisco Bay provides the setting for a technological revolution of startling proportions.

It's where two bright Stanford students, William Hewlett and David Packard, started their company in a one-car garage." says *Fortune* magazine writer Gene Bylinsky. "Hewlett-Packard now employs 42,000 people worldwide, with annual sales approaching \$2 billion."

In "The Wizards of Silicon Valley" (page 54), Bylinsky and coauthor Zheniya Lane profile those scholars and soldiers of fortune who have made Silicon Valley the technological haven it is today. One English-born computer manufacturer says, "The effect on Earth of Silicon Valley will be as dramatic over the next two centuries as the effect of Dr. Louis Leakey's discoveries on the evolution of man."

"Earth was the only choice left," said Dr. Ozmo Zidimdogi, mission director at Thought Propulsion Laboratory (TPL),

about the most recent space probe. "Everything else was too far away and too damned expensive, except maybe the moon. And who wants to go there? We've been there about six times, and it always looks like Winnemucca!"

Because of meager funding, scientists at TPL were forced to scrap their long-established plans for exploring the lesser-known outer planets and concentrate instead on much more "convenient bodies." Despite subtle differences, all the findings concur on one point: There definitely is life on the third planet! Author David Searls provides the humor in "Vagabond" (page 98).

During the past 30 years attempts to protect ourselves from shark attacks have greatly improved. Researchers are becoming more confident that antishark defenses will be both inexpensive and totally effective in the not-too-distant future. Marine specialist Kenneth Jov Rose presents a detailed glimpse of some of these incredible devices in "Shark!" (page 80). The day will soon arrive when you will enter the sea without fear of attack, allowing the shark to play its proper role as merely an animal, with common animal instincts, not the mindless monster we've made it out to be.

Undoubtedly the strongest science-fiction story to come along in a long time, "Sandkings," by George R. R. Martin, will be remembered as one of Omnis's most outstanding works. You won't want to miss this gripping tale of mounting horror and

suspense that's guaranteed to make your flesh crawl. Keep the lights on, the terror starts on page 50.

Crafty, stubborn, quick on the trigger, and "smart" are all outstanding traits of Robert A. Heinlein's memorable character Lazarus Long. Since his first appearance in Heinlein's 1941 novel *Methuselah's Children*, Lazarus Long has become one of science fiction's most popular personalities. We've added color to this venerable character, to form a stunning pictorial—"The Notebooks of Lazarus Long" (page 60).

Besides providing yet another appearance by the ever-popular Orson Scott Card ("Quietus," page 76), this month's fiction offers the versatile John Anthony West ("The Fox and the Hedgehog," page 86), whose works include *Serpent in the Sky: The High Wisdom of Ancient Egypt* (Harper & Row, 1979), a nonfiction novel, and a few works of fiction, *Call Out the Mitts* (E. P. Dutton, 1967) and *Osborne's Army* (William Morrow, 1967). West is currently working on *The Sound of Healing* (Wildwood), a nonfiction work scheduled for 1980 publication in the United Kingdom.

Finally, Carl Sagan contributes an intriguing exposé in "White Dwarfs and Green Men." The astronomer-lecturer examines the ancient-astronaut theories made fashionable by pop archaeologist Erich von Däniken and others, with particular emphasis on the Dogon tribe of Mali. Turn to page 44. **OO**



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LETTERS

COMMUNICATIONS

Worth a Thousand Words

Since the late 1950s and early 1960s the phenomenon of unidentified objects in the sky has progressed from "flying saucers" to UFOs to UFOs (distastefully pronounced you-foes), out of which has developed the study of "ufoology." The mania of the previous decade has been tempered somewhat in the 1970s to the point where more rational approaches are now taken in the investigation of this phenomenon.

The gallery of such photographs earned in your April issue is perhaps the cream of the crop of UFO images, and I was impressed by the fact that they were presented in an objective light and not heralded to be either genuine or fake.

A picture is worth a thousand words, some say, I would submit that in the case of UFOs such is anything but the case.

Much store is placed in photographs—too much. The emphasis placed on a photograph during a UFO investigation is usually blown all out of proportion. In fact, if it cannot be proved that a photo was "doctored" or faked in some way, then it is classed as genuine, and the whole incident gains an almost indisputable credibility. This is akin to saying, "Because the moon covers the sun during a solar eclipse, then it must be the same size. It is all a matter of perspective."

A photograph should be a very weak link in the chain of evidence compiled during a UFO investigation. The more empirical, untakable evidence is the real thing to zero in on during an objective investigation.

Dr. J. Allen Hynek, who is mentioned in the copy accompanying the excellent photo layout, would, I am sure, agree with me on this point about photographs. Indisputable evidence will not be gathered through pretty pictures. Cross correlation and checking out of similarities and differences between cases will provide the best base to work from.

The bottom line is this: Seeing is believing, but a photograph is only as good as the paper it is printed on.

Jon Stone
Nova Scotia, Canada

Brilliant Spider

I have, in the course of a not-too-lengthy but overwhelmingly well-rounded lifetime, indulged myself in absorbing as much printed matter as can possibly be digested. On occasion I have been moved by word or script to thank various contributors to my self-indulgence for doing so brilliantly I do so now, to Spider Robinson, for "God is an Iron" [May 1979].

And, though not at all as an afterthought, to Omni magazine, for consistently making my choice of self-indulgences so delightful.

Jana Elliot
Dallas, Tex

Fearsome Faces

Of all the interviews published in Omni so far, I find E. O. Wilson's certainly the most mind-prodding one, since it deals so directly with all of us [Interview February 1979]. The sociobiological explanation of racism and xenophobia originating from a predisposition to identify with one's own group (or to mistrust strangers) makes much sense. These feelings, be they weak or strong, show up in all societies. A good example is found in that same Omni issue I am referring to: Kenneth Brower's Earth column, in which he expresses his uneasiness at the aspect of Guayaquil's inhabitants. Our "gringo" eyes may find the indigenous faces a little fearsome at first, but to say that they are cutthroats is going too far. I've had nice times with people in southwestern Colombia, who, when I first met them, filled me with doubts. One can't necessarily judge by looks alone.

John E. Lattice
Caracas, Venezuela

News in Dark Cases

Your correspondent R. F. Norman (May 1979) may have been misled by the precise wording of my interview [January 1979]. Nevertheless, the text did contain my comment that Natural Rejection could be called Natural Selection, but that the former name is "more descriptive." When news that live for many generations in dark caves become blind, or CONTINUED ON PAGE 128

FORUM

In which the readers, editors and correspondents discuss topics arising out of Omni and theories and speculation of general interest are brought forth. The views published are not necessarily those of the editors. Letters for publication should be mailed to Omni Forum, Omni Magazine, 909 Third Avenue, New York, NY 10022.

Ominous Plateau

In his interview with *Omni* [March 1979], Arthur C. Clarke inveighs against the "astrology people" who prophesy global calamity in 1982.

These prophets of doom are not astrologers. They are two Cambridge-trained physicists, John Gribbin and Stephen Plagemann, whose best-selling potboiler *The Jupiter Effect*, exemplifies the kind of irresponsible and fallacious reporting Clarke attributes to the fringe.

The theory advanced by these scientists—that the planets falling within a 60-degree arc on one side of the sun will seriously affect the earth—is not supported by past experience. It is not supported by anything, least of all by astrology.

Clarke's and Frank Kendig's mutual contention that Uri Geller has been discredited is totally unsubstantiated. Geller has been subjected to rigorous scrutiny on three continents, and the findings are conclusive. His abilities are paranormal. Furthermore, professional magicians were indeed called upon to observe Geller for legerdemain and to attempt to duplicate his feats. The magicians were hopelessly outmatched. I refer to Charles Panati's *The Geller Papers* (Houghton Mifflin, 1976) for an objective treatment of this matter.

Both Clarke and Kendig cite magician James Randi as having categorically refuted Geller. I would like to know where this singular fact has been documented. To be sure, Randi is a very efficient mouthpiece for the debunking fraternity, he personally profits from maligning Geller and the entire paranormal population, but his credibility is seriously in doubt.

John Wheeler's recommendation that

parapsychologists be kicked out of the American Association for the Advancement of Science now raises the paranormal debate to an ominous plateau.

By purging science of the parapsychologists, Wheeler is removing the only credible means by which paranormal claims can be effectively investigated.

Brenda Calla Thomas
St. Paul, Minn.

Computer Warriors

I was fascinated and distressed by Jonathan V. Post's article "Cybernetic War" [May 1979]. The technology represented exemplifies modern science's most fantastic achievements in recent history: computers, lasers, nuclear physics, etc. But these achievements are overshadowed by militaristic implications. It is unfortunate that as soon as a developing science is recognized as having military capabilities, it is clothed in secrecy in the name of "national security."

The advent of ever more complicated and sophisticated weapons has escalated the arms race to hysterical levels. It has created a vicious circle between the scientists, the military and the paranoid public. Sooner or later we will be forced to take a responsible look at the continuing buildup of arms in the world, before it is too late.

Stuart D. MacDonald
Los Gatos, Calif.

I enjoyed very much the article "Cybernetic War," and I can attest to the fact that the military is steadily becoming more dependent upon computers for our nation's defense.

As Post stated, computers and lasers have their futures inextricably linked, but to say that "lasers can be used directly as weapons" makes me somewhat skeptical. Granted high-energy lasers can vaporize flesh and metal. But it would not take much to render the aggressor's laser totally useless. Any substance that did not absorb the electrons of the laser beam at the specific wavelength in which they were "generated" would be quite safe from such an attack. Furthermore, the energy

required to power such a laser would have to be tremendous. As only 6 percent of a laser's total input can be effectively utilized, that plus the distance the laser beam would have to cover to destroy a target at a safe range would only lessen the effectiveness of that weapon.

As a taxpayer, I hope that the government, for purposes other than navigation tracking and communications, will keep laser technology out of the war field and spend our tax dollars on more worthwhile projects.

STG 3 Alan Majeski
U.S. Navy
San Diego, Calif.

In an article entitled "Cybernetic War," the author, Jonathan V. Post, mentions that scientists in Geneva have recently announced the first containment of antimatter. I have always thought that antimatter was strictly a fictional device used in the television series *Star Trek*. I do not recall ever hearing of such an announcement being made. If this is true, don't you think the majority of your readers would like to hear more about it? I know I would. I was somewhat surprised that in such an article there would be so little mentioned about something so big! *Omni* is the only magazine for which I have stood at the newsstand, waiting every month for each issue to be put on the shelf. Please keep 'em coming.

David G. Morrison
San Francisco, Calif.

One year ago scientists at CERN in Geneva were able to store antimatter for the first time by using a technique called ICE, or stochastic cooling. The system utilized a 2-billion-electron-volt storage ring that contained the antimatter for a period of 85 hours.—Ed.

In his article "Cybernetic War," Jonathan V. Post spoke of the use of antimatter as a weapon and of how it would be controlled. Post spoke of antimatter as one substance that could destroy every type of regular matter. But what he did not mention, and probably did not think of, is that there may

CONTINUED ON PAGE 125

NIGHT OF THE CONDOR

EARTH

By Kenneth Brower

Dr. Carl Koford led the way past tall, gray rows of museum cases, then up a flight of stairs and past more museum cases. We were in a scientific mausoleum—the Museum of Vertebrate Zoology of the University of California at Berkeley—and the navy-gray cases filled the place. The air was cool and smelled faintly of naphthalene. At the far end of the room, bone-white atop the navy gray, too big to fit inside, was the skull of a gray whale. Dr. Koford turned hard right, into an aisle between two navy-gray rows. He did not have to pause to read the number. He knew this aisle by heart.

"You can tell the condor case," he said, nodding upward. "It's the biggest one." He was right. The case labeled "Cathartidae" was twice as long as the others. He reached high to undo the hasps.

Koford is a trim, graying man, retired now, but youthful in his movements and expression. He wore an old red-checked shirt, with frayed holes in one shoulder. His face was pleasantly weathered from a life spent observing animals in the field—*vouhas* in South America, monkeys in Puerto Rico, prairie dogs on the prairie, and, at the beginning of his career, condors in southern California.

He removed the front panel, setting it on the floor. An invisible cloud of naphthalene escaped the case and enveloped us. Inside the case were four horizontal trays, and Koford rolled out the lowest. For an instant I felt like a relative called down to the morgue to identify a cadaver. Clearly though, the corpse on the tray was no kin of mine. The bird was enormous—in life, condors weigh nine kilograms or more—and it lay on its back. There were two others supine behind it. I studied the great hooked beak, designed to tear at carcasses. I ran my finger along a foot, which, uncurled, would have had the span of a human hand. With a fingertip I tested the pinpoint of a talon, designed to hold a carcass down while the beak tore. There were, I knew, only about 30 condors left in the wild. It occurred to me that sometime early in the next century, perhaps sooner, the only California condors on the planet

might lie supine on trays like these.

I read the labels. The condor's scientific names were felicitous. The condor and the other American vultures belong to the family Cathartidae, from the Greek *kathartes*, "a cleanser," from *katharos*, "pure." The etymology recalled the grisly occupation. The vultures are responsible for a catharsis of the landscape. Their job is to take things down to the bone again. The condor's generic name is *Gymnogyps*, its specific name *californianus*. *Gymnogyps* derives from *gymnos*, Greek for "naked," and *gyps*, Greek for "vulture." The condor's head and neck are naked of feathers, an adaptation that allows the bird to clean itself more easily after the gruesome work.

"This one is a juvenile male shot near Pasadena in 1908," Koford said, "tingering a tag tied to the foot." And this one was taken in 1886." He burrowed his fingers into the downy neck of another young bird, as if searching for something there. "This

one is still pretty downy," he said. "It was probably killed the same year it came out of the nest."

He demonstrated how the young bird defends itself in the nest. Putting his head down, he hissed and hit at me awkwardly with his wingtips. Then he looked embarrassed. He had forgotten himself for a moment and had become a condor.

Several detached flight feathers lay at the foot of one bird, and Koford now picked up two of them. "Individual feathers are over twenty-four inches long," he said. Holding a feather in either hand, he extended his arms, pointing the feather tips outward. "The length of the wing bones is about the same as in a human's arms. So this would be the wingspread."

"Eight feet?" I estimated, too quickly.

"Nine," he said. He stood with his wings extended. He had forgotten himself again. For a moment, there in the narrow navy-gray aisle, he soared.

Riding the wind currents above the chaparral-covered California hills, condors make a musical, whistling sound as air splits past their pinions. "As if," Peter Kapten has written, "all the grace and freedom of flight were expressed in a few singing notes."

The distinctive feature of condor flight is high stability in soaring. The condor's "loading"—its ratio of body weight to wing surface—is heavy, nearly twice that of the turkey vulture. Turkey vultures can ascend more quickly, but in any kind of turbulence they wobble markedly by comparison. Soaring on the thermals, condors hold rock-steady. Human observers, even experienced ones, often mistake condors for transport planes, and planes for condors. Condors can soar for an hour without flapping their wings. They can glide for eight minutes or more without turning and can travel about 16 kilometers on one tack.

Gymnogyps is a survivor of an epoch when the scale of life was larger. In the Pleistocene Era condors appear to have been more abundant in North America than black vultures or turkey vultures. The smaller vultures, perhaps, were unable to



One of the last of the California condors.

PLANET OBSOLESCENCE

SPACE

By Mark R. Chartrand III

By the end of next month, much of our information about the planet Saturn will be obsolete. Pioneer 11 will fly past Saturn on September 1, giving us the first-ever close-ups of that unusual gaseous giant.

Not all of our information will be changed. We have long known exactly how much time Saturn takes to go once around the sun (29.46 of our years), how far it is from our system's central star (a mean distance of 1.427 billion kilometers), and that its orbit is slightly elliptical and inclined 2.5 degrees from the earth's orbit. What we will find is unknown, but we hope for detailed views of the planet's "surface"—really the top of Saturn's atmosphere—and of its satellites. We will look for a magnetic field, new rings, and possible new satellites.

Through most of our history Saturn's rings remained unknown, for the eye alone cannot see them. In 1610 Galileo, with his first crude telescope, saw that Saturn seemed to be in three pieces, and he wondered whether the planet had

handles, or "ears." It wasn't until 1655 that Christiaan Huygens saw more clearly with a better instrument, that Saturn had a ring around it. At the same time he discovered Titan, Saturn's largest satellite and the largest moon in the solar system.

More satellites came into view as telescopes were improved. In 1671 Giovanni Domenico Cassini—who moved to the new Paris Observatory and changed his name to Jean-Dominique—found Iapetus, and in the next year he discovered Rhea. In 1675 he found that there was not just one ring, but at least two, separated by a dark gap, which he named Cassini's Division. In 1684 Cassini discovered two more moons, Tethys and Dione.

A century passed before Sir William Herschel found a pair of moons, Mimas and Enceladus. It was Herschel who first measured the planet's rotational speed. Measuring Saturn's speed had proved to be very difficult, because Saturn has no very prominent features that can be tracked as the planet rotates. Herschel

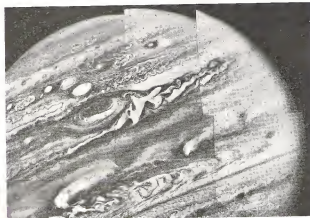
found that Saturn turns in a little more than ten hours, just slightly more slowly than Jupiter. This means that an object on Saturn's equator is traveling 36,900 kilometers an hour, just slightly less than the escape velocity of Earth and a quarter that of Saturn itself.

Another half century went by before George Phillips Bond, an American, found the satellite Hyperion (in 1848), and yet another 50 years passed before William Pickering found the real oddball of Saturn's system, Phoebe. Not only is this satellite much more distant from Saturn than any other, but it is moving counter to all the others, in a retrograde orbit. Until Phoebe's discovery only one other retrograde satellite was known—Titan, of Neptune—and the discovery of Phoebe caused considerable consternation among astronomers. One anonymous astronomer committed his vexation to verse, with a parenthetical addition by the late Donald Menzel, of Harvard

*Phoebe, Phoebe, whirling high
In our neatly plotted sky
Phoebe, listen to my lay,
Won't you swirl the other way?
Never mind what God has said,
We have made a law instead
Have you ever heard of this
Nebular hypothesis?
It prescribes, in terms exact,
Just how every star should act,
Tells each little satellite
Where to go and whirl at night
(Disobedience incurs
Anger of astronomers,
Who—you mustn't think it odd—
Are more finicky than God.)
And so, my dear, you'd better change
Really we can't rearrange
All our charts from Mars to Hebe,
Just to fit a chit like Phoebe.*

Now we know that Saturn has at least 11 satellites. Janus was discovered in 1966, and an unnamed one, the innermost, was found just last year. Pioneer may show us others.

There are some odd things about these satellites. Titan has a thick atmosphere consisting of hydrogen and methane. The



Voyager 1 mosaic of Jupiter foretells the revelations Pioneer 11 will soon send back from Saturn

DEATH RIDDLE

LIFE

By Dr. Bernard Dixon

One year ago this month a minuscule bacillus growing in canned salmon produced a rare tragedy in Great Britain. The immediate result was four serious illnesses, two of them fatal. Over the long term, another dire consequence befell the food company concerned: a \$2-million (approximately \$4-million) shortfall in profits.

The cause of all this, *Clostridium botulinum*, measures 1 micrometer by about 3-4 micrometers (one millionth of a meter), it is not easy to grow even in the laboratory. Yet the accidental contamination that led to its proliferation inside a single can of John West salmon marketed by Unilever, triggered off horrendous infections of a sort that had been unknown in the United Kingdom for at least 20 years. The fatalities and later massive losses in sales provide a grim reminder of the influence of microbes on human affairs.

C. botulinum is not a common cause of human disease, as are typhoid and cholera bacilli and the legions of various bacteria that ravage us from time to time with food poisoning. These malevolent microorganisms are pathogenic by design. Their life-style involves invading our guts, producing disease as they go. *C. botulinum* is feared for its consummate skill in manufacturing the most potent toxin known to mankind. Given the right conditions, it does so in foodstuffs. And the result for anyone ingesting it is sudden, calamitous, and invariably fatal illness.

One peculiarity of this pathogen is that it is an anaerobe. It multiplies only in the absence of oxygen. Otherwise, in the aerated conditions that are necessary for most bacteria to flourish, it merely survives, as a hardy spore, awaiting the next period of oxygen starvation. Bottled or canned food can provide that circumstance. Even if only one tiny spore has escaped sterilization, *C. botulinum* may thrive. By a quirk of biochemistry the bacillus then synthesizes its deadly botulinus toxin. Ten millionths of a gram can kill a person. And the form of death is chillingly abhorrent. The toxin paralyzes nerves of the eye and throat, disabling the

pupils and making speech or even swallowing impossible. Thick, vile saliva interferes with the victim's breathing, and the muscles then weaken, precipitating respiratory paralysis and death by suffocation.

Despite the fact that they received speedy treatment (chiefly huge doses of antitoxin), two of the four persons stricken with botulism in Britain last summer succumbed to the poison. Bacteriologists traced the organism to just one damaged tin from the False Pass Cannery in Alaska. For three months, while investigations were being conducted, Unilever suspended all sales of tinned salmon and recalled products made at the plant. Sales lost then and since slashed the company's profits by an amount comparable with the millions of dollars lost earlier this year when Britain's road-haulage network and docks were immobilized by a lengthy strike of truck drivers.

Thankfully, owing to modern developments in food processing, *C. botulinum* has become a rare and unnatural

scourge of *Homo sapiens*. Yet the same bacterium visits frequent disease upon wildlife. Botulism is the major natural cause of death of ducks in the western United States, for example. The scenario here is interesting. Strong winds wrench aquatic plants adrift, leaving them uprooted along a shore or lakeside. Invertebrates feed on the rotting vegetation, and, as the oxygen level falls, *C. botulinum* begins to multiply in the putrid mass. Ducks consume the infected poisoning material and then die, their bodies becoming riddled by further bacteria, making more poison to perpetuate the outbreak. Flies settle on, and feed off, the decaying carcasses, the flies help to promote the wider spread of disease.

But what is the purpose of this virulent toxin? Unlike snake venoms, it cannot be considered a defensive weapon against predators. Unlike the endotoxins, which are partly responsible for the food poisoning caused by *Salmonella*, it is not part of the structure of the bacterium itself. The toxin plays no apparent role in the internal metabolism of *C. botulinum* if the organism is deprived of its ability to produce toxin, it grows just as well as before.

Although research on the precise mechanisms and molecules involved in microbial disease has burgeoned recently, the purpose of this fiendish poison is still unknown. Its existence is all the more puzzling when we remember that, unlike viruses, many bacteria do not need to cause disease. All viruses are necessarily parasitic, and all are capable of causing disease. This is certainly not true of bacteria, in general, and certainly not true of *C. botulinum*, in particular.

When antibiotics were first discovered, scientists puzzled over their significance. Did bacteria really make such substances so that man could turn them into drugs to treat infections caused by other bacteria? Not at all. We now know that antibiotics play an important role in regulating microbial populations in soil and water. Yet we still do not understand why a humble bacillus, deprived of oxygen, generates a poison more lethal than plutonium. □



Incubators of man's most dreaded microbe

MEAN LITTLE BROTHERS

OFFICIAL CIRCLES

By William K. Stuckey

Few men contrast more sharply in background or appearance than Senator Mark Hatfield, the handsome Baptist college dean and Oregon Republican, and Karl Hess, the writer, welder, and supporter of the Black Panthers, Barry Goldwater, the SDS, the Birchers, Prince Piotr Kropotkin, and the right not to pay federal income taxes.

Under the surface, however, they are not only ideological brothers, but ideological Mean Little Brothers. Hatfield is about the only living politician whom the politics-hating Hess would support for the presidency, and Hatfield notes (seriously?) that he would ring doorbells for Hess. Both believe that individuals can learn and accomplish just about anything they want to and will not only lose ground but slide blissfully toward slavery if they allow any large institution—government, corporation, church, union, etc.—to do the learning and accomplishing for them. They believe, in short, in neighborhood government as a basic governing unit of the United States, and to hell with both public and private Big Brothers.

Hatfield, by far the more mainstream of the two, would pass laws to provide neighborhood independence—allowing taxpayers, for example, to retain up to 80 percent of their federal income taxes to use for local purposes. The free-wheeling Hess would have his small communities declare unilateral independence from Washington by using a combination of science, technology, and town-hall meetings.

Rather radical thinking, until you realize that politicians as diverse as Ronald Reagan and Senator Edward Kennedy—along with Tom Hayden and other elements of the old New Left—have spoken kindly of increasing a neighborhood's independence from government and from corporations by employing "community technology" to fulfill its own survival needs. Note also that a Carter-appointed Presidential Commission on Neighborhoods this past spring reported that the flourishing neighborhood-government movement came into being because of the public's

pervasive frustration with Big Brother government and that it "represents a demand for debureaucratising America."

Community Technology, incidentally, is also the title of Hess's latest book (Harper & Row). Any 1980 presidential candidate who ignores it stands to lose the truly considerable vote of the "Don't Tread on Me's," the national referendum supporters who want not only to send Washington a message but to make it binding, the 1964-is-nearly-here intellectuals, and the Karl Hessian tech-enthusiasts who shout, "I'd rather do it myself." There are a lot of mean little brothers out there. (Prediction: Governor Jerry Brown of California soon will imply that he was the silent coauthor of *Community Technology*. Hess, however, doesn't coauthor anything with anybody.)

Hess not only preaches what I call populistic science; he also practices it. How he drifted into it, what he did with it, and what he is doing now should become one of the great American folktales.

Hess, a Filipino-German, who is as American as Plymouth Rock, was born 56 years ago in the Adams-Morgan

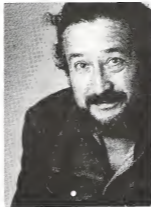
neighborhood of the nation's capital (now predominantly black and Hispanic). His mother taught him how to read—he doesn't believe in schools—and, in short order, he dropped out of high school at fifteen, was a Washington city editor at twenty, and began writing speeches for the Republican party. He capped that career with his 1964 speech for Barry Goldwater, and particularly with that (then) most controversial phrase: "Extremism in defense of liberty is no vice, moderation in pursuit of justice is no virtue."

(In his book *The Dosadi Experiment*, Frank Herbert—author of *Dune*—created a most Hess-like society, the Gowachins, who gave their highest honors to those lawyers who most thoroughly discredited the law.)

Goldwater lost in 1964, and Hess was out of a job. He drove trucks, learned welding, and by the late 1960s was hanging around with the Black Panthers and the Students for a Democratic Society. An astonishing change, observers noted. Not at all, as Hess told me recently over the kitchen table of his self-built solar home in West Virginia.

"The SDS was like Senator Robert A. Taft come to life, a superb organization," he remarked as my jaw unhinged. "They believed in participatory democracy—and that's my passion—and isolationism—they called it anti-imperialism—which is fine with me. As President, I would immediately break relations with all nation-states and establish ties with all neighborhoods on Earth. But I was particularly close to the Panthers, absolutely the best of the black groups. They were straight individualist Republicans in their actions, although their newspaper was bullshit."

Hess drifted back to Adams-Morgan and, with his wife and a physicist friend, began an astounding—and highly successful—experiment in little-brother self-reliance. He became frustrated with New Left partisans who would talk theory into the night but didn't know how to do anything. He wanted to prove that technology was great—not a killer—if you understood and controlled it. He wanted to



Karl Hess, author of *Community Technology*

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THE ARTS

By James Delson

Even before *Star Wars* and 2001, *A Space Odyssey* brought the feeling of space home to Earth. American television audiences had flown to the moon and beyond. They were led into the vast reaches of space by none other than Walt Disney. Disney melded together a variety of diverse scientific and technical elements to present a truly realistic approach to the special effects of space travel. Disney's three-part television series on space, *Man in Space*, *Man and the Moon*, and *Mars and Beyond* presented first in the 1950s, was produced and directed by Disney animator Ward Kimball, with scientific input from Werner von Braun, Willy Ley, Dr. Heinz Haber, and Dr. Ernst Stuhlinger.

Kimball, now retired from the Disney Studio, still runs the only private backyard railroad and model-train museum in the country. He talked recently about the television trilogy and suggested we see the new Disney release, *King Arthur and the Astronaut*.

"George Pal, the creative force behind *Destination Moon* and *The Conquest of Space*, was dealing with science fiction,"

Kimball related. "He took all sorts of liberties with space and even more with things that might happen there. This wasn't a bad thing. Pal made wonderful films, but you had to lose yourself in his logic. It was a different scale. But we dealt in something that was a little more logical, using known facts."

Collier's magazine had run a series dealing with space as the Fifties began, showing what the leading scientists of the time predicted for the future of colonization and travel in space and the military use of space. Disney borrowed both ideas and scientists from the articles to create what was originally planned as a one-shot program, to be called *Rockets and Space*.

"Walt called an initial meeting, at which he said, 'Let's do something following the Collier's articles and Von Braun's theories and so forth.' We came up with a general concept and then filled up the whole room with all the aspects of the intended show, *Rockets and Space*. He looked at all this during the second meeting and said, 'Gee, you've got enough here for two shows.' At our third meeting I said, 'Look, we have this idea of breaking off a third

segment to deal with Mars.' It was coming in very close to the earth at that time, fifty million miles or something. Walt said, 'Yeah, right away!'"

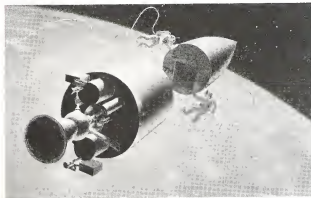
Immersed in his dream of Disneyland at the time, Disney gave Kimball considerably more creative freedom than he would have allowed earlier. "He might have gone for more of a documentary feel, downplaying the fantasy stuff, but he trusted me to do it well," Kimball said. "We didn't know exactly what the state of the art was when we started the picture. We could only get it through Von Braun. At the time he was working on his first satellite, *Explorer 1*. He was doing it almost as a hobby. But to understand the situation, you have to get back to the initial reasons for things."

"The Navy was always fighting the Air Force, which was fighting the Army, and all for prestige reasons. For appropriations. For budgets. The Navy wanted to have the prestige of launching the first satellite, the Vanguard rocket. I don't know how Von Braun felt about it, but we had already developed *Explorer 1*, and the Navy knew he was taking appropriations money to develop his sideline when he was supposed to be working on modernizing and improving the V-2 missiles. But he wasn't interested in killing people. He wanted to take the load in space travel. Well, when people got wind of his satellite work, they told him to stop. He was very bitter about it for a time, because he thought America could have beaten the Russians into space by a year."

"It was our idea to bring Von Braun in as an expert. And he jumped at the chance because he was trying to publicize his idea. Collier's had been the best coverage he'd had, but he realized the potential of television. Millions of people would be looking at a Disney show and with the prestige of the Disney name this would be a big step forward in his campaign to get the Pentagon off their ass and do something about the space program."

2001. *A Space Odyssey* was the first major film to use what is now known as the "hardware" approach to outer space, because of the rough look of the

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A "space walk" as depicted for television, in the Disney production of *Man and the Moon*.

THE ARTS

By James Delson

It's doubtful that many filmgoers have ever stopped to think how important a part science fiction has played in the 17-year, 11-film cycle of films about the world's most famous spy, James Bond. Struck by the glamour, the gunplay, the gimmickry, and the wisecracks, one comes away moved more by the overall effect of the component parts than by any specific element. Under closer examination, however, scientific speculation traces a continuous thread through the series.

Over time there has been a gradual proliferation in Bondian gadgetry as each film attempted to surpass its immediate predecessor in creating newer, better, more original, and, ultimately, more expensive toys to feed the audience's insatiable appetite for electronic complexity. The correlation between elaborate gimmickry as created by the film's special-effects men, and box-office profits has remained constant. More of the former results in more of the latter.

Moving with the times, the Bond pictures have constantly been aimed at the current audience, not the one that went to see the last film. Properly infused with the most current technology and utilizing incredible variations on the matériel of current-day news items (supertankers, moon shots, communications satellites), they have moved ever closer to science fiction as the Cold War has receded from the consciousness of world leaders. Albeit the East-West rivalry of the Fifties dominated Ian Fleming's first few Bond books, the later offerings (both in print and on film) have cast aside the cloak-and-dagger aspects for more colorful, larger-than-life items, most of which are of a scientific provenance. Scientific gadgetry for military or civilian use has been at the core of most Bond films. Dr. No in *Dr. No* misguidedly U.S. missiles, in *Goldfinger* the villain planned to contaminate Fort Knox with a "particularly dirty" bomb, *Thunderball* saw the world held at ransom by those who had "skyjacked" nuclear weapons, both Russian and American astronauts and their craft were "space-jacked" in *You Only*

Live Twice: sophisticated brainwashing techniques were used on daughters of world leaders in *On Her Majesty's Secret Service*; a laser-armed communications satellite was used to threaten the world in *Diamonds Are Forever*, and American, British, and Russian submarines were "sea-jacked" in *The Spy Who Loved Me*. Each subsequent film has been more grotesque, more improbable, and more gimmick-laden than the last, but the saga of James Bond has proved successful for almost two decades.

And now comes *Moonraker*—at \$25 million, the costliest Bond to date. Derek Meddings, one of 1979's Academy Award-winning special-effects men (for *Superman*), was *Moonraker*'s supervisor of special effects, serving on his fourth Bond film. "Of course, I've actually been working on *Superman II* for a while now," Meddings said, "but I suppose it's all right to spend some time making *Moonraker*." We were sitting in the restaurant of the Pinewood film studio, an hour outside of central London. As we talked, well-wishers came up to congratulate Meddings on his



Moonraker, the \$25-million James Bond movie.

recently won Oscar. Quiet, but spirited, he physically resembles the men who sell after-shave lotion in television commercials, his graying hair topping distinguished English features. After he had worked in the film industry nearly all his adult life, and in special effects for over two decades, his greatest creative period began on the Bond series.

"I'd been involved in low-budget films and had graduated to bigger and better pictures, but the Bond films always seemed magical to me. I had thought that someone just sort of pointed his finger and all those things just materialized. Once I started on them, however, I realized that they were just like every other film. Just bloody hard work."

"I started on *Live and Let Die* [1973], which was also the first picture that had Roger Moore as James Bond. Like all Bond films, it was a special-effects man's dream, because essentially people go into cinema houses to see Bond do his stuff, and his stuff is our creation. On *Live and Let Die* we had to really outdo what had been done in the Sean Connery pictures in order to get the audience to accept Roger as James. He had a hell of a task, you know. A hell of a man to follow Sean Connery."

"I always think back to who was Sherlock Holmes and think of Basil Rathbone. Nobody has ever played Holmes as well as he did. He's the one who comes to mind. And the same with poor Roger. He's always got Connery in the shadows. Well, the whole picture was laid out to give Roger a chance to fit into the part. It was like, 'Let's stick him into every possible situation and let him act his way out of it; then, as soon as he's out, get him into another one.' A lot of people have accepted him as Bond now, but this is a matter of opinion."

"On *The Man with the Golden Gun* the script didn't hold together. To me it was one of the worst Bonds, but Christopher Lee was such a stylish villain that the level was brought up."

When *The Spy Who Loved Me* came along, Meddings and the effects team were told, as usual, that it had to beat all

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XEROGRAPHICS

THE ARTS

By Stephen Demorest

They are powerful magic to an artist, these visions that come sliding out of the black box at the press of a button. He casts an image under the spell of three swooping colored lights, and it returns vivid as a dream—textured, richly colored, hallucinated.

Born and bred to be imitative drones for the business world, color-copying machines like 3M Corporation's Color-in-Color and the Xerox 6500 have surprised and captivated their masters with the infinite range of their personalities. After a decade of continuous exploration, new ideas capable of sustaining an artist's relentless addiction to discovery keep floating out of the slot. Thanks to unique assistance from the scientific community, the color copier has become the modern graphic artist's most essential new tool.

"I think the machine is an intimate miracle," says Patrick Firpo, coauthor of *Copy Art*, the first thorough layman's guide to the copy machine. Firpo, who used to stage rock and-roll light shows at New York's Fillmore East, got hooked on copy

art when publishers rejected his proposal for a book of album-cover art but flipped over the quality of his Xerox color samples. "It's really instant gratification, you push a button, and thirty seconds later you see what you've got. Then you can make some changes, push the button again, and out comes a modified version. It's ideal as a fast, inexpensive way to develop themes.

"We've found a lot of artists using copy machines, from Robert Rauschenberg to people just fooling around in Des Moines. Peter Max had a color machine he was using for drawings. Larry Rivers works with multiples. He'll take a sketch and copy it and then color it in fifteen or twenty different ways until he comes up with the combination he wants. I would say any major artist who's had anything to do with printing has at one time or another fooled around with color xerography. If Michelangelo or Leonardo da Vinci had had a Xerox machine, they'd have whaled with it."

Dry copiers are based on an electrophotographic process that was developed in 1938 by Chester Carlson.

Basically, a photoconductive surface is charged with static electricity, which attracts a dry powder. The powder is then transferred to paper or fused to it by heat. Carlson spent ten frustrating years being rebuffed by companies such as IBM, RCA, and Kodak before the Haloid Company agreed to back what it called xerography ("dry writing") and made stock-market history.

It wasn't Xerox, though, but 3M Corporation's Don Conlin and Dr. Douglas Dybvig who came up with the first dry-color machine in 1968. Their Color-in-Color system involves red-, green-, and blue-filtered light exposures that successively zap iron-oxide powder on coated Mylar sheets. This intermediate image conducts heat that causes microencapsulated yellow, magenta, and cyan dyes on the other side to burst, thus printing a multihued blend on the plain paper.

During their investigations, Conlin and Dybvig took the unusual step of consulting a veteran artist, Sonia Landy Sheridan. As a teacher, she has been concerned with a broad range of imaging systems for over 30 years, the past 10 as head of the Generative Systems program at Chicago's School of Art Institute. She seems to have scant respect for those who "don't know more than to press a button" and will patiently lecture you like an old-fashioned schoolmarm on the classic "Meet Mr. Wizard" home-style techniques involving carbon paper, static electricity, and lemon juice.

"We have a program here that's ten years old and that's trained maybe ten thousand people with the help of 3M Corporation. We've set up machines from northern Minnesota to Texas, and our students have taught at UCLA. The young people coming up now have not just discovered this stuff. The teaching has been going on for well over a decade."

Nevertheless, the simplicity of the copy operation encourages anyone coordinated enough to slap a button to try his hand (actually just his finger) at creating "art." Color machines are now available at copy centers in most major cities, and the rates

CONTINUED ON PAGE 133



Jack Kaminsky made Guggenheim by superimposing three blue photos on a color Xerox.



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UFO OVER IRAN

UFO UPDATE

By James Oberg

Nearly three years ago a spectacular UFO appeared in the night sky over Tehran, Iran. In past ages comets were said to foretell the fall of kings. Perhaps in this space-minded era flying saucers fulfill the same function. Turmoil was soon to topple the shah.

The UFO chased by Iranian Air Force F-4 fighters on the night of September 19, 1976, spawned a baffling story, claims of a cover-up by the United States, and a legend that went far beyond the drab facts of the event. Late in 1977 the *National Enquirer* selected the incident as the "most scientifically valuable" UFO case of 1976. A special "blue-ribbon panel" of UFO experts sponsored by the newspaper testified that the Iranian UFO represented a genuinely unexplainable phenomenon.

Skeptics, of course, quickly pointed out that the UFO "experts" had relied principally on a two-page summary prepared by a bored U.S. Air Force officer who had

attended the debriefing of an Iranian F-4 crew and on some news clippings and a few telephone calls. Nobody, it seemed, had actually researched the case. They had merely agreed that it sounded like a good story.

Better yet, considering Iran's political situation, it seemed certain that nobody else would ever be able to investigate the story adequately. Thus, the reported UFO could remain safely unidentified forever. But the mystery of the UFO was due more to the political confusion surrounding the incident than to the details of the case itself.

It certainly sounds like a good story. During the thrilling encounters the Iranian pilots appear to have been in fear for their lives. Earthly explanations seem weak next to human terror.

Shortly after midnight on September 19, 1976, Mehrabad Air Force Base received several phone calls. Some civilians had spotted a bright light in the sky and were

concerned. The officer in charge, Major General Yousefi, went out to see for himself and saw a bright starlike object. (In fact, the planet Jupiter was near its maximum brilliance in the east.) A check with radar at the Babolsar and Shahroki air force bases showed nothing unusual.

But Yousefi, surprised by the brilliance of the light, decided to scramble an F-4 Phantom jet, an extremely unusual event, as most Iranian jet pilots are very inexperienced in nighttime air operations.

UFO investigators have been frustrated because the UFO's direction and the pursuing Phantom's flight path have never been adequately described. Explanations and searches for contradictions in the accounts are therefore fruitless.

According to a debriefing summary given by the U.S. Air Force, this F-4 suddenly experienced a communications blackout and returned to base. Since it had been chasing a UFO, though there is nothing to indicate that it had gotten close, the experts immediately decided that the UFO had caused the blackout.

A second jet had been launched ten minutes after the first. It, too, tried to approach the UFO, which appeared to recede constantly as the pilot, Lieutenant Jafari, approached. (That, incidentally, is exactly how a distant light in the sky would have appeared.) But suddenly the UFO seemed to attack the second F-4.

In the published accounts the pilot reports seeing an object suddenly break away from the main UFO and come at the jet head on. Jafari tried to fire an AIM-9 missile, one of the Sidewinder series, but "his weapons-control panel went off" and froze his attempt. At the same time his communications blacked out.

These reports, based on tape recordings of the air-to-ground communications, were played for newsmen the following day. What is interesting about them is that the account of the failures on the first jet was based on a story told by the second pilot the next day. The tape recordings played for the reporters evidently failed to mention the loss of communications.

The electrical failure on the second jet, however, seems to have been quite real.



UFO flew along a rural road in Diamante Entre Rios, Argentina for a few minutes in July 1976.

The pilot panicked and put his plane into a steep dive as the smaller UFO zoomed right at him, then passed inside his turn and slid back to the original object for "a perfect report."

Such maneuvers are remarkable. If they had taken place as described, however, it would have been even more remarkable for Jafari to see them. In fact, he thought the object was getting closer because it was getting brighter. In a dead-on approach the object would not appear to move in the sky at all. As for the maneuvers seen during the pilot's panicked dive, they seem similar to maneuvers reported by other pilots who, misjudging the range to an unknown light in the night sky, have miscalculated the object's light path.

Based on the information at hand, we just do not know what took place between that jet and the light. We may never know, and this uncertainty must please UFO experts who have been touting the case without ever investigating it.

The story is not over, though. Another object appeared, dropping from the purported mother ship. The F-4 attempted to approach it, and the pilot reported seeing a light on the ground—presumably the one that had dropped from the UFO some minutes earlier. The light dazzled Jafari's eyes, wiping out his night vision.

While returning to the air base, Jafari noticed some radio interference. Later he reported seeing another UFO pass over him. When prompted, ground controllers in the airport tower also saw a light in the sky.

The UFO story was everywhere in the Tehran newspapers for days afterward. Military attachés at the U.S. embassy noted the account, had it translated, and forwarded it to Washington. The Iranians, meanwhile, seemed puzzled. But as time went by they were less and less alarmed. Early in October the shah himself brought up the encounter during a ceremonial visit by American astronauts. They too, were unable to explain it.

The actual event had barely ended when the myths began to grow. First came a story that the U.S. government was trying to hush it up by keeping its files secret—files that were nothing more than translations of Tehran newspaper accounts and an account of the Iranian pilots' debriefing. Later stories told of a humanoid space creature that had attacked local farmers during the dogfight. In St. Louis, Missouri, UFO buffs claimed that the Iranian jet had been kidnapped by the UFO and that the pilot had never been found. The Iranian UFO was well on its way to becoming a classic.

Official sanction of the case came last January 31, when the *National Enquirer* publicized the decision of its experts. The paper gave a check for \$5,000 to the ambassador from Iran at the time, Ardeshir Zafarani, on behalf of the four pilots, an air force general, and an

air-traffic controller. Since the Iranian military personnel were not allowed to accept cash gifts, the money was donated to the Red Lion and Sun, the Iranian equivalent of the Red Cross.

According to Dr. James Harder, professor of civil engineering at the University of California at Berkeley and director of research for the Aerial Phenomena Research Organization, a long-established civilian UFO group, "the case was particularly important, because it provided evidence for long-range jamming of free-control electronics. You can always jam communications, but [the capability] to jam the electronics of free control within the plane is something that has not been firmly established before."

Another panel member, Dr. Frank Salisbury, a plant physiologist at Utah State University, dismissed any possible explanations beforehand: "If a UFO cannot be explained as a natural or psychological phenomenon, hoax, or secret weapon,



UFO above Indonesian waters, 1976

then it's of high interest to scientific UFO investigation. This case meets this criterion. Too many witnesses in highly responsible positions were involved for us to think of hoaxes or hallucinations."

This statement presents a summary judgment. Its list of alternatives is incomplete. And as far as "secret weapons" are concerned, the panel lacked the top-secret Soviet records for that date. Even Iranian and American records were unavailable. That avenue of research is definitely still untrod—and likely to remain so forever.

Harder and Salisbury, along with panel members Dr. John L. Warren, of the Los Alamos Scientific Laboratory, and Dr. Leo Sprinkle, of the University of Wyoming, in Laramie, were evidently convinced that here at last was a UFO case that could not be solved by archskeptical Philip J. Klass. Klass, a Washington-based aviation journalist and author of two books on UFO cases he claims to have solved, has made a habit of investigating the *National*

Enquirer's "best cases" over the years. He has often uncovered information that the pro-UFO investigators had not found or had chosen not to tell the public.

Klass's difficulties in attacking this case were compounded by distance and by the web of military security that had been wrapped around it. The language barrier promised to throw more snafus in his path. In fact, some cynical observers of the strange world of UFOs privately suggested that the Iranian case had been chosen over a hypnotic-regression UFO kidnapping in Kentucky primarily because it would prove impossible to research.

If so, the panel has been partially successful. Klass has not yet issued a full report on his investigation. Recently, though, he told *Ozwa* that he has turned up some very interesting details. "I have talked with several American technical representatives who were in Iran," he recounted. "Two were at Shahrokh. They offered an explanation for the electronic outage experienced by the second F-4." Klass promises to publish his findings in the near future.

The dramatic story of the panicked pilot, Jafari, trying to fire his Sidewinder missile with a frozen weapons-control panel also turned out to have been garbled in the retelling. Experts from the Tactical Air Command told Klass that the weapons panel has nothing to do with the Sidewinder, which is fired from another electrical circuit entirely.

"Most important to me," Klass concluded, "the Iranian Air Force never called in American experts to do a thorough checkout for damage."

In examining this case, Klass noted that fireballs had been seen in the skies over Morocco that same night, and a Portuguese jet liner had reported a bright fireball over the eastern part of the Atlantic Ocean. To some, this suggests that the UFO was streaking westward at high speed. To skeptics, it reveals the existence of a bright meteor shower that could have helped confuse the frightened Iranian pilots.

Because of recent events in Iran, investigations seem to have reached a dead end. But Klass is continuing to search for American engineers who were in Iran at the time. The idea that the "sighting" was really a series of coincidences and panicked misidentifications, while possible, has not yet been established.

Without a thorough investigation, this Iranian case should never have received the official pro-UFO endorsements that it has garnered. Nor should it be so widely lauded as the best proof that UFOs are real. Of course, it could be the best. If there are no better cases to rely on, that in itself would be a harsh indictment of the quality of UFO evidence available today!

Anyone recently returned from Iran who has insights into this case can contact Philip Klass through this column. **CC**

CONTINUUM

COMPUTERS AND CARCINOGENS

Last November a worker at Union Carbide's Texas City, Texas, vinyl chloride plant complained to the Occupational Safety and Health Administration (OSHA) that he and a number of his fellow employees had suffered brain tumors. Two weeks later inspectors from OSHA found that 11 workers did indeed have tumors. A quick check of Monsanto's Texas vinyl chloride plant turned up five more cases.

The workers suspected all along that their jobs were giving them cancer. OSHA's conclusion was more guarded: "The incidence would appear to be higher than expected" and "one of the chemical agents associated with this type of tumor is vinyl-chloride monomer," read the OSHA statement of February 14, 1979.

By this date, however, most of the brain-tumor victims were already dead. A computerized early-warning system might have saved them. Unfortunately, most human carcinogens today are identified only after the workers have died.

"The truth is that we do not know who is exposed to what carcinogens and how much exposure they have," admitted Dr. Marvin Schneiderman, associate director of science policy for the National Cancer Institute (NCI) and former director of SEER (Surveillance, Epidemiology and End Results). SEER was established by NCI in 1973 to obtain information on the incidence of, and mortality from, tumors in the United States. It gets its information from 10 million hospital records. But hospitals often fail to record job histories accurately or completely. "If we were to take those records literally we would believe that all occupations were either 'retired' or 'housewife,'" Dr. Schneiderman said.

The information provided to SEER includes area of residence, site of tumor, condition of the patient, and how the diagnosis was established. But even such meager information can pay off. SEER epidemiologists picked up a high incidence of lung cancer along the southeast coast and in Maine. They placed an industrial map over the area and discovered a concentration of wood-industry facilities. They thought that this was the answer. But when investigators went into the area, they were surprised at what they found. Instead of the wood industry being the common denominator, shipyard work during World War II was. The lung-cancer victims had been employed years before in places where asbestos, a lung carcinogen, had been used.

SEER epidemiological studies have also made correlations

between Sun Belt states and skin cancer, estrogen use and melanoma (a deadly skin cancer), estrogen use and cancer of the uterus, smoking and lung cancer in women, and, for some as yet unexplained reason, a decrease in breast cancer in women under forty years of age.

The information developed by SEER has already saved some lives and could save many more. However, the entire Agency has only 35 workers and a total budget of \$20 million. Compared to the cost of cancer—\$30 billion per year—the amount is ludicrously spare. To be more effective, Schneiderman said, more than ten times the staff would be needed and a reporting system would have to be set up for the entire nation.

SEER personnel, for instance, would like to follow the health records of residents in the area of the nuclear accident at Three Mile Island. The ideal way to do so would be to base records on social security numbers, but federal law states that such numbers may be used only for purposes of social security. Schneiderman has mixed emotions, as do other epidemiologists. If social security numbers or some other effective tracking system were used, would the information gathered then be vulnerable to law enforcement officials, insurance companies, and employers? No one would deny such Big Brother dangers exist. However, safeguards could be established. Epidemiologists could be protected by confidentiality laws, just as doctors, lawyers, and clergymen are. Codes could be used and participants could be given a choice of providing further information or remaining anonymous.

Every primary cancer diagnosed should be reported to a computer facility. Pertinent information, such as current and former places of employment, current and former areas of residence, family medical history, habits, hobbies, and diet, should be included. Impossible? Impractical? Such information already exists about most of us. Credit bureaus and insurance companies base decisions upon such data.

With sufficient information, epidemiologists could pinpoint those cancer-causing agents to which we are exposed, and steps could then be taken to protect us before it is too late. For the vinyl-chloride workers in Texas, the clock ran out.

We have a choice. Risk privacy or risk cancer.

—RUTH WINTER

CONTINUUM

PSORIASIS CURE

If you're one of those unfortunates afflicted with "the heartbreak of psoriasis," there's a new cure. Take a bath in the Dead Sea.

Dr. Willy W. Avrach, director of the Dead Sea International Psoriasis Treatment Center, has found that a month of bath treatments in the fabled body of water is just as effective as traditional hospital therapy, according to the *Journal of the American Medical Association*.

The highly saline waters of the Dead Sea, in combination with ultraviolet rays from sunlight, can clear up the skin disease. And the results are spectacular. Of the 1,631 patients whose data were analyzed by Dr. Avrach, 95 percent showed improvement during the four-week therapy session. Forty-four percent had recurrences within four weeks after the

sessions, but this rate compares favorably with other therapies, which have recurrence rates ranging from 45 percent to 95 percent.

—Joel Davis

FOOD APPEAL

The texture of your food may be more important in appeal than taste. "Foods like potato chips, raw carrots, and nuts are popular because of texture, not because of taste. And some foods, like lettuce, have prominent texture but no taste," explains Dr. Cho-Kun Rha, associate professor of food-process engineering at Massachusetts Institute of Technology. Her present goal is to find foods that might have better structure, or texture, than the real thing.

"Free-water release" (juiciness) is one prime consideration, says Dr. Rha. And a promising material for controlling water release is the cell-wall material of cranberries after their juice has been extracted.

A tiny amount of the cranberry material mixed with water becomes like applesauce. Tasteless, the cranberry cells catch water in tiny sacs, much as juice is encapsulated in fruit cells. "The capsules, with an average diameter of about ten microns, could be layered with protein from soy or corn, and help solve the problem of the 'juicy steak' goal," Rha says. Cranberry-cell walls also offer the prospect of making synthetic fruit or other foods, including "caviar" and food spreads.

—Alton Blakeslee

SF INVENTIONS

Computers, lasers, holograms, test-tube babies, communications satellites—science fiction



Robert Heinlein "invented" *Waldo*, a remote control arm has invented these and many more.

Cleve Cartmill wrote, in a 1944 story called "Deadline," a detailed description of the atomic bomb. Yet neither he nor the rest of humanity then knew about the secret work of the Manhattan Project.

One of the greatest SF writers, Robert Heinlein, predicted correctly a long hiatus in space exploration after people walked on the moon. He also invented, in a 1940s story, the mechanical arm, or *Waldo*, that is used today to move radioactive material.

Space warps, the fictionalized tunnels through the universe, may someday become reality. Scientists have already discovered

black holes, the remains of collapsed stars that suck in all matter and light around them. They have speculated about white holes that spit out matter. Theorists believe that these black and white holes may somehow be connected as tunnels through space and time.

Even SF movies have been prophetic. German filmmaker Fritz Lang wanted to heighten the drama of his 1929 movie, *Woman in the Moon*. So he added a countdown from ten seconds. Later NASA adopted the idea of counting backwards for the space program.

—Kenneth Jon Rose

BEEES AND MELONS

As if producing honey and cross-pollinating flowers weren't enough, bees have now been found to be useful for growing melons. The U.S. Agriculture Department has discovered that placing beehives in cantaloupe fields increases both the size and the number of melons.

Four hives, each containing 30,000 bees, on an Indiana farm caused enough extra pollination to increase the number of melons by 23 percent. In addition, individual melons averaged 10 percent heavier than those in a control group—2.2 kilograms each, instead of 2.0.

Researchers believe that one hive per acre is enough to induce the changes. Already the demand for beehives is up sharply among melon farmers.

—Stuart Diamond



Dead Sea mud bath. The waters may be good for the skin.

OLD CONDUCTORS

There's something healthy about conducting a major symphony orchestra, according to a California

Philharmonic, is now 90.

"I couldn't find a premature death in any of the great conductors," he says.

Not only do leading maestros die at advanced ages,



Igor Stravinsky lived to be 88. Longevity of conductors has been attributed to world recognition and "gratifying stress."

physician and amateur musician Dr. Donald H. Atlas, of the school of medicine at the University of California at San Diego, found that the mean age of death for 35 famous conductors selected at random was 73.4 years.

The life expectancy of the average American male is only 68.5 years.

Some conductors died at very advanced ages, including Leopold Stokowski, at 95; Arturo Toscanini, at 90; Igor Stravinsky, at 88; Walter Damrosch, at 88; and Bruno Walter, at 85. Although no women were in the group studied, Dr. Atlas notes that Nadia Boulanger, the first woman to conduct a full concert of the New York

but they remain productive almost until their death. Atlas believes that the "sense of fulfillment that comes with world recognition" contributes to the longevity of conductors. Stress is often present, but it is "gratifying stress." Atlas discounts the theory that the energetic arm waving of today's conductors provides exercise that prolongs life. The early conductors, he noted, scarcely moved their arms, yet they too, reached advanced ages.—Barbara Ford

"Law of Thermodynamics"
1. You cannot win
2. You cannot break even
3. You cannot get out of the game"

—Anonymous

WEIGH-IN

A process that will touch every American was quietly completed last fall—the standardization of weights and measures for the first time in 100 years.

Each of the 50 states, Puerto Rico, the Virgin Islands, and the District of Columbia were given 53 sets of weights and measures by the National Bureau of Standards. Copies of these measures will be distributed to local inspectors, who will check everything from the calibration on gasoline pumps to the scales in the supermarket. Weights and measures that are off by even a fraction of a percent can cause the overcharging—or undercharging—of millions of dollars a year.

The standards from which these measures were made are no longer physical, except for the kilogram, which is defined by a platinum-iridium cylinder. The meter, once defined by a platinum-iridium bar, is now defined by wavelengths of light. The second, once kept by carefully built mechanical clocks, is now measured by the radiation cycles of a cesium-133 atom.—S.D.

THIRSTY TIGERS

Bengal tigers have been killing people in certain regions of India and Bangladesh for decades because the tigers don't have enough fresh water to drink, according to a study financed by the World Wildlife Fund.

The research concluded

that most of the 40 human deaths caused by tigers each year in the Sunderbans—a 1,300-square-kilometer area along the Bay of Bengal—could be prevented if the tigers had more fresh water. Forced to get by with salty water, the tines undergo a chemical imbalance that can be corrected by eating humans, who constitute high-quality food, Hubert Hendrichs, the German scientist who authored the study reported.

The victims are usually honey collectors, fishermen, or woodcutters who frequent the mangrove swamps that cover most of the Sunderbans. The latest tiger population in the Sunderbans is estimated at 430.

In an attempt to end the human carnage, the government of India plans to build giant troughs in the region and to fill them with fresh water for the tigers.—S.D.



What do you serve a thirsty tiger?
Anything he wants.

CONTINUUM

MIRAGE

A "high latitude" mirage that makes distant lands visible may explain how Norse seamen discovered North America around A.D. 1000. The high latitude, or Arctic mirage differs from other mirages in that it reflects something that actually exists, in this case a real landscape that lies below, or beyond, the horizon.

Two University of Manitoba (Canada) scientists, Waldemar H. Lehn and H. Leonard Sawatzky, speculate that the mirages allowed explorers to "see" between distant landfalls in the North Atlantic. Lehn has calculations showing that the feat is theoretically possible.

An Arctic mirage is caused by a temperature inversion created when the air immediately above the earth's surface is colder than air at higher elevations.

Under these conditions, light rays are bent around the curvature of the earth. The stronger the inversion, the more bending. With a high degree of bending, the earth's surface looks like a saucer, and landscapes and ships normally out of sight below the horizon are raised into view on the saucer's rim. The effect can last for days and cover thousands of kilometers.

Lehn and Sawatzky speculate that an Arctic mirage allowed Eric the Red to see Greenland from his home in Iceland and emboldened him to make the 300-kilometer voyage despite contrary winds and currents.

There is at least one recent report of this mirage. In 1939 a sea captain saw a mountain in Iceland from 500 kilometers away. An Arctic mirage is the best explanation for the sighting.

—Barbara Ford

THE WORST OF ASBESTOS

Add asbestos to the list of miracle products with a dark side. Asbestos has been

exposed to asbestos fibers while constructing ships during World War II. Researchers say that as little as one day's exposure has been found to cause cancer three



Warren Beatty (shown with Jane Christie) turned the hair dryer into a phallic symbol in *Shampoo*. Now it's a potential health hazard.

used widely as a fireproofing, heat-resisting, and noise-controlling material in ceilings, brake linings, ironing boards, insulation, cement, and furnace-patching compounds. Now the mineral's fibers are being linked to lung cancer.

The U.S. Consumer Product Safety Commission has asked for the voluntary recall of millions of hair dryers, which may be blowing asbestos fibers into the faces of their users. Authorities are still trying to gauge the health effects of asbestos flaking off from school ceilings, for which it was used extensively until the early 1970s.

Moreover, several million naval-shipyard workers were

decades later. Asbestos has also been found in the drinking water of Atlanta, Boston, Philadelphia, San Francisco, and Seattle.

Compared with other cancer risks that people face daily—from cigarette smoking to eating food additives—asbestos exposure is not considered particularly deadly. But scientists believe that it is another of the materials that is contributing to the rising rate of cancer, which claims 1,000 lives each day in the United States.—S.D.

"Our time is a time for crossing barriers, for erasing old categories—for probing around."

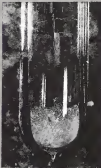
—Marshall McLuhan



Photos are identical except that in photo at left the lake is frozen and the air higher up is warm, causing wick-like mirage above horizon.

SOLID HYDROGEN

Scientists have taken a major step toward turning hydrogen into a metal, which they think could become a



Liquid hydrogen: Pressure can turn it into a solid

superconductor, leading to far more compact and efficient electric generators and transmission lines. Hydrogen is the main stuff of the universe and is contained in the sun, water, and the human body.

By creating tremendous pressures with diamond-anvil cells, two scientists of the Carnegie Institute's Geophysical Laboratory, Drs. Peter M. Bell and Hwakang Mao, developed a new form of solid hydrogen that they believe brings them closer to making metallic hydrogen. Soon, they hope, they may demonstrate that metallic hydrogen might be made at room temperature.

Beginning with liquid hydrogen, the experimenters

increased pressure until the liquid was converted into a dense crystalline solid at room temperature. More pressure increased the density.

The solid form of high-density hydrogen could make an efficient, nongpolluting fuel for nuclear-fusion reactors or could become a rocket fuel, aircraft fuel, or explosive, says the National Science Foundation, which recently released the Carnegie research — A. B.

SOLAR ECONOMICS

A solar-collector system can supply twice as much heat in New York City as in Rochester, New York, approximately 420 kilometers away Billings, Montana, gets as much solar energy as St. Louis, Missouri, whose latitude is about 800 kilometers to the south.

How far south you live is not necessarily the key indicator of how successful a solar-collector system in your area will be, according to the National Oceanic and Atmospheric Administration (NOAA). Cloud cover, altitude, and air pollution also affect the amount of solar energy that a building receives.

NOAA's Air Resources Laboratories in Silver Spring, Maryland, has published a booklet showing the relative solar-heating value for localities throughout the United States. The report assigned the regions around Lake Ontario and in central Washington State a heating value of 1, the lowest. Key West, Florida, was rated

highest, with a 60, but most of the country is rated between 2 and 4.

The report, of course, assumes that there is an identical efficiency for all solar collectors. To compare various systems and to obtain general information on solar energy, you can call the National Solar Heating and Cooling Information Center in Philadelphia, toll-free, 800-523-2929. Or write the center at Box 1607, Rockville, Md 20850 —S. D.

SAY CHEESE!

At this very moment the U.S. government may be taking a picture of your house. And for a reasonable fee you may be able to buy one of these pictures.

NASA and the U.S. Geological Survey (USGS) are capable of photographing our country (and others)

from the air and even from outer space. NASA and USGS research and aerial-mapping aircraft provide a bird's-eye view of our world from 610 to 19,716 meters overhead. Landsat satellites provide even loftier pictures from 920 kilometers up Skylab, which orbited much lower, has also contributed to the government's photo album of the earth.

All of these photographs are available to the public. Black-and-white prints, some color slides, and even infrared images can be had for prices ranging from \$1 to \$50.

To order photos, write to: User Services, EROS Data Center, Sioux Falls, S. Dak. 57198. You'll be sent a packet of information and an order form. If you want a specific area—such as your old neighborhood in the Bronx—indicate it on a road map or give latitude and longitude coordinates.



EROS has a full library of photographs—all for sale—taken from high-altitude planes and spacecraft. Above: the San Francisco area.

CONTINUUM

UFO TIPS

Nine percent of adult Americans have seen an unidentified flying object (UFO), according to a recent Gallup poll. This means there have been about 13 million UFO sightings. Unfortunately, many witnesses who report sightings provide inadequate information.

There's always the chance that you will be the one confronted with that once-in-a-lifetime UFO sighting. Here's what to look for to make your UFO report a significant one.

- Note the precise time of day and how long the UFO stayed in sight.
- "Measure" the object's size, but avoid descriptions such as "big as a house." Instead, estimate size in degrees. Compare the UFO to the size of the moon (half a degree), the width of your thumb held at arm's length (one and a half degrees), or the width of an outstretched fist (ten degrees).
- Describe its position in the sky. Don't say it "hovered 200 feet away" as distance is very hard to judge. Estimate its altitude in degrees above the horizon. Again, you can do this by using fist or thumb widths. If you can also supply compass directions, all the better.
- Note specific details: shape, color or changes in shape or color.
- Most important: get other witnesses to write down their observations as soon as possible after the sighting. J. Allen Hynek, astronomer and director of the Center for UFO Studies, says

multiple-witness cases are far more valuable to UFO researchers than single ones.

There's a good chance your UFO will turn out to be a natural phenomenon.



J. Allen Hynek stresses need for additional witnesses.

(meteor, aurora, cloud) or a man-made device (airplane, weather balloon, satellite). But if you see something truly baffling, report it to one of the major private UFO research groups. (Government agencies may accept your report, but nothing will be done with it.) Each of the following groups will respect your privacy, if you wish, and you can be sure the report will be examined by an experienced investigator. Center for UFO Studies, 1609 Sherman Avenue, Evanston, Ill. 60201; Aerial Phenomena Research Organization, 3910 East Kleindale Road, Tucson, Ariz. 85712; Mutual UFO Network, 103 Oldtowne Road, Seguin, Texas 78155. —Terrence Dickinson

LOW-CAL SEX

Indoor sportsmen who think they are keeping in shape by doing their workouts in bed are in for a rude awakening. Mother Nature is the original energy conservationist. No matter how enthusiastic or athletic your sexual activities, your body converts calories to energy at the sly rate of 4.5 calories per minute—or 270 calories per hour.

Researchers at Case Western Reserve University School of Medicine discovered this fact while conducting studies on postcoronary patients who wore continuously monitoring electrocardiogram devices. The original purpose of the study was to discover how stressful sexual activity is on the heart of the postcoronary patient. The findings: Sex was less stressful than many people's jobs. Heartbeats of 120.1 per

minute were recorded during occupational or professional activity in contrast to an average of 117.4 beats per minute during coitus.

Thus, while your chances of suffering a fatal coronary during sex are "virtually nonexistent," according to Dr. V. K. Tallury, a New York cardiologist, sex won't make you thin, either. It would take the sexual athlete about 13 hours to lose a pound as compared to 7.5 hours for a tennis player. And if it took two martinis to get you into the mood, you might find your workouts rather fattening.

Varying positions also seems to have little effect on caloric intake. In fact, Dr. Tallury deflated the concept of sex as athletics by pointing out that "sex is about as strenuous as walking up a flight or two of stairs—or walking briskly for one or two blocks." —Sherry Romeo



Bob, Carol, Ted, and Alice may have had a good time, but doctors warn that, calorie-wise, they'd have been better off playing tennis.

EATING WATCHES

If you ate your luminous-dial watch, you'd get a dose of radiation equal to about 25 X rays. Luminous dials

standing in New York City's Grand Central Terminal for a year, because of the radioactivity in the train depot's granite structure.)

With characteristic under-



You'd get as much radiation by spending a year in New York's Grand Central Terminal as you would by eating a luminous dial watch.

contain small amounts of radioactive tritium, radium, or promethium paint. U.S. government researchers recently conducted tests to determine the possible health dangers posed by the materials.

The average American can expect to get about 100-200 millirems of radiation per year from natural sources, such as the sun and rocks. And under normal circumstances luminous watches give off only 0.3 to 2.5 millirems per year.

But if you were to eat a watch, you could get as much as 500 millirems in your gastrointestinal tract, according to government figures. (Oddly enough, you'd get just as much from

statement, researchers at Oak Ridge National Laboratory, which made the study, said the likelihood of such high exposures from swallowing watches "is very low and near zero in most cases."—S. D.

LEGIONNAIRES' DISEASE

The seemingly innocuous germ that causes Legionnaires' disease has been found, but the real cause of the mysterious malady is deeper and even more innocuous: air conditioners... and the American Way of Life.

At a symposium held recently at the Center for Disease Control in Atlanta,

Georgia, Dr. Jay P. Sanford reported that the microbe finds its way from the ground into the evaporation pans and filters of big air conditioners. With the right temperature and humidity, the bacillus multiplies and is spread throughout the air-conditioned building.

Legionella hemophytus infects only 2 percent of those exposed to it, but it wouldn't have even that high an attack rate if it weren't for the very life-style of Americans, claims Dr. Sanford, who is dean of the School of Medicine of the Uniformed Services University of the Health Sciences in Bethesda, Maryland. He says the disease may be contracted only by someone whose respiratory system has been polluted by such things as smoking or drinking.

At least 18 separate outbreaks of Legionnaires' disease have been reported

since 1965, involving 677 people and 99 deaths. All but four of the outbreaks have been in the United States.—J. D.

NEWS ON BEER AND POT

A Maryland scientist's search for a more effective cholera vaccine has turned up good news for beer drinkers. For pot smokers there's good news and bad.

Heavy beer drinking produces high levels of stomach acid, according to David Nalin, of the University of Maryland's Center for Vaccine Development. These acids kill bacteria and protect beer drinkers from diarrhea.

Marijuana, on the other hand, lowers stomach-acid levels. This may protect pot smokers from peptic ulcers, but it also makes them more prone to cholera and other diarrhea-causing diseases.

In other words, Nalin suggests, if you drink the water south of the border you may be safer quaffing Dos Equis afterward than smoking Acapulco Gold.

Nalin's research team hopes to test these implications soon. The stakes are higher than just finding a cure for Montezuma's Revenge. Noncholeraic diarrhea is the number-one killer of infants outside the U.S.

Eventually, Nalin says, he would like to examine stomach-acid levels of returning Mexican tourists. Right now he is on a two-year research program in Pakistan, testing the stomachs of heavy hashish smokers.



Famous Philadelphia hotel was also victim of the disease.

CONTINUUM

IMPRINTING TURTLES

Since the late 1940s the number of ridley sea turtles has dwindled from an estimated 40,000 to fewer than



Ridley sea turtle. Catching its eggs in plastic bags 20,000. The problem: The species' only known nesting place in Rancho Nuevo, Mexico, is an open hunting ground for predators, including humans, some of whom prize the eggs as aphrodisiacs.

In a unique experiment to save the turtle—*Lepidochelys kempi*—from extinction, American and Mexican scientists are attempting to recondition the reptiles to shift their age-old nesting place to a protected site in South Padre Island National Seashore, in Texas. The process is called imprinting.

Dr. Joseph Sylvester, National Marine and Fisheries' southeast division "turtle man," explains that the rid-

leys, which are found along the Gulf Coast, may be drawn back to Rancho Nuevo by sensory information acquired when they hatch.

At egg-laying time, biologists held plastic bags under the females to catch the eggs before they could drop into the sand. Half the eggs were then flown to South Padre Island, where they were incubated in the sand.

As a control, the other half were placed in Rancho Nuevo sand. After the eggs hatched, the young turtles were flown to Galveston, Texas, so that their development could be carefully monitored. In February and May groups of the turtles, tagged for identification, were released from beaches in Florida.

The biologists plan to repeat the procedure, but they are cautious. "We hope they will imprint," says Dr. Sylvester, but he added that success will not be known for "five to six years."

—Joseph A. Gambardello

BRAIN POLLUTION

Bad air can affect the brain as well as the body, sometimes for the better, reports a team of scientists from St. Louis, Missouri. Carbon monoxide (CO) and nitrogen dioxide (NO₂) may promote alcoholism, for example, while the pollutant nitrogen oxide (NO), a known anesthetic, appears to make people feel better.

After comparing a meticulous 149-day record of air pollution with admissions

to Malcolm Bliss Mental Health Center, a psychiatric hospital in St. Louis, researchers found that on certain high-pollution days psychiatric admissions either climbed or dropped, depending on what pollutant predominated.

On days when the St. Louis atmosphere was rich in carbon monoxide and nitrogen dioxide, the number of patients admitted for alcoholism and organic brain disorders increased noticeably according to Drs. Meir and Aharon Strahlevitz and researcher John E. Miller.

The opposite was true on days when there was a high level of nitrogen oxide, a form of which is nitrous oxide, or laughing gas, often used by dentists for relaxing their patients.

"The study sprang from

my interest in biological and environmental factors and their effects on psychiatric illness," Dr. Meir Strahlevitz told *Omn*. In St. Louis he had the nearly ideal conditions to explore this interest. "We had this large psychiatric hospital and an air-pollution-control center on the next block," he explained.

The team's findings indicate that people suffering from alcoholism and organic brain problems may be particularly sensitive to some yet-undiscovered disturbing effect of NO₂ and CO. It may also be that the pollutant NO cancels out some of the upsetting effects of the two other gases. The St. Louis report even recommends checking out nitrogen oxide as a treatment for alcoholism and organic brain problems.

—Douglas Colfagan



Larry Mauro, 40, sits off in the first-ever solar-powered manned flight at Flabob Airport, near Riverside, California. Solar cells on the wings were charged for one and a half hours. The electricity was stored in batteries, then released in this first flight, which lasted about 1.5 minutes. Mauro reached a maximum altitude of 12 meters.



WHITE DWARFS AND GREEN MEN

Did ancient astronauts visit the Dogon?

BY CARL SAGAN

Humanity has already achieved interstellar spaceflight. With a gravitational assist from the planet Jupiter, the Pioneer 10 and 11 and the Voyager 1 and 2 spacecraft have been boosted into trajectories that will leave the solar system for the realm of the stars. They are very slow-moving spacecraft.



despite the fact that they are the fastest objects ever launched by our species. They will take tens of thousands of years to traverse typical interstellar distances.

Unless some special effort is made to redirect them, they will never enter another planetary system in all the tens of billions of years of future history of the Milky Way galaxy. The star-to-star distances are too large. They are doomed to wander forever in the dark between the stars. But even so, these spacecraft have messages attached to them for the remote contingency that at some future time alien beings might intercept the spacecraft and wonder about the beings who launched them on these prodigious journeys.

If we are capable of such constructions at our comparatively backward technological state, might not civilizations thousands or millions of years more advanced than ours, on a planet of another star, be capable of fast and directed interstellar travel? Interstellar spaceflight is time-consuming, difficult, and expensive for us, and perhaps also for other civilizations with substantially greater resources than ours. But it surely would be unwise to contend that conceptually novel approaches to the physics or engineering of interstellar spaceflight will not be discovered by us sometime in the future, reducing cost and travel time.

It is evident that for economy, efficiency, and convenience, interstellar radio transmission is much superior to interstellar spaceflight, and this is the reason why our own efforts have concentrated strongly on radio communication. But radio communication is clearly inappropriate for contact with a pretechnological society or species. No matter how clever or powerful the transmitter, no such radio message would have been received or understood on Earth before the present century. And there has been life on our planet for about 4 billion years, human bio-

● A kind of Galactic Survey may keep an eye on emerging worlds and seek out new planets. ●

ings for several million, and civilization for perhaps 10,000.

It is not inconceivable that there is a kind of Galactic Survey, established by cooperating civilizations on many planets throughout the Milky Way galaxy which keeps an eye (or some equivalent organ) on emerging planets and seeks out undiscovered worlds. But the solar system is very far from the center of the galaxy and could well have eluded such searches. Or survey ships may come here, but only every 10 million years, say—with none having arrived during historic time. However, it is also possible that a few survey teams have arrived recently enough in human history for their presence to have been noted by our ancestors, or even for human history to have been affected by the contact.

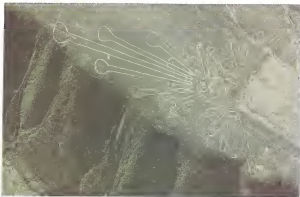
The Soviet astrophysicist I. S. Shklovskii and I discussed this possibility in our book, *Intelligent Life in the Universe*, in 1966. We examined a range of artifacts, legends, and folklore from many cultures and concluded that not one of these cases provided even moderately convincing evidence of extraterrestrial contact. There are always more plausible alternative explanations for the evidence that are based on known human abilities and behavior.

Among the cases discussed were a number later accepted by Erich von Däniken and other uncritical writers as valid

evidence of extraterrestrial contact: Sumerian legends and astronomical cylinder seals; the Biblical stories of the Sumerian Enoch and of Sodom and Gomorrah; the Tassili mesos in North Africa, the matched metal cubes allegedly found in ancient geological sediments and said to be displayed in a museum in Austria; and so on. Over the years I have continued to look as deeply as I am able into such stories and have found very few that require more than passing attention.

In the long litany of "ancient astronaut" pop archaeology, the cases of apparent interest have perfectly reasonable alternative explanations, or have been misreported, or are simple prevarications, hoaxes, or distortions. This description applies to arguments about the Pirri Reis map, the Easter Island monoliths, the heroic drawings on the plains of Nazca, and various artifacts from Mexico, Uzbekistan, and China.

Yet it would be so easy for errandmen of an advanced extraterrestrial civilization to leave a completely unambiguous calling card of their visit. For example, many nuclear physicists believe that there is an "island of stability" of atomic nuclei, near a hypothetical superheavy atom with about 114 protons and about 184 neutrons. All chemical elements heavier than uranium (with 238 protons and neutrons in its nucleus) spontaneously decay in cosmically short periods of time. But there is reason to think that the bonding between protons and neutrons is such that stable elements would be produced if nuclei having about 114 protons and 184 neutrons could be constructed. Such a construction is just beyond our present technology and clearly beyond the technology of our ancestors. A metal artifact containing such elements would be unambiguous evidence of visitation by some advanced extraterrestrial civilization in



Art of the Dogon (left) and heroic drawings of Nazca, Peru. Are they proof of alien visits?

the dimmest reaches of our past.

Or consider the element technetium, whose most stable form has 99 protons and neutrons. Half of it radioactively decays to other elements in about 200,000 years; half of the remainder is gone in another 200,000 years, and so on. As a result, any technetium formed by stars with the other elements billions of years ago must all be gone by now. Thus, terrestrial technetium can only be of artificial origin, as its very name indicates. A technetium artifact could have only one meaning.

Similarly there are common elements on Earth that are immiscible, for example, aluminum and lead. If you melt them together, the lead, being considerably heavier, sinks to the bottom. The aluminum floats to the top. However in the zero-g conditions of spaceflight there is no gravity in the melt to pull the heavier lead down, and exotic alloys, such as Al/Pb, can be produced. One of the objectives of NASA's early shuttle missions will be to test out such alloying techniques. Any message written on an aluminum lead alloy and retrieved from an ancient civilization would certainly attract our attention today.

It is also possible that the content rather than the material of the message would clearly point to a science or technology beyond the abilities of our ancestors: for example a vector calculus rendition of Maxwell's equations (with or without magnetic monopoles), or a graphical representation of the Planck black-body distribution for several different temperatures, or a derivation of the Lorentz transformation of special relativity. Even if the ancients could not understand such writings, they might revere them as holy.

But no cases of this sort have emerged, despite what is clearly a profitable market for tales of ancient or modern extraterrestrial astronauts. There have been debates on the purity of magnesium samples from purported crashed UFOs, but their purity was within the competence of American technology at the time of the incident. A supposed star map said to be retrieved (from memory) from the interior of a flying saucer does not, as alleged, resemble the relative positions of the nearest stars like the sun; in fact, a close examination shows it to be not much better than the "star map" that would be produced if you took an old-fashioned quill pen and splattered a few blank pages with ink spots.

With one apparent exception, there are no stories sufficiently detailed to dispose of other explanations and sufficiently accurate to portray correctly modern physics or astronomy to a prescientific or pretheoretical people. The one exception is the remarkable mythology surrounding the star Sirius that is held by the Dogon people of the Republic of Mali, in West Africa.

There are at most a few hundred thousand Dogon alive today, and they have been studied intensively by anthropologists only since the 1930s. There are some elements of their mythology that

are reminiscent of the legends of the ancient Egyptian civilization, and some anthropologists have assumed a weak Dogon cultural connection with ancient Egypt. The hellacious risings of Sirius, central to the Egyptian calendar, were used to predict the inundations of the Nile.

The most striking aspects of Dogon astronomy have been recounted by Marcel Griaule, a French anthropologist working in the 1930s and 1940s. While there is no reason to doubt Griaule's account, it is important to note that there is no earlier Western record of these remarkable Dogon folk beliefs and that all the information has been funneled through Griaule. The story has recently been popularized by a British writer, R.K.G. Temple.

In contrast to almost all prescientific societies, the Dogon hold that the planets as well as the earth rotate about their axes and revolve around the sun. This is a conclusion that can, of course, be achieved without high technology, as Copernicus

• *They have knowledge that cannot be had save with a large telescope. Thus they had contact with an advanced technical civilization. But which one—European or extraterrestrial?* •

demonstrated, but it is a very rare insight among the peoples of the earth. It was taught, however, in ancient Greece by Pythagoras and by Philolaus, who perhaps held, in Laplace's words, "that the planets were inhabited and the stars were suns, disseminated in space, being themselves centers of planetary systems." Such teachings, among a wide variety of contradictory ideas, might be just an inspired guess.

The ancient Greeks believed there were only four elements—earth, fire, water, and air—from which all else was constructed. Among the pre-Socratic philosophers there were those who made special advocacy for each one of these elements. If it had later turned out that the universe was indeed made more of one of these elements than of another, we should not attribute remarkable prescience to the pre-Socratic philosopher who made the proposal. One of them was bound to be right on statistical grounds alone. In the same way, if we have several hundred or several thousand cultures, each with its own cosmology, we should not be astounded if, every now and then, purely by chance, one of them proposes an idea that is not only correct but also impos-

sible for them to have deduced.

But, according to Temple, the Dogon go further. They hold that Jupiter has four satellites and that Saturn is encircled by a ring. It is perhaps possible that individuals of extraordinary eyesight under superb seeing conditions could, in the absence of a telescope, have observed the Galilean satellites of Jupiter and the rings of Saturn. But this is at the bare edge of plausibility. Unlike every astronomer before Kepler the Dogon are said to depict the planets moving correctly in elliptical, not circular, orbits.

More striking still is the Dogon belief about Sirius, the brightest star in the sky. They contend that it has a dark and invisible companion star, which orbits Sirius (and, Temple says, in an elliptical orbit) once every 60 years. They state that the companion star is very small and very heavy made of a special metal called sagala, which is not found on Earth.

The remarkable fact is that the visible star, Sirius A, does have an extraordinary dark companion, Sirius B, which orbits it in an elliptical orbit once each 50.04±0.09 years. Sirius B is the first example of a white dwarf star discovered by modern astrophysics. Its matter is in a state called relativistically degenerate, which does not exist on Earth, and since the electrons are not bound to the nuclei in such degenerate matter, it can properly be described as metallic. Since Sirius A is called the Dog Star, Sirius B has been dubbed the Pup.

At first glance, the Sirius legend of the Dogon seems to be the best candidate evidence available today for man's past contact with an advanced extraterrestrial civilization. As we begin a closer look at this story, however, let us remember that the Dogon astronomical tradition is purely oral, that it dates with certainty only from the 1930s, and that the diagrams are written with sticks in sand. (Incidentally, there is some evidence that the Dogon like to frame pictures with an ellipse, and that Temple may be mistaken about the claim that in Dogon mythology the planets and Sirius B move in elliptical orbits.)

When we examine the full body of Dogon mythology, we find a very rich and detailed structure of legend—much richer, as many anthropologists have remarked, than those of their near geographical neighbors. Where there is a rich array of legends there is, of course, a greater chance of an accidental correspondence of one of the myths with a finding of modern science. A very spare mythology is much less likely to make such an accidental concordance. But when we examine the rest of Dogon mythology, do we find other cases hauntingly reminiscent of some unexpected findings in modern science?

The Dogon cosmology describes how the Creator examined a plated basket, round at the mouth and square at the bottom. Such baskets are still in use in Mali

copy. The Creator opened the basket and used it as a model for the creation of the world—the square base represents the sky and the round mouth, the sun. I must say that this account does not strike me as a remarkable anticipation of modern cosmological thinking.

In the Dogon representation of the creation of the earth, the Creator implants in an egg two pairs of twins, each pair composed of a male and a female. The twins are intended to mature within the egg and fuse to become a single and "perfect" androgynous being. The earth originates when one of the twins breaks from the egg before maturation, whereupon the Creator sacrifices the other twin in order to maintain a certain cosmic harmony. This is a variegated and interesting mythology, but it does not seem to be qualitatively different from many of the other mythologies and religions of humanity.

The hypothesis of a companion star to Sirius might have followed naturally from the Dogon mythology, in which twins play a central role, but there does not seem to be any explanation this simple about the period and density of the companion of Sirius. The Dogon Sirius myth is too close to modern astronomical thinking and too precise quantitatively to be attributed to chance. Yet there it sits, immersed in a body of more or less standard prescientific legend. What can the explanation be? Is there any chance that the Dogon or their cultural ancestors might actually have been able to see Sirius B and observe its period around Sirius A?

White dwarfs, such as Sirius B, evolve from stars called red giants, which are very luminous and, it will be no surprise to hear, red. Ancient writers of the first few centuries of the Christian Era actually described Sirius as red—certainly not its color today. In a conversation piece by Horace called "Hoc Quoque, Tiresias" (How to Get Rich Quickly) there is a quotation from an earlier work that says, "The red dog star's heat split the speechless statues."

As a result of these less than compelling ancient sources there has been a slight temptation among astrophysicists to consider the possibility that the white dwarf Sirius B was a red giant in historical times and visible to the naked eye, completely swamping the light of Sirius A. In that case perhaps there was a slightly later time in the evolution of Sirius B when its brightness was comparable to that of Sirius A, and the relative motion of the two stars about each other could be discerned with the eye.

But the best recent information from the theory of stellar evolution suggests that there simply is not enough time for Sirius B to have reached its present white-dwarf state if it had been a red giant a few centuries before Horace. What is more, it would seem extraordinary that no one except the Dogon noticed these two stars circling each other every 50 years, each alone being one of the brightest stars in the sky. There was an extremely competent school

(●●)



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FICTION

SANDKINGS

His interest piqued when told of the creatures' proficiency for warfare and worship

BY GEORGE R. R. MARTIN

Simon Kress lived alone in a sprawling manor house among dry rocky hills fifty kilometers from the city. So, when he was called away unexpectedly on business, he had no neighbors he could conveniently impose on to take his pets. The carrion hawk was no problem; it roosted in the unused belfry and customarily fed itself anyway. The shambler Kress simply shoed outside and left to fend for itself; the little monster would gorge on slugs and birds and rockjocks. But the fish tank, stocked with genuine earth piranhas, posed a difficulty. Finally Kress just threw a haunch of beef into the huge tank. The piranha could always eat one another if he were detained longer than expected. They'd done it before. It amused him.

Unfortunately, he was detained *much* longer than expected this time. When he finally returned, all the fish were dead. So was the carrion hawk. The shambler had climbed up to the belfry and eaten it. Kress was wroth.

The next day he flew his skimmer to Asgard, a journey of some two hundred kilometers. Asgard was Baldur's largest city and boasted the oldest and largest starport as well. Kress liked to impress his friends with animals that were unusual, entertaining, and expensive. Asgard was the place to buy them.

This time, though, he had poor luck. Xenopets had closed its doors, Eltherans the Petseller tried to foist another carrion hawk off on him, and Strange Waters offered nothing more exotic than piranha, glowsharks, and spider squids. Kress had had all those;

PAINTING BY ERNST FUCHS



he wanted something new, something that would stand out.

Near dusk he found himself walking down Rainbow Boulevard, looking for places he had not patronized before. So close to the starport, the street was lined by importers' marts. The big corporate emporiums had impressive long windows, in which rare and costly alien artifacts reposed on felt cushions against dark drapes that made the interiors of the stores a mystery. Between them were the junk shops—narrow, nasty little places whose display areas were crammed with all manner of offworld bric-a-brac. Kress tried both kinds of shops, with equal dissatisfaction.

Then he came across a store that was different.

It was very near the port. Kress had never been there before. The shop occupied a small, single-story building of moderate size, set between a euphoria bar and a temple brothel of the Secret Sisterhood. Down this far, Rainbow Boulevard grew tacky. The shop itself was unusual. Arresting.

The windows were full of mist—now a pale red, now the gray of true fog, now sparkling and golden. The mist swirled and eddied and glowed faintly from within. Kress glimpsed objects in the window—machines, pieces of art, other things he could not recognize—but he could not get a good look at any of them. The mists flowed sensuously around them, displaying a bit of first one thing and then another, then cloaking all. It was intriguing.

As he watched, the mist began to form letters. One word at a time. Kress stood and read.

WO AND SHADE IMPORTERS ARTIFACTS ART LIFEFORMS AND MSC.

The letters stopped. Through the fog Kress saw something moving. That was enough for him, that and the LIFEFORMS in their advertisement. He swept his walking cloak over his shoulder and entered the store.

Inside, Kress felt disoriented. The interior seemed vast, much larger than he would have guessed from the relatively modest frontage. It was dimly lit, peaceful. The ceiling was a starscape, complete with spiral nebulas, very dark and realistic, very nice. All the counters shone faintly to better display the merchandise within. The aisles were carpeted with ground fog. It came almost to his knees in places and swirled about his feet as he walked.

"Can I help you?"

She almost seemed to have risen from the fog. Tall and gaunt and pale, she wore a practical gray jumpsuit and a strange little cap that rested well back on her head.

"Are you Wo or Shade?" Kress asked. "Or only sales help?"

"Jala. Wo ready to servo you," she replied. "Shade does not see customers. We have no sales help."

"You have quite a large establishment," Kress said. "Odd that I have never heard of you before."

"We have only just opened this shop on Bajdur, the woman said. "We have franchises on a number of other worlds, however. What can I sell you? Art, perhaps? You have the look of a collector. We have some fine Nor T'alush crystal carvings."

"No," Kress said. "I own all the crystal carvings I desire. I came to see about a pet."

"A lifeform?"

"Yes."

"When?"

"Of course."

"We have a mimic in stock. From Celia's World. A clever little simian. Not only will it learn to speak, but eventually it will mimic your voice, inflections, gestures, even facial expressions."

"Cute," said Kress. "And common. I have no use for either. Wo. I want something exotic. Unusual. And not cute. I detest cute animals. At the moment I own a shambler imported from Cotho, at no mean expense. From time to time I feed him a litter of un-

—————

● *The black castle
was the first completed,
followed by the
white and red fortresses.
Kress . . . sat
on the couch, so he could
watch. He expected
. . . war to break out . . . now.* ●

wanted kittens. That is what I think of cute. Do I make myself understood?"

Wo smiled enigmatically. "Have you ever owned an animal that worshiped you?" she asked.

Kress grimaced. "Oh, now and again. But I don't require worship, Wo. Just entertainment."

"You misunderstand me," Wo said, still wearing her strange smile. "I meant worship literally."

"What are you talking about?"
"I think I have just the thing for you," Wo said. "Follow me."

She led him between the radiant counters and down a long, fog-shrouded aisle beneath false starlight. They passed through a wall of mist into another section of the store, then stopped in front of a large plastic tank. An aquarium, Kress thought.

Wo beckoned. He stepped closer and saw that he was wrong. It was a terrarium. Within lay a miniature desert about two meters square. Pale sand tinted scarlet by wan red light. Rocks: basalt and quartz and granite. In each corner of the tank stood a castle.

Kress blinked and peered and corrected

himself; actually, there were only three castles standing. The fourth leaned, a crumbled, broken ruin. The three others were crude but intact, carved of stone and sand. Over their battlements and through their rounded porticoes tiny creatures climbed and scrambled. Kress pressed his face against the plastic. "Insects?" he asked.

"No," Wo replied. "A much more complex lifeform. More intelligent as well. Smarter than your shambler by a considerable amount. They are called sandlings."

"Insects," Kress said, drawing back from the tank. "I don't care how complex they are." He frowned. "And kindly don't try to gull me with this talk of intelligence. These things are far too small to have anything but the most rudimentary brains."

"They share hiveminds," Wo said. "Castle minds, in this case. There are only three organisms in the tank, actually. The fourth died. You see how her castle has fallen."

Kress looked back at the tank. "Hiveminds, eh? Interesting." He frowned again. "Still, it is only an oversized ant farm. I'd hoped for something better."

"They fight wars."

"Wars? Hmmm." Kress looked again. "Note the colors, if you will," Wo said. She pointed to the creatures that swarmed over the nearest castle. One was scurrying at the tank wall. Kress studied it. To his eyes, it still looked like an insect. Barely as long as his fingernail, six-limbed, with six tiny eyes set all around its body. A wicked set of mandibles clacked visibly, while two long, fine antennae wove patterns in the air.

Antennae, mandibles, eyes, and legs were sooty black, but the dominant color was the burnt orange of its armor plating. "It's an insect," Kress repeated.

"It is not an insect," Wo insisted calmly. "The armored exoskeleton is shed when the sandling grows larger. If it grows larger in a tank this size, it won't." She took Kress by the elbow and led him around the tank to the next castle. "Look at the colors here."

He did. They were different. Here, the sandlings had bright red armor, antennae, mandibles, eyes, and legs were yellow. Kress glanced across the tank. The denizens of the third live castle were off-white, with red trim. "Hmmm," he said.

"They war, as I said." Wo told him. "They even have truces and alliances. It was an alliance that destroyed the fourth castle in this tank. The blacks were becoming too numerous, and so the others joined forces to destroy them."

Kress remained unconvinced. "Amazing, no doubt. But insects fight wars, too."

"Insects do not worship," Wo said.

"Eh?"

Wo smiled and pointed at the castle. Kress stared. A face had been carved into the wall of the highest tower. He recognized it. It was Jala Wo's face. "How . . . ?"

"I projected a hologram of my face into the tank, then kept it there for a few days. The face of god, you see? I feed them. I am always close. The sandlings have a rudimentary psionic sense. Proximity telep-

athy. They sense me and worship me by using my face to decorate their buildings. All the castles have them, see." They did.

On the castle, the face of Jala Wo was serene, peaceful, and very lifelike. Kress marveled at the workmanship. "How do they do it?"

"The foremost legs double as arms. They even have fingers of a sort, three small, flexible tendrils. And they cooperate well, both in building and in battle. Remember, all the mobiles of one color share a single mind."

"Tell me more," Kress requested.

Wo smiled. "The maw lives in the castle. Maw is my name for her—a pun, if you will. The thing is mother and stomach both. Female, large as your fist, immobile. Actually, sandking is a bit of a misnomer. The mobiles are peasants and warriors. The real ruler is a queen. But that analogy is faulty as well. Considered as a whole, each castle is a single hermaphroditic creature."

"What do they eat?"

"The mobiles eat pap, predigested food obtained inside the castle. They get it from the maw after she has worked on it for several days. Their stomachs can handle anything else. If the maw dies, they soon die as well. The maw... the maw eats anything. You'll have no special expense there. Table scraps will do excellently."

"Live food?" Kress asked.

Wo shrugged. "Each maw eats mobiles from the other castles, yes."

"I am intrigued," he admitted. "If only they weren't so small!"

"Yours can be larger. These sandkings are small because their tank is small. They seem to limit their growth to fit available space. If I moved these to a larger tank, they'd start growing again."

"Hmmm. My piranha tank is twice this size and vacant. It could be cleaned out, filled with sand."

"Wo and Shade would take care of the installation. It would be our pleasure."

"Of course," Kress said, "I would expect four intact castles."

"Certainly," Wo said.

They began to haggle about the price.

Three days later Jala Wo arrived at Simon Kress's estate, with dormant sandkings and a work crew to take charge of the installation. Wo's assistants were aliens unlike any Kress was familiar with—squat, broad bipeds with four arms and bulging, multifaceted eyes. Their skin was thick and leathery and twisted into horns and spines and protrusions at odd places upon their bodies. But they were very strong and good workers. Wo ordered them about in a musical tongue that Kress has never heard before.

In a day it was done. They moved his piranha tank to the center of his spacious living room, arranged couches on either side of it for better viewing, scrubbed it clean, and filled it two thirds of the way up

with sand and rock. Then they installed a special lighting system, both to provide the dim red illumination the sandkings preferred and to project holographic images into the tank. On top they mounted a sturdy plastic cover, with a feeder mechanism built in. "This way you can feed your sandkings without removing the top of the tank," Wo explained. "You would not want to take any chances on the mobiles escaping."

The cover also included climate-control devices, to condense just the right amount of moisture from the air. "You want it dry, but not too dry," Wo said.

Finally one of the four-armed workers climbed into the tank and dug deep pits in the four corners. One of his companions handed the dormant maws over to him, removing them, one by one, from their frosted cryonic traveling cases.

They were nothing to look at. Kress decided they resembled nothing so much as mottled, half-spotted chunks of raw meat. Each with a mouth.

The alien buried them, one in each corner of the tank. Then the work party sealed it all up and took their leave.

"The heat will bring the maws out of dormancy," Wo said. "In less than a week mobiles will begin to hatch and burrow up to the surface. Be certain to give them plenty of food. They will need all their strength until they are well established. I would estimate that you will have castles

CONTINUED ON PAGE 101

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WIZARDS OF SILICON VALLEY

*California's new
'Gold Coast' owes its
remarkable legacy to a
handful of visionaries*

BY GENE BYLINSKY AND
ZHENYA LANE

Silicon Valley is not some barren lunar crater or black crevice in the ocean's depths. Rather it is a lush triangle of unusual real estate stretching 30 miles to the south of San Francisco, along placid San Francisco Bay, to the Santa Cruz Mountains. In this verdant place where prune orchards and wildflowers blossom even in February, something else has burst into full bloom: 1,000 innovative science and high-technology companies flying flags like Hewlett-Packard, Intel, Syntex, Varian, Atari, Andros, and Zoccon. From the first seedlings of this new empire—planted barely a century ago—Silicon Valley has become the world's leading center for industrial innovation. Silicon Valley also mass-produces millionaires. *Fortune* magazine estimates that no fewer than 500 high-technology millionaires live there, many of them still in their late twenties and early thirties. No comparable mecca of high tech exists anywhere else. The closest counterpart is Boston's Route 128, that golden crescent of high-technology firms hugging the outer reaches of Beantown. But Silicon Valley long ago surpassed Route 128 in both the number of companies and the diversity of their products.

Aerial view of Silicon Valley highlights Palo Alto (middle left) as the nerve center of the world's most innovative technologies



6 *Dramatic growth of industry in the area has caused employment to expand at seven times the national rate.* 6

Birthplace of electronic games and home computers, of those tiny computers-on-a-chip known as microcomputers and of the world's most powerful supercomputers, of cordless telephones and digital thermometers of laser technology and computer memories, of food colors and additives ingeniously designed to be harmless to the body—Silicon Valley is all that with much more to come.

Surprises like an artificial heart that requires no potentially poisonous nuclear fuel, bacteria engineered to make human insulin, computers that understand human speech and talk back—all are under intensive development in Silicon Valley's sparkling laboratories.

In some ways Silicon Valley is like medieval Spain, a launchpad for great expeditions into new worlds. But no territory in the world's history has launched more far-reaching, heavily financed journeys to unknown places than this tiny valley at the edge of the Pacific.

"The effect on Earth of Silicon Valley will be as dramatic over the next two centuries," says resident and computer manufacturer John Peers, "as the effect that [Dr. Louis Leakey's discoveries in] the Rift Valley will have on the evolution of man."

The Santa Clara Valley—to give Silicon Valley its proper name—is located on San Francisco Peninsula. It extends as far south as San Jose, the newest California metropolis, which to the surprise of many non-westerners is already bigger than Pittsburgh or Minneapolis. At the northern tip of the peninsula are all the attractions of that jewel of cities, San Francisco, and across the scenic bay are the distant lights of Berkeley and Oakland.

TRACKS OF THE FLY

No description of Silicon Valley would be complete, however, without mentioning Palo Alto, cradle of the first budding technologies in the area. Palo Alto is split right down the middle by El Camino Real, the broad highway that runs much of the length of California. Stanford University and Stanford Industrial Park, along with such various other citadels of science and technology as the Stanford Linear Accelerator and Linus Pauling's Institute of Science and Medicine, lie to the west of El Camino.

To the east is the city of Palo Alto itself



William Hewlett: An empire begun in a garage.

And it was right here, as you can read on a plaque outside a white clapboard house at 913 Emerson Street, that the marching tramp of a common housefly ushered in the electronic age and paved the way for the wizards of Silicon Valley.

It was a dramatic moment on that memorable day in 1912 when a group of excited young men leaned over a table to watch a housefly saunter across a sheet of drawing paper. The fly's footsteps were amplified by a vacuum tube, making them sound like the steps of a marching soldier. This was the first application of the vacuum tube as a sound amplifier and generator of electromagnetic waves. The tube's inventor was Silicon Valley's first true giant, Leo DeForest.

The vacuum tube made possible such electronic wonders as radio, television, the long-distance telephone, electronic computers, tape recorders, and electronic eyes that open doors in stores and office buildings.

DeForest and his associates were then working for the Federal Telegraph Co., in Palo Alto, the oldest American radio company. But development of electronics in the San Francisco Bay Area dates back even earlier, to the turn of the century. Talented young men living in the area propelled the

growth of radio by building the first major wireless station and by establishing the first wireless contact from an airplane to the ground. Federal Telegraph became the dominant force in this nascent industry.

The company proved to be the nursery of the first generation of the valley's wizards, for among the many bright young men it attracted in addition to DeForest were such men as Charles Litton, who later founded the giant Litton Industries, starting it in a garage in San Carlos.

An event almost as dramatic as that fly's monstrous march was the invention of the loudspeaker by two former employees of Federal Telegraph, Peter Jensen and E. S. Pridham. One day in 1917 the two men set up their apparatus on Mare Island in San Francisco Bay. From a window the loudspeaker faced the dock in the city of Vallejo, about a quarter of a mile away. The town's streets were deserted, but there was a man on the dock. Jensen's voice boomed over the loudspeaker, asking the startled man to remove his hat. He promptly did, apparently thinking he had heard a voice from heaven. That year Jensen and Pridham established the Magnavox Co., which manufactures loudspeakers and radios.

Federal Telegraph continued to breed other giants. While working at the company, Frederick Kolster developed the radio detection finder. In 1921 Ralph Hentz founded Heinz and Kauffmann. This company devised and built advanced shortwave radio transmitters, including those used by Rear Admiral Richard E. Byrd in his South Pole explorations.

The man most responsible for the snowballing buildup of new high-technology companies in and around Palo Alto before World War II, however, was Frederick Terman. The son of the developer of the famous Stanford-Binet intelligence quotient (I.Q.) test, Terman studied as an undergraduate at Stanford and took a doctorate in electrical engineering from MIT. In 1925 he began teaching a course in radio engineering at Stanford and soon started the university's radio communications laboratory. He attracted gifted students, and the fame of the laboratory spread. But it bothered Terman that the scarcity of local jobs forced most of his graduates to go into "exile in the East," and so he began to encourage them to start companies near the university.

● *Judging from activity under way, only the first harvest of innovative products has been reaped from the valley.* ●

The biggest payoff came in 1937 when two of his brightest students, William Hewlett and David Packard, started a company on a part-time basis in the one-car garage of the house where Packard and his wife lived. The two young inventors began by making an audio-oscillator, a device that generates signals of varying frequencies. Terman recalls that he could always tell when the fledgling firm had received an order: "If the car was in the garage, there was no backlog. But if the car was parked in the driveway, business was good."

That garage shop is known today as the Hewlett-Packard Co., the world's largest producer of electronic measuring devices and equipment. The company now employs more than 42,000 people worldwide, including some 12,000 in Silicon Valley. The company's annual sales are approaching \$2 billion.

Many other famous companies came out of Stanford University. In 1937 Professor William H. Hansen teamed up with Sigurd and Russell Varian, young brothers and backyard inventors in Palo Alto, to develop the klystron tube. A variant of the vacuum tube, the klystron generates strong microwaves that can be focused like the beam of a searchlight. The klystron tube became a foundation of radar and microwave communications, and out of it grew Varian Associates, a lucrative and prestigious company.

During World War II Terman headed a big defense electronics project at Harvard where, among other things, he developed the aluminum chaff, which Allied bombers dropped on Germany and Nazi-occupied countries to confuse the Germans' radar. When Terman returned to Stanford, he continued to fan innovative flames in another pioneering move, for instance, he set up Stanford Industrial Park near the university which became the prototype of such facilities. It induced still more companies to locate in the area.

Although it may seem as if Terman built Silicon Valley singlehandedly, there were other influences on the area's growth. William Shockley, coinventor of the transistor, for instance, returned to Palo Alto, his boyhood town, in 1955 and set up Shockley Transistor Corp. The transistor, of course, was the successor to the vacuum tube, perfected in Palo Alto 40 years earlier, and Santa Clara Valley was the logical place



Frederick Terman, Benefactor of young geniuses

to cash in on this electronic technology.

A brilliant scientist, Shockley gathered around him a large group of gifted electronics specialists whom he had picked from big companies and universities throughout the country. In 1959, however, his operation fell apart as those bright young men, led by Robert N. Noyce, then only thirty-two, left and, with the backing of Fairchild Camera and Instrument Corp., founded Fairchild Semiconductor in Mountain View near Palo Alto. While there, Noyce became the coinventor of the integrated circuit, the successor to the transistor, which now jams thousands of micro-miniaturized transistors onto a tiny chip of silicon. He also built up Fairchild Semiconductor into a \$150 million-a-year operation. He left in 1968 and with his friend Gordon E. Moore, a talented chemist who had contributed some of the major advances in semiconductor technology founded Intel Corp. in Santa Clara. About 14,000 people are now employed at Intel, which expects to have sales of about \$500 million this year.

MICROBOOM

Intel became the brightest star in the hottest high technology going semiconductor. The company pioneered a computer memory chip that has become an industry

standard, and more recently it has introduced that revolutionary microcomputer—a computer-on-a-chip, which has led to the creation of many new consumer and industrial products. This pioneering, in turn, has contributed to the emergence of still other new companies which are incorporating the tiny electronic devices into new consumer products.

One of the microcomputers' most spectacular applications has been the creation of electronic games. Nolan Bushnell, an engineer who went to Silicon Valley after having worked his way through the University of Utah by operating a game arcade in a local amusement park, was largely responsible for the birth of electronic games.

Bushnell began in a proverbial garage. (The process of small-company formation in Silicon Valley, incidentally, has been honed to the point where in some industrial parks budding entrepreneurs can rent a garage, complete with a roll-up door, and two or three offices adjoining it.) Later Bushnell moved the company he named Atari into a medium-sized one-story building alongside an apple orchard. Inside this building long-haired kids assembled games to the sound of rock music. More recently Atari has moved into huge quarters in nearby Sunnyvale. A cavernous game room off the main lobby is usually filled with excited youngsters playing fabulous electronic gadgets for free. For the most part, they are employees' children celebrating their birthdays.

The remarkable growth of Silicon Valley companies is a wonder to behold. One year you may visit a company founder in crammed quarters shared with a handful of fellow dreamers. Next year you may be visiting him in a spacious factory, which turns out data disks, or whatever he makes, like so many McDonald's hamburgers.

That kind of growth is what has made employment in Silicon Valley expand at seven times the national rate during the past five years and almost twice as fast as elsewhere in California. Jobs go bagging for both specialists and the unskilled. This year an estimated 19,000 jobs will be available in Silicon Valley.

The beautiful setting and attractive job market have drawn many newcomers to the affluent communities of the valley. Real-estate prices have soared, and housing is now in very high demand. Many workers have begun to commute to the area from

the outskirts, making automobile-generated pollution an increasing problem. The cost of living is high, too.

Yet most people already in Silicon Valley would not exchange it for any other place on Earth—so enamored are they of the climate and their surroundings, which includes a friendliness and informality not usually encountered in the big cities on the East Coast.

BECKONING MECCA

The valley is also changing in subtler ways. It is, for example, becoming more a professional, and less a manufacturing, center. Now the young fortune seekers are colonizing such obscure places as Aloha, Michigan, and Nampa, Idaho, where they are putting up plants because land and labor are cheaper. It has gotten harder to become a millionaire in the valley partly because of higher taxes and restrictive federal regulations. However, new companies are continually being formed in the valley, and young men continue to get rich. Spreading applications of microcomputers, in particular, have recently given rise to a whole battery of companies that manufacture home computers—among them Apple Computer, Inc., Video-Brain Computer Co., and Cromemco—as well as chains of computer stores, such as Computerland and ByteShops.

Entrepreneurs now arrive from faraway places to establish companies in the valley. John Peers came all the way from England because he felt that Silicon Valley offered the best expertise for manufacturing his unusual product—a talking computer called Adam. For similar reasons, David and Doris Bossen moved to the valley from Columbus, Ohio, and started Measurix Corp., a highly successful company that makes computer-guided controls for paper mills and other manufacturing plants. As they explain, "Paper mills are in the woods because that's where their raw materials are. We are here because our raw materials are brains." The Bossens knew that the types of diverse specialists they needed could be found only in Silicon Valley, and they found them easily.

There is a lot more company development to come. According to Bob Noyce, semiconductor wizard and cofounder of Intel, the applications of microelectronics have yet to create a change as fundamental in our society as the automobile did. But he predicts that they will create such a change in applications where "slices" of electronic brainpower will be incorporated into a myriad of products for the home, office, and factory—from the telephone to the computer-controlled lathe. The recent appearance of those ubiquitous electronic wristwatches, pocket calculators, and electronic cash registers is just the first swelling of the ocean of products roaring up on those slopes of electronic intelligence created by Noyce and Moore.

As for semiconductor devices themselves, Noyce adds, the technical prob-

lems have largely been overcome. Innovation in the semiconductor area, he thinks, is mostly over—at least for the time being.

Maybe so. But to find out for sure, we had to check with the financial backers of these contemporary Morfins who have the ability to transform equations into LED wristwatches, desktop computers, and bacteria that breed human insulin.

In their suite atop the Embarcadero Center, which houses their operation—with sunlit panoramas of San Francisco hills and billowing sails on the bay—neither Gene Kleiner nor Tom Perkins seemed much alarmed about any decline in innovation in the valley.

With good reason. Venture capitalists Kleiner and Perkins—whose previous successes include Fairchild Semiconductor, which Kleiner helped start, and a laser company that Perkins founded and sold to Spectra-Physics, the major laser-producing company in the world—are more active than ever with new and successful com-

**•Bacteria engineered
to produce human insulin,
an artificial heart
not dependent on nuclear
fuel, computers that
can understand speech—
Silicon Valley is
all that with more to come. •**

panies. Tandem Computers, specializing in multiprocessor "fail-proof" computers, was one of the few companies able to go public in 1977, a tough year for such enterprises. Another of their new branchinches, Genentech, a firm working in recombinant DNA, has already successfully engineered bacteria into microscopic factories that churn out human insulin.

"Another one of our companies," Kleiner says, "is developing an artificial heart." That company is Andros, in Berkeley.

"Although we're looking at many different companies, and helping to develop some here," Perkins says, "I don't think we'd dream of financing a new semiconductor company." The costs of doing that have soared into tens of millions of dollars.

Kleiner and Perkins sometimes lend money to new businesses and leave them to their own resources, but they often take a more direct interest in new companies. Both Tandem and Genentech, for example, are being run by people who worked for Kleiner and Perkins in those same Embarcadero Center offices before setting out to chart new seas.

Well, then, if not semiconductors, what

do these two ambitious capitalists think the wave of the future is going to be?

"If you look across the horizon," Perkins says, "we think the next wave is biological."

BIOMED WHIZ KIDS

Two other giants of the valley, Alejandro (Alex) Zaffaroni and Carl Djerassi, actually got this biological revolution going. The smooth-talking Zaffaroni was born in Montevideo, Uruguay, the son of a banker. He started out by studying medicine, but, as so often happens, a brilliant instructor soon redirected his interest into biochemistry. The instructor had explained in exciting terms the central role of the carbon atom in organic chemistry, and Zaffaroni decided to explore that role. He came to the University of Rochester and obtained a doctorate in biochemistry there. Soon his brilliant flashes of insight produced what is known in chemistry textbooks as the Zaffaroni System, a method for separating steroid compounds by paper chromatography. This method served as a stepping-stone toward large-scale production of steroids by pharmaceutical companies. Several years later Zaffaroni became executive vice-president of Syntex Corp., in Mexico City, where he led the company's pioneering drive toward the synthesis of the birth-control pill and other advanced drugs.

At this stage the ubiquitous Fred Terman enters the picture once more. In his effort to build up Stanford University's chemistry department, Terman, as the university's vice-president, asked Djerassi to become a professor there. Djerassi did so—without leaving Syntex. Djerassi is the father of the birth-control pill, which he developed while working for Syntex. He would be a giant anywhere. Born in Vienna, Austria, of a Bulgarian father and an Austrian mother, both physicians, he was expected to follow in their footsteps. Like Zaffaroni, however, Djerassi was drawn into chemistry by an outstanding instructor, receiving his Ph. D. from the University of Wisconsin in 1945. Medicine's loss has been chemistry's gain, according to a friend who is a Nobel laureate, Djerassi has done enough high-quality work to win two or three Nobel prizes.

Both highly creative and imaginative individuals, Zaffaroni and Djerassi have since been responsible for the formation of four pioneering companies, all located in Palo Alto. To accommodate Djerassi, in a modern mountain-comes-to-Muhammad move, Syntex relocated its entire research and its manufacturing operation to Palo Alto—thus bringing still another high-technology company into the area. Zaffaroni came from Mexico to head the Syntex operation. While both men were with Syntex, they originated Syva Corp., which jointly with Varian Associates engaged in the manufacture of medical instrumentation, and Zeecon Corp., a firm pioneering the applications of hormonal regulators of insect growth. Djerassi later left Syntex to direct Zeecon, while continuing to teach

CONTINUED ON PAGE 178



"Don't wait up!"



*The wit and wisdom
of science fiction's most renowned
character—and his author!*

THE NOTEBOOKS OF LAZARUS LONG

BY ROBERT A. HEINLEIN

Science-fiction writers create visions of tomorrow, but Robert A. Heinlein, the dominant figure of twentieth-century science fiction, has created a coherent scenario of the future in a long, interlinked series of novels and shorter works called the Future History series. One of the recurring characters in the Future History series is Lazarus Long—a man who has lived for thousands of years, a man who has traveled to the stars, a man who is in effect immortal. Lazarus Long first appeared in Heinlein's 1941 novel, *Menjassiah's Child*, and 50 years later became the central character in his novel, *Time Enough for Love*.

A man who has spent dozens of human lifetimes in going everywhere, living life to its fullest, and surviving it all is a man who has accumulated a vast wealth of wit and wisdom. In *The Notebooks of Lazarus Long*, Heinlein has amassed the key ingredients of Lazarus Long's philosophy, his thoughts on the human condition, politics, love, religion, the art of living.

Here, then, are just a few of Lazarus Long's choice bits of wisdom. Ponder them carefully. They are precision-engineered to help you (in the words of another science-fiction character) to "live long and prosper!"

—Ben Bova

Text excerpted from *The Notebooks of Lazarus Long* © P. Putnam's Sons, New York, © Robert A. Heinlein 1973, 1979

• A generation that ignores history has no past—and no future. You live and learn. Or you don't live long. ♻️

When a place gets crowded enough to require fides, social collapse is not far away. It is time to go elsewhere. The best thing about space travel is that it made it possible to go elsewhere.

There are hidden contradictions in the minds of people who "love Nature" while deploring the "artificialities" with which "Man has spoiled Nature." The obvious contradiction lies in their choice of words, which imply that Man and his artifacts are not part of "Nature"—but beavers and their dams are. Such contradictions go deeper than this prima facie absurdity. In declaring his love for a beaver dam (erected by beavers for beavers' purposes) and his hatred for dams erected by men (for the purposes of men), the "Naturalist" reveals his hatred for his own race—i.e., his own self-hatred.

"No man is an island." Much as we may feel and act as individuals, our race is a single organism, always growing and branching—which must be pruned regularly to be healthy. This necessity need not be argued; anyone with eyes can see that any organism which grows without limit always dies in its own power. The only rational question is whether pruning is best done before or after birth.





• *Everything in excess!*
To enjoy the flavor of life, take big bites.
Moderation is for monks. •

What are the facts? Again and again—what are the facts?
Shun wishful thinking, ignore divine
revolution, forget what "the stars foretell," avoid opinion,
care not what the neighbors think, never mind
the unguessable "verdict of history"—what are the facts,
and to how many decimal places? You pivot
always into an unknown future, facts are your single clue.
Get the facts!

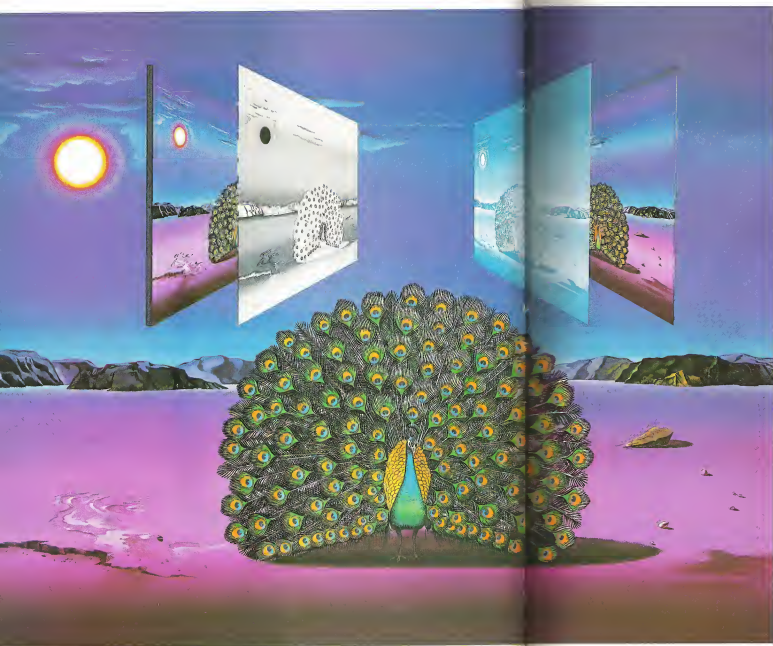
Tilting at windmills hurts you more than the windmills

Men rarely (if ever) manage to dream up a god superior to
themselves. Most gods have the manners
and morals of a spoiled child

A human being should be able to change a diaper, plan
an invasion, butcher a hog, conn a ship,
design a building, write a sonnet, balance accounts,
build a wall, set a bone, comfort the dying,
take orders, give orders, cooperate, act alone, solve
equations, analyze a new problem, pitch
manure, program a computer, cook a tasty meal, fight
efficiently, die gallantly. Specialization
is for insects.

The difference between science and the fuzzy subjects is
that science requires reasoning, while those
other subjects merely require scholarship.





• To be "matter of fact" about the world is to blunder into fantasy—and dull fantasy at that—as the real world is strange and wonderful. •

Do not confuse "duty" with what other people expect of you; they are utterly different. Duty is a debt you owe to yourself to fulfill obligations you have assumed voluntarily. Paying that debt can entail anything from years of patient work to instant willingness to die. Difficult it may be, but the reward is self-respect.

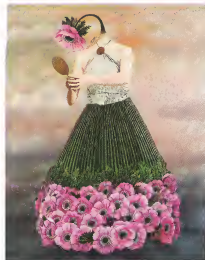
To stay young requires unceasing cultivation of the ability to unlearn old falsehoods.

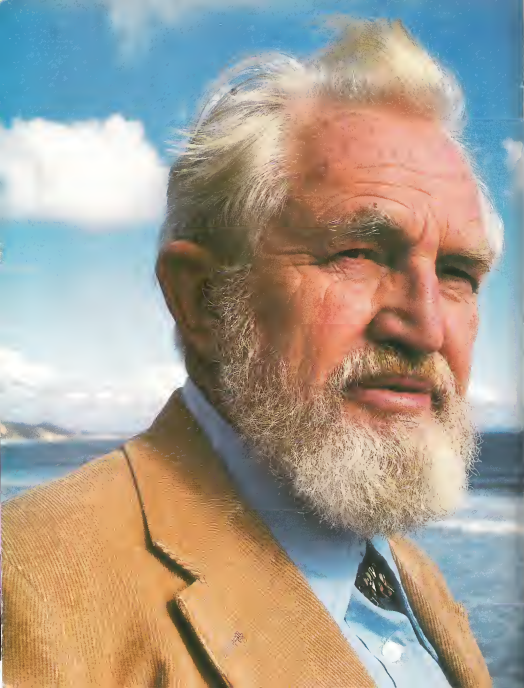
This sad little lizard told me that he was a brontosaurus on his mother's side. I did not laugh; people who boast of ancestry often have little else to sustain them. Humoring them costs nothing and adds happiness in a world in which happiness is always in short supply.

Anyone who cannot cope with mathematics is not fully human. At best, he is a tolerable subhuman who has learned to wear shoes, bathe, and not make messes in the house.

The more you love, the more you can love—and the more intensely you love. Nor is there any limit on how many you can love. If a person had time enough, he could love all of that majority who are decent and just.

DD





Are we starving the ocean by not dumping enough garbage into it? Are we ignoring the Pacific as an ideal storeroom for nuclear wastes? An unconventional expert attacks some sacred cows

INTERVIEW

JOHN D. ISAACS

The things he says would curdle the blood of any self-respecting conservationist. For one thing, oceanographer John D. Isaacs loudly advocates the storing of radioactive wastes on the ocean bottom. Environmentalists say the wastes would poison the planet. Isaacs retorts that "oceanic disposal of atomic wastes may be the sea's greatest contribution to power for humanity." For another, Isaacs opposes sophisticated secondary treatment of garbage before dumping it into the ocean. In fact, he'd like to see more waste in the sea. "That doesn't hurt the ocean," he says. "It helps it." Perhaps worst of all, Isaacs won't even spare that great sacred cow of the ocean, the porpoise, from his caustic tongue. He describes the public concern over the slaughter of this intelligent beast by tuna fishermen as being woefully misdirected. "In typical Isaacs fashion, he seems more worried about the tuna. 'Instead of demanding, 'How do we stop the slaughter?' " he suggests, "we should be finding ways to preserve the populations of both predators—porpoises and tuna."

PHOTOGRAPH BY BOB D'AMICO

Who is this madman, and why is he saying all these strange things about the ocean?

John Isaacs, who spends most of his waking hours tilling at popular notions about the sea, may just be the most creative oceanographer and lover of salt water in the world. He is no headline-hunting amateur, but a man with impressive credentials from more than 31 years of marine research and study. Since 1971 he has been director of the University of California's prestigious 25-year-old Institute of Marine Resources (IMR), based in La Jolla. There he presides over an annual budget approaching \$5 million, which funds research and public information in a wide spectrum of oceanic concerns: the nature of the sea itself, its contours and boundaries, its interrelated processes, and the effects of man's presence and actions.

Brimming with what he calls "modified optimism," Isaacs most enjoys destroying the popular notion that the ocean, poisoned by man, is dying and that nothing can be done about it. "Nonsense,"

says Isaacs: That's a belief generated by marine idols of the oceanic world (are you listening Jacques Cousteau?), compounded by a few scientists "who have come to value problems more than solutions."

"I am neither an optimist nor a pessimist," he says. "I'm a meliorist. A pessimist says things will get worse regardless of what we do. An optimist says they'll get better, regardless. But a meliorist says they'll get better if we do something about them."

Isaacs's purpose in life, as IMR director, is to "do something about them." And as a staff member of the Scripps Institution of Oceanography which he joined in 1948, Isaacs has literally roamed the globe to conduct research of his own: studies of the sea's deep-scattering layer, deep-sea photography (his cameras once snatched a hitherto unknown species of shark), climatology, water supplies, sea energy forms, sand transport, and the marine food web. It was Isaacs who, 25 years ago, proposed that Antarctic icebergs be towed to northern latitudes as a freshwater source. Equally eyebrow-raising was his suggestion, delineated in a formal scientific paper that the American custom of driving on the right side of the road may be an important contributor to the number, duration, and intensity of tornadoes. ("At least fourteen percent of U.S. tornadoes are under man's control," he insists.)

Born in Spokane, Washington, in 1913, Isaacs came to oceanog-

raphy in a roundabout way. Bored with college, he dropped out, becoming a merchant seaman and later a commercial fisherman. He has also been a logger and a forest-fire lookout. He returned to college (the University of California) and received a bachelor's degree in engineering in 1944, at the age of thirty-one. Meanwhile, he had bombarded Scripps officials with letters seeking a job ("I thought they could use a layman's viewpoint down there"), and in 1948 he was hired as assistant oceanographer. Despite his not having an advanced degree, he's been there ever since, presently as professor of oceanography; he was the director of the important Marine Life Research Group from 1958 to 1974, was acting chairman of the department of oceanography in 1966-67, and has been director of IMR since 1971.

He is a gregarious, good-natured man with a flowing, Santa Claus-like white beard who collects quotations as a hobby (they're sprinkled liberally through every Isaacs lecture and paper), and his La Jolla office, a study in orderly clutter, commands a view of the Pacific Ocean, whose secrets Scripps scientists have probed for 75 years.

Despite man's incessant impact, the ocean remains a major, virtually untapped resource for mankind, Isaacs believes. Our reporter, Joseph E. Brown, former editor of *Oceans* magazine, began the interview by testing Isaacs's "modified optimism."

Omniv: Is man killing the sea?

Isaacs: That is the widespread assumption, but I am strongly opposed to this view. With the exception of effects stemming from the highly selective nature of his fisheries, there is no evidence that man's activities can or will alter the general environment of the open sea.

I was present [as a scientific observer] and watched for more than three years, most often with horror, the indescribable violence that was perpetrated on Bikini in the Marshall Islands. Multimegaton explosions of nuclear devices ripped craters two kilometers wide in the coral reefs. Millions of megacubes of nuclear debris fell into the lagoon and into the surrounding sea. I don't condone these acts, and I hope that man will rapidly pass the phase in which he deems them to be necessary. The point is that Bikini epitomizes the immense resilience of the sea and its creatures. Despite the apparent fragility of the reef and lagoon ecosystems, in subsequent continuous studies it has been almost impossible to discover any abnormalities of these creatures or their populations.

Omniv: Surely, though, you are not suggesting that there should be no controls on the poisons and pollutants we put into the sea?

Isaacs: Of course not. The disposal of high-level radioactive waste in the sea or the deep subbottom must be undertaken with the most thoughtful study and caution. As for other waste disposal, such as domestic waste, there must be adequate source control of chemical pollutants. It's insanity to introduce into the sea such levels of organic mercury or DDT as have been discharged in the past into Minamata Bay in Japan or at Whites Point in California. Also, removal of floatable materials and other advanced primary treatment of sewage must be exercised, and offshore discharges must be properly designed. There must also be continuous monitoring for important pollutants, such as PCB, or

mutagenic compounds and mitotic poisons, such as dioxin.

But to devote immense amounts of precious capital for secondary, tertiary, or quaternary treatment to avoid feeding the open sea totally disregards, in my opinion, the true nature of the sea.

Omniv: You made this point about a year ago in testifying before a congressional committee in opposition to the proposed new Environmental Protection Agency rules that would require such treatment. At that time you discussed how life in the sea is actually stimulated by introduction of sewage and other materials. Can you give examples?

Isaacs: Certainly. Just offhand, witness the doubling of fisheries production in the North Sea over the last two decades, now reluctantly being attributed to the stimulating effects of the input of domestic wastes. Generally the same thing holds true in the southern California coastal area.

Omniv: What you are saying, then, is that as a result of some waste disposal restrictions we may starve the ocean of valuable materials essential to the survival of fish and other marine life.

Isaacs: Yes. Essentially all man does is take things out of the ocean, and, unlike any other member of the marine food web, he does not put back the things that can regenerate that life. In the eastern Mediterranean this is going to be particularly serious, where even the great inputs from the rivers, including millions of tons of organic material and nutrients from the Nile, are no longer flowing into that hungry sea. The Mediterranean is already a starved ocean. All of man's acts now are going to exacerbate that.

Omniv: How would you reverse this trend?
Isaacs: We should recycle organic material into the ocean, at least as much as was naturally introduced. Certainly, man should also put back at least as much as he takes out. Also, since the ocean in general is a

starving ocean—even in relatively rich places of the sea, like the California Current, the productivity is far below the potential—I cannot conceive that a doubling or tripling of the input can have any other than a beneficial effect. Even primitive people manure their fields.

In general, we fail to appreciate how the ocean operates. And nowhere is this more apparent than in the various proposals for secondary treatment of sewage. Somebody has said that secondary treatment [additional treatment of garbage before dumping it into the sea] is just an expensive way to pump oxygen into the ocean, a substance it already has in abundance. And to a degree this is true.

Omniv: Despite our accelerated research in the sea during the past few years, then, we still do not fully understand all that goes on there?

Isaacs: In the case of disposal of domestic wastes in the ocean, it is more a matter of not applying what we do know. Many countries bordering on the sea are planning these extremely expensive and highly advanced municipal waste-treatment plants, ostensibly to avoid "polluting" the sea with organic materials and nutrients. Such plans reflect a serious misunderstanding of science.

They neglect these specific facts: that a major part of the adaptation and activity of the creatures of the sea is directed to the conversion of waste particles into new organisms; that most of the sea is starved and particularly deficient in just those sorts of material that are introduced by domestic waste; that seawater is a toxic material to most land organisms, such as disease bacteria, and highly inimical to their survival; and that many parts of the sea are even denied the millions of tons of organic materials that once flowed annually from rivers for the natural flow of these materials is now being stopped by dams. There is no evidence that the marine discharge of "sec-

ondary rather than primary, effluent improves anything, and there are reasons to believe it may be more disturbing than any present practice.

In other words, these inputs appear mainly to be beneficial, contrary to the proclamations of [Jacques-Yves] Cousteau and [Thor] Heyerdahl.

Omn: What do you believe to be the basis of this misunderstanding of the sea's processes?

Isaacs: There are some very common myths. The bioaccumulation of trace metals via domestic waste disposal, for instance. The "delicate balance" of the marine environment. The alleged al-fearing properties of secondary sewage treatment. And many other clichés and misperceptions that have led us to a serious estrangement from reality.

Omn: Exactly what is this myth of the sea's "delicate balance"?

Isaacs: People do not understand that the "game plan" of the sea is different from that of terrestrial environments. Almost all the creatures of the open sea, unlike those on land, are born into a highly variable and stochastic [chance-dominated] system, in which they have little assurance of the nature of their prey predators, associates, or competitors. They eat anything grossly accessible to their mode of feeding and are eaten by anything to which they are available. Although this may seem repulsive to us, nevertheless it is the way of marine life.

At every step in the two living game plans of the land and the sea, these differences are further complicated. And the differences must be recognized if we are not to be misled in our attempts to deal with man's needs from the sea and his effects on it in the oftentimes painful process of his accommodation on this planet.

Omn: And the other myths?

Isaacs: There is an abundance of problems, if in fact they are problems, which have been defined too narrowly or erroneously or capriciously. Indeed, once these definitions have been recorded on the printed and persistent tablets of law or policy, the enforcing and regulatory agency involved may specifically constrain any research that questions the validity of the premises under which the law was established.

Omn: Can you cite any examples?

Isaacs: The Marine Mammals Act, as administered, in effect eliminates the possibility of meaningful inquiry on the tuna-porpoise problem [The act prohibits the killing or capturing of sea mammals, such as porpoises and whales.] The point can be made that marine mammals, including fishermen, and birds are a potentially serious destabilizing influence on the higher pelagic food web. They take from it but only vicariously participate in its maintenance. The question should be, How can a balance be maintained between these groups in the face of a selective mortality on the tuna? [Referring to the controversy over the fact that fishermen incidentally kill many

porpoises in their nets while harvesting tuna, one of the factors that led to passage of the Marine Mammals Act.] But this question can never be fully answered, because in order to do so, you must take porpoises from the sea to study them, and the law prohibits you from doing this. Thus, the fundamental problem, by law, is difficult to examine, for it questions the law.

Similarly, the policy on domestic-sewage effluent discharged into the open sea precludes research into its actual effects, for this would also question the presumption of law. This is the most ominous cut of all. Many of the regulatory agencies in the United States are beginning to adopt the pose of medieval churches, with regard not for what is true or right, but for what supports their own delusions of power omniscience, and infallibility.

Omn: You said in a speech in Oregon last year that "problems are our new frontier." What did you mean by that?

Isaacs: I meant that we have come to value

● *The aftermath of
the Bikini multimegaton
nuclear-bomb tests
has shown us the immense
resilience of
the sea, and its creatures,
despite its
much-popularized fragility.* ●

problems more than solutions. As Meg Greenfield has pointed out, we tend to "colonize" problems greeting each new one, real or otherwise, as new and precious land for settlement and a joyous, profitable existence. In fact, much effort is spent in cultivation and refurbishment of the problem so that it continues to appear fresh, important, and worthy down through the fiscal years.

Omn: Once again, an example?

Isaacs: Oil in the sea. We seem to think that oil is immensely and permanently damaging, something introduced only by man. Certainly the quantities and concentrations affecting beaches are unique in our era. But oil in the ocean is not unique. Geological structures eroding away have released great quantities of oil, you can look at the Trinidad or La Brea tar pits and imagine the immense quantities of oil that must have gone into the atmosphere and ocean. Innumerable ships were sunk along our coasts during World War II. Do you see any great permanent scars from them?

Omn: You're not suggesting that we should tolerate oil spills without trying to do something to stop them, are you?

Isaacs: Of course not. Oil spills are nasty. They are insults to the planet. People shouldn't be allowed to let them happen. Oil damages birds. It screws up the beaches. It fouls rocks. But the thing I really object to is how a scientist can take that situation—a single oil spill—and keep it where it ceases to be one.

Omn: In what way?

Isaacs: A well-known scientist several years ago investigated an oil spill in a small cove in Baja California. A small tanker had gone aground there. Recently, in commenting on another oil spill, he said on national television, in effect, "I've checked this cove every year since, and conditions are not yet back to normal." What he did not say is that for the past eight years the cove's biological community has been the richest he'd ever seen along the Baja coast.

Now what is it in a man's mind that makes him take a flap like that and build it up? Why does he keep the controversy going in public while in scientific reports he admits that that cove is at the richest point in its history?

Omn: Meg Greenfield's concept of "colonizing"?

Isaacs: Exactly. He's homesteaded that problem, and, by God, he doesn't want to damage it with the truth. I think this is highly reprehensible, as are scientists who always couch their findings in such language that no one but an associated specialist can understand. They are thieves, stealing knowledge from humanity with a thief's argot.

Omn: To the layman, at least, oil in the sea seems much less of a hazard to human health than nuclear wastes do. Yet you have endorsed a proposal for dumping nuclear wastes in the sea.

Isaacs: No, I haven't said that. I said storage, not dumping. There's quite a difference. Nor have I endorsed it. What I've said is that we have a great opportunity to determine the ocean's capacity for the safe storage of waste atomic materials. Obviously, the final solution to their disposal is subject to controversy, it involves providing certainly over great periods of time. Fortunately, man is presently gaining an unprecedented understanding of the geological and geophysical behavior of our planet.

Omn: You are referring to what we have learned about plate tectonics, the theory that the continents end stop huge and slowly shifting subsurface plates, causing continents to "drift" and causing earthquakes where one plate interacts with another?

Isaacs: Exactly. There are large areas of the sea that are far from these active zones. There are regions in the deep North Pacific, where we could store nuclear wastes far beneath the sediments and nothing would crack them open for ten million years.

Omn: Have we really learned enough about "continental drift" to say with absolute certainty that there are areas well-enough defined that we can deposit atomic wastes there safely?



FICTION

He had a good life, a good marriage, but the challenge was—death

QUIETUS

BY ORSON SCOTT CARD

I came to him suddenly, a moment of blackness as he sat at his desk, working late. It was as quick as the blink of an eye. Before the darkness the papers on his desk had seemed terribly important, and now he stared at them blankly, wondering what they were and then realizing that he didn't really give a damn what they were and he ought to be going home now.

Ought definitely to be going home now. And C. Mark Tapworth, of CMT Enterprises, Inc., arose from his desk without finishing all the work that was on it, the first time he had done such a thing in the twelve years it had taken him to bring the company from nothing to being a multimillion-dollar-a-year business. Vaguely it occurred to him that he was not acting normally, but he didn't really care; it didn't really matter to him a bit whether any more people bought . . . bought . . .

And for a few seconds Tapworth could not remember what it was that his company made.

This frightened him. It reminded him that his father and his uncles had all died of strokes. It reminded him of his mother's senility at the fairly young age of sixty-eight. It reminded him of something he had always known and never quite believed: that he was mortal and that all the works of his days would gradually become more and more trivial, until his death, at which time his life itself would be his only act, a forgotten stone whose fall in the lake had set off ripples that would in time reach the shore, having made, after all, no difference.

I'm tired, he decided.

MaryJo is right. I need a rest. But he was not the resting kind, not until that moment when, standing by his desk, the blackness came again, this time a jolt in the mind. And he remembered nothing, saw nothing, heard nothing, was falling interminably through nothingness.

Then, mercifully the world returned to him and he stood trembling, regretting now the many, many nights he had stayed far too late, the many

hours he had not spent with MaryJo, had left her alone in their large but childless house. And he imagined her waiting for him forever, a lonely woman dwarfed by the huge living room, waiting patiently for a husband who would, who must, who always had, come home.

Is it my heart? Or a stroke? he wondered. Whatever it was, it was enough that he saw the end of the world lurking in the darkness that had visited him, and, as for the prophet returning from the mount, things that once had mattered overmuch mattered not at all, and things he had long postponed now silently importuned him. He felt a terrible urgency that there was something he must do before—

Before what? He would not let himself answer. He just walked out through the large room full of ambitious younger men and women trying to impress him by working later than he, noticed but did not care that they were visibly relieved at their reprieve from another endless night. He

walked out, got into his car and drove home through a thin mist of rain that made the world retreat a comfortable distance from the windows of his car.

No one ran to greet him at the door. The children must be upstairs, he realized. The children, a boy and a girl had his height and with twice his energy were admirable creatures who ran downstairs as if they were sking, who could hold completely still no more than a hummingbird in midair could. He could hear their footsteps upstairs, running lightly across the floor. They hadn't come to greet him at the door because things in their lives, after all, were more important than mere fathers. He smiled, set down his attaché case, and went to the kitchen.

MaryJo looked harried, upset. He recognized the signals instantly—she had cried earlier today.

"What's wrong?" "Nothing," she said, because she always said Nothing. He knew that in a

PAINTING BY MICHEL HENRICOT

moment she would tell him. She always told him everything, which had sometimes made him impatient. Now as she moved silently back and forth from counter to counter, from cupboard to stove, making another perfect dinner, he realized that she was not going to tell him. It made him uncomfortable. He began to try to guess.

"You work too hard," he said. "I've offered to get a maid or a cook. We can certainly afford one."

MaryJo just smiled thinly. "I don't want anyone else mucking around in the kitchen," she said. "I thought we dropped that subject years ago. Did you—did you have a hard day at the office?"

Mark almost told her about his strange lapses of memory but caught himself. He would have to lead up to telling her gradually. MaryJo would not be able to cope with it, not in the state she was already in. "Not too hard. Finished up early."

"I know," she said. "I'm glad." She didn't sound glad. It irritated him a little. Hurt his feelings. But instead of going off to nurse his wounds, he merely noticed his emotions as if he was a dispassionate observer. He saw himself important self-made man, yet, at home, a little boy who could be hurt, not just by a word but by a short pause of indecision. Sensitive, sensitive, and he was amused at himself. For a moment he almost saw himself standing a few inches away, could observe the amused expression on his own face.

"Excuse me," MaryJo said, and she opened a cupboard door as he stepped out of the way. She pulled out a pressure cooker. "We're out of potato flakes," she said. "Have to do it the primitive way." She dropped the peeled potatoes into the pan.

"The children are awfully quiet today," he said. "Do you know what they're doing?"

MaryJo looked at him with a bewildered expression.

"They didn't come meet me at the door. Not that I mind. They're busy with their own concerns, I know."

"Mark," MaryJo said.

"All right. You see through me so easily. But I was only a little hurt. I want to look through today's mail." He wandered out of the kitchen. He was vaguely aware that behind him MaryJo had started to cry again. He did not let it worry him much. She cried easily and often.

He wandered into the living room, and the furniture surprised him. He had expected to see the green sofa and chair that he had bought from Desert Industries, and the size of the living room and the tasteful antiques looked utterly wrong. Then his mind did a quick turn, and he remembered that the old green sofa and chair were fifteen years ago, when he and MaryJo had first married. Why did he expect to see them? he wondered, and he worried again, worried also because he had come into the living room expecting to find the mail, even though, every day, for years, MaryJo had been putting it on his desk.

He went into his study and picked up the

mail and started sorting through it until he noticed, out of the corner of one eye, that something dark and massive was blocking the lower half of one of the windows. He looked. It was a coffin, a rather plain one, sitting on a rolling table from a mortuary.

"MaryJo," he called. "MaryJo."

She came into the study, looking afraid.

"Yes?"

"Why is there a coffin in my study?" he asked.

"Coffin?" she asked.

"By the window, MaryJo. How did it get here?"

She looked disturbed. "Please don't touch it," she said.

"Why not?"

"I can't stand seeing you touch it. I told them they could leave it here for a few hours. But now it looks like it has to stay all night. The idea of the coffin staying in the house any longer was obviously repugnant to her."

"Who left it here? And why us? It's not as

● He went into his study and picked up the mail and . . . noticed out of the corner of one eye that something . . . was blocking . . . one of the windows. He looked. It was a coffin. ●

if we're in the market. Or do they sell these at parties now like Tupperware?"

"The bishop called and asked me—asked me to let the mortuary people leave it here for the funeral tomorrow. He said nobody could get away to unlock the church and could we take it here for a few hours—"

It occurred to him that the mortuary would not have parted with a funeral-bound coffin unless it was filled.

"MaryJo, is there a body in it?"

She nodded, and a tear slipped over her lower eyelid. He was aghast. He let himself show it. "They left a corpse in a coffin here with you all day? With the kids?"

She buried her face in her hands and ran from the room, ran upstairs.

Mark did not follow her. He stood there and regarded the coffin with distaste. At least they had the good sense to close it. But a coffin! He went to the telephone at his desk and dialed the bishop's number.

"He isn't here." The bishop's wife sounded irritated by his call.

"He has to get this body out of my study and out of my house tonight. This is a terrible imposition."

"I don't know where to reach him. He's a

doctor, you know, Brother Tapworth. He's at the hospital. Operating. There's no way I can contact him for something like this."

"So what am I supposed to do?"

She got surprisingly emotional about it. "Do what you want! Push the coffin out into the street if you want! I'll just be one more hurt to the poor man!"

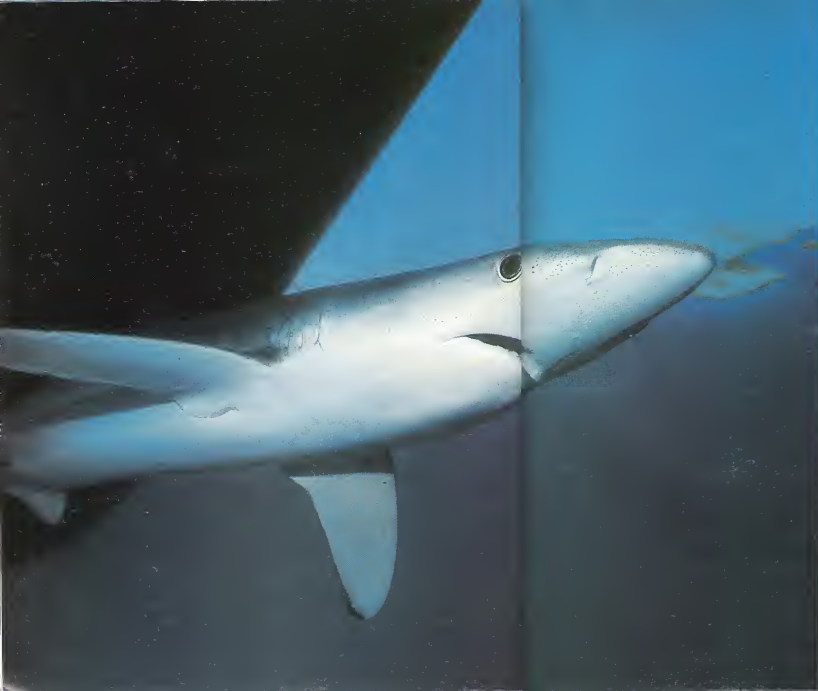
"Which brings me to another question. Who is he, and why isn't his family—"

"He doesn't have a family. Brother Tapworth. And he doesn't have any money. I'm sure he regrets dying in our ward, but we just thought that even though he had no friends in the world, someone might offer him a little kindness on his way out of it."

Her intensity was irresistible, and Mark recognized the hopelessness of getting rid of the box that night. "As long as it's gone tomorrow," he said. A few antiques, and the conversation ended. Mark sat in his chair, staring angrily at the coffin. He had come home worried about his health and found a coffin to greet him when he arrived. Well, at least it explained why poor MaryJo had been so upset. He heard the children quarreling upstairs. Well, let MaryJo handle it. Their problems would take her mind off this box, anyway.

And so he sat and stared at the coffin for two hours and had no dinner and did not particularly notice when MaryJo came downstairs and took the burned potatoes out of the pressure cooker and threw the entire dinner away and lay down on the sofa in the living room and wept. He watched the patterns of the grain of the wood, as subtle as flames, winding along the coffin. He remembered having taken naps at the age of five in a makeshift bedroom behind a plywood partition in his parents' small home. Watching the wood grain there had been his way of passing the empty, sleepless hours. In those days he had been able to see shapes: clouds and faces and battles and monsters. But on the coffin the wood grain looked more complex and yet far more simple. A road map leading upward to the lid. A draft describing the decomposition of the body. A graph at the foot of the patient's bed, saying nothing to the patient but speaking death to the trained physician's mind. Mark wondered, briefly about the bishop, who was right now operating on someone who might very well end up in just such a box as this.

And finally his eyes hurt, and he looked at the clock and felt guilty about having spent so much time closed off in his study on one of his few nights home early. He meant to get up and find MaryJo and take her up to bed. But instead he got up and went to the coffin and ran his hands along the wood. It felt like glass because the varnish was so thick and smooth. It was as if the living wood had to be kept away, protected from the touch of a hand. But the wood was not alive, was it? It was being put into the ground, also to decompose. The varnish might keep it a little longer. He thought whimsically of what it would be like



*Promising new research
may soon shield
us from an age-old terror*

SHARK!

BY KENNETH JON ROSE

A suntanned young boy swimming with his friends is the first to spot the shark. He points to its brown dorsal fin only meters away. The other children turn and look. Unconsciously the boy's hand reaches toward a small device belted to his bathing suit; he relaxes, knowing that the sonic repeller is vibrating its protective song. He looks at his friends. They are laughing. On the hot, sandy beach the swimmers' mothers watch and smile, then rub on some more Shark Away before they enter the water.

Elsewhere on choppy Pacific waters two stranded fliers drift in a small rubber raft and rifle through their emergency kit. Besides the usual food rations and medical supplies, they find a man-sized plastic shark bag and a small metal box containing a penlight battery and several spring-loaded electrodes. The two airmen glance at each other; their faces composed. The sharks are circling now. Yet the pilots know that, however long they must wait for help, they will be safe.

Such incidents may actually happen in the next few years. Scientists have realized for quite some time that the shark is neither the mindless monster it's been made out to be nor a willful killer bent on the destruction of human lives, but merely another animal, with common animal instincts. This viewpoint has become more and more prevalent among biologists, and



its greatest impact has been to open the way for the first effective shark repellent.

Since they first ventured out on the sea, men have leered the shark. Sailors made "magic" devices to ward off the swimming terror, and though these contrivances may have pleased ancient gods, they served only as dessert for the sharks.

In the last few decades we have made significant advances in our attempts to protect ourselves from shark attack. Yet many recent means of defense, including nets, bubble banners, and steel fences, have proved impractical, too expensive to maintain, or simply unworkable. Now it appears that researchers have become more confident that antishark defenses will be both effective and inexpensive in the not-too-distant future. Their assurance is based on a growing understanding of the shark's physical makeup and senses.

Pretend that you are swimming and playing in the ocean at a summer resort. Half a kilometer away a shark hears your splashing and veers toward the beach. It is searching for food.

Do not be surprised that the shark can sense you from such distances. The sound of your splashing is transmitted through water both faster and farther than it would be through air. Arthur Myberg and Donald Nelson, working at the University of Miami in Florida, have found that, although sharks are sensitive to most ocean noises, they seem very interested in pulsed, low-frequency sounds. The intriguing thing is that low-frequency pulses are typical of the sounds made by struggling fish—or by swimming, splashing human beings.

In one experiment Nelson placed a loudspeaker several meters under the ocean surface and played a sound he had discovered sharks found most attractive. Within minutes several gathered around the speaker, circling it as if it were lunch.

Although Myberg and Nelson have yet to discover a sound that repels sharks instead of attracting them, a protective noise generator that could be attached to your bathing suit or installed to defend a bathing area is not out of the question.

The shark is now 450 meters away from you. Unlike many sharks, it swims near the surface, its dorsal fin knitting the surf as it approaches you.

The shark is not an intelligent animal, but it is a highly adaptable one. Why the shark did not die out with the dinosaurs has baffled the scientific community for years. Because the shark's skeleton is composed of cartilage (the material that makes up the flexible framework of your ear), it decomposes instead of being fossilized after the shark's death. Thus millions of years of evolutionary answers have been lost forever under tons of earth. However, harder re-

From top left: Researchers capture, dissect, and strip the toxin from a Red Sea sole (also seen at right), whose potent nerve poison prevents sharks from biting down on their intended prey.



mans, such as ancient sharks' teeth, tell a fascinating story—one that may give insights into our own future.

The first chapter of shark history began more than 300 million years ago in the restless oceans of the Devonian Period. At that time, long before the appearance of dinosaurs and flowering plants, much of the land that now forms continents was under water. What little hot, dry land did exist was the site of fierce ecological competition among ferns and other vegetation.

When the sharks arrived in this environment, they were but a meter long, not yet the terror of the seas. These primitive sharks looked somewhat different from most of the sharks that range the oceans today. Modern sharks evolved from them, as modern man did from Neanderthal man.

The shark survived because it could generalize both its physical structure and its eating habits. When the environment changed, opportunities for shark survival greatly increased. In many ways their history has paralleled our own. We have also changed with our surroundings.

Several scientists have suggested that the shark's mating structures and behavior are more similar to those of mammals, and to our own, than to those of fish. During courtship, the male tries to get the female's attention by bumping into her and lightly biting the back of her head or the fins on her side. If he succeeds, the female will allow the male to swim belly to belly with her, much as whales position themselves in mating. Finally, the male shark inserts one of two penislike appendages, called claspers, into the female, and life begins again. The ability of a supposedly primitive animal to mate as mammals do underscores the method's success.

Also surprisingly like humans, some sharks bear live young. Most are ovoviviparous, that is, the eggs are hatched inside the oviducts, and the hatchlings feed on their yolk. Several shark species lay thick, rubbery eggs on the ocean bottom and leave the hatchlings to the whims of the sea. But a few sharks, like the marmals, are viviparous; the eggs are hatched in the oviducts, but a placenta connects the embryos with their mother. In as little as nine or ten months as many as 70 baby sharks arrive in the world, equipped to hunt from their very first day.

When the shark is within 400 meters or so, it has probably located you by a sense of smell so acute that it has earned sharks the nickname "swimming noses." The shark's nostrils, actually nasal capsules, are located just in front of the mouth, on the bottom of the flat snout. When the shark swims in its characteristic zigzag pattern, it is trying to expose both nasal capsules to the strongest odors, tracking its prey much as a bloodhound twists its head to sniff the air. Sharks may pick up the scent of blood in amounts as low as 1 part in 25 million.

During World War II the U.S. Navy invented what it thought was an effective repellent, confidently called Shark Chaser.

Composed of black dye and copper acetate in a slowly dissolving tablet, the mixture eased the fears of pilots and Navy personnel. It did little else. The repellent, clearly effective on a few species of sharks in laboratory tanks, was tragically ineffective in keeping away the wild sharks that really mattered.

The main drawback with chemical repellents has been that after a while in the water they begin to lose their effectiveness. They soon become completely worthless.

Recently something found in the Red Sea changed this picture. Eugenie Clark, of the University of Maryland, and other scientists discovered a fish that secretes the fastest-working poison found in the animal kingdom. The fish, a member of the sole family, emits a chemical that, even when diluted by 5,000 times its weight of water, can kill some aquatic life. Yet it is virtually harmless to humans.

Clark and her colleagues have determined that this chemical is an effective

● Sharks are very sensitive to ocean noises.

Pretend you are swimming in the sea: Half a kilometer away a shark has heard you and is heading to the beach, searching for food. ●

shark repellent. Watching a sole tethered underwater, they found that when a shark approached the fish, the shark's mouth locked open and could not bite down. Biochemists at Hebrew University in Jerusalem are now trying to synthesize the poison. When they succeed, it may be applied like suntan lotion. Perhaps it can even be incorporated into a bathing suit.

But how much chance is there that you will ever be attacked by a shark in the first place? If nothing else, the odds against shark attack are in your favor. Of the 4 billion people on this planet, only about 100 are attacked each year, and only 50 of these attacks prove fatal. More people are killed by venomous spiders than by sharks, and three times as many are killed by lightning.

Not all sharks are man-eaters. Of the roughly 250 species of sharks in the world, only 27 are known to be dangerous. The two giants of the shark kingdom, the 12-meter basking shark and the 16-meter whale shark, are both harmless. They eat only the fry life that drifts just under the ocean's surface. They very nearly resemble the baleen whale. There are several sharks that mature when they are as large as an adult's

hand. One species that lives in the ocean's depths is only as large as a human finger.

Perry Gilbert, a noted shark expert associated with the Mote Marine Laboratory in Sarasota, Florida, and with Cornell University, has found that even man-eating sharks are really not interested in people as things to eat. Their diet consists principally of fish. But when a fish is struggling near a bather or is attached to a diver's belt, the story is different. The shark may well attack the swimmer because he or she is in the way of the real food. This is one reason why many people are attacked. Others may be attacked as intruders in the shark's territorial waters. Either way the shark repellents now being developed may soon make such incidents things of the past.

By the time the shark is within 30 meters of you, it has picked up the turbulent streams and vortices your swimming creates in the water. It does so by means of a complex sense organ called the lateral line. Common to almost all fish, the lateral line consists of fine, liquid-filled channels that run under the skin of the head and sides of the body. Inside the channels, clusters of sensory cells, called neuromasts, connect to the outside through tiny pores. It is the neuromasts, which have small hairs reaching into the pores, that sense movement in the water.

At 15 meters, the shark can clearly see your arms and legs flapping at the surface. The shark's eye is normally focused for long-distance vision. Unlike the lens of a human eye, its lens must be pulled forward to discern nearby objects. Eugenie Clark has found that sharks are highly sensitive to contrasts of light, shadow, and motion. They are not very good at picking out dark stationary objects. She has even found that sharks can recognize different shapes. These sharks might be able to learn which target shapes have food behind them.

Both the lateral line and the shark's vision can be fooled by a single device. Dr. Scott Johnson, working with the Navy, has invented a man-sized plastic bag that, drawn around a swimmer, is nearly 100-percent effective in preventing shark attack. Named the Johnson Shark Screen, the large, dark-colored sack is held partially out of the water by three air-filled floats at the bag's opening. The bag helps contain the user's odors and movements, thus canceling out the shark's sense of smell, its lateral line, and its vision, and so protecting the swimmer inside. Still in the testing stage, the Johnson Shark Screen seems to promise an excellent defense for sailors and downed airplane pilots.

The shark is now five meters away; its gray form boiling toward you, mouth open.

The shark has a most impressive bite. One incredible example is the 2.5-meter dusky shark, which has a biting pressure of three metric tons per square centimeter.

Then there is the matter of teeth. Shark "teeth" are really modified and enlarged placoid scales that move to the front of the jaws. Unlike the teeth of mammals and

those of other fish, they are not set into the bone but are attached to the gums. The teeth form in rows, the row in front being used and five or more rows of replacement teeth waiting behind it. Shark's teeth don't wear down. Always moving, the rows slowly migrate like interlocking tombstones toward the front of the jaw, where they eventually fall out. Within a lifetime a shark may produce thousands of teeth. A whole row can be replaced in as little as a week. Divers have reported finding high-tensile cable completely bitten through, with the unmistakable marks of sharks' teeth cut into the metal.

Facing these weapons, how can you hope to get to shore safely if the shark decides to attack? For that matter, what makes the shark attack in the first place?

Not long ago Adrianus Kalmijn, working at Woods Hole Oceanographic Institute, in Massachusetts, isolated one key factor that decides whether the shark will finally attack. Sharks have an electric sense.

These sense organs line the shark's snout, looking like tiny pinholes. The holes communicate with an extensive system of jelly-filled canals just beneath the skin. Called the ampullae of Lorenzini, these canals can detect electrical fields as weak as one hundred millionth of a volt per centimeter, a feat equal to detecting the electrical field of a flashlight battery with electrodes 1,600 kilometers apart in the ocean.

Every living organism, including a human being, produces an electrical field in water. Sharks always associate an electrical field with their prey and can pinpoint their food with extreme accuracy even when it is buried and invisible under the sand. Although the electric sense is effective only within a few centimeters of the food, it is very reliable. With it, the shark can zero in on its prey when the odor and the light are too faint to detect it by smell or sight.

Kalmijn has found that he can substitute the shark's regular prey with electrodes that look nothing like a fish but simulate a fish's electrical field. The sharks, dependent on the electrical signal of the prey, will attack the electrodes over and over again.

Though biophysicist Kalmijn is working with sharks solely to study their electrical orientation, the day may come when this sense is used to protect swimmers. A device attached to your swimsuit could both warn when a shark is in the area and deploy electrodes around your body to confuse it while you slip out of the water unharmed.

At three meters away from you, the shark suddenly turns and swims off, shaking its head violently. It will not return. You turn off the device on your bathing suit and head for shore.

It seems reasonable to assume that an effective shark repellent will be made in the next few years. When that day arrives, you will be able to enter the water without fear of attack, and the shark, for so long the evil monster of the seas, will finally become just another fish. **DD**



JACK NEWTON DANIEL made whiskey in 1866 by a method called charcoal leaching. We say charcoal mellowing today.

Whatever you call it, you start with hard maple from the Tennessee uplands and burn it to char. You grind this charcoal to the size of small peas and tamp it tight in vats. Then you trickle whiskey down through the vats to mellow its taste. Around 1945 we changed the name of this method from *leaching* to *mellowing*. It seemed a better way of describing it. But that's the only part of Mr. Jack's process that needed improving.



CHARCOAL
MELLOWED



DROP



BY DROP

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Placed in the National Register of Historic Places by the United States Government

FICTION

*It isn't easy to reach paradise, even when
you devote all your
hardest labor and guile to the task*

THE FOX AND THE HEDGEHOG

BY JOHN ANTHONY WEST

It was Friday afternoon, payday. Fox was on his way to tip off the supermarket. But as he trotted along, his head full of new schemes, he was stooped in his tracks by a strange sight.

Before him, stretching as far as he could see either to the right or to the left, there was a high wall. At the base of this wall Hedgehog was digging furiously.

Now Fox knew that Hedgehog was a prickly customer, edible only under extreme duress, and then only by paying assiduous care to culinary technique.

"Outsight, Pricklypork!" said Fox with familiarity and a hint of derision. "Would you mind telling me what you're at, Man?"

Knowing his low rating on the gourmand scale, Hedgehog had no fear. Without ceasing his furious digging, he said, "Trying to get to the other side, Man. Obviously."

"Far out!" said Fox. "But you'll never get there that way, Man! That wall is made of solid stone. On reinforced concrete foundations. Can't you read, Man?" Fox pointed to a sign on the wall, slightly to the left.

Because Hedgehog always looked straight ahead, he had never noticed the sign. It read:

This wall is guaranteed against hurricane, earthquake, holocaust, flood, and all acts of God.

This wall is guaranteed against battering rams, artillery, napalm, nuclear attack, and all acts of Man.

This wall is guaranteed to withstand seven days' march about its perimeter and subsequent trumpet blast.

This wall is guaranteed termite- and hedgehog-proof.
Adam and Sons, Ltd.,
Bldg. Contractors

"Builders will say anything," Hedgehog replied calmly. "And I am determined to get to

the other side." He resumed his digging.

But now Fox was intrigued, though it was getting late, and the supermarket would soon be emptying out.

"Hey, Man! What do you want to get to the other side for, when all the good things of life are over here? Rabbits in the hedges, Man! Fridays, payday, supermarket jammed. You can rip off anything you want. Everywhere you look, little vixens twitch their bushy tails!" He pointed knowingly at his head. "Use your tuchis, Man. You can make all the bread you need without even working!"

Hedgehog did not understand this latter allusion, and Fox explained contemptuously. "You don't know that did one Man? Like there are these two Irishmen, dig? Pat and Mike. They both open shops in the Jewish quarter. Pat goes broke. Mike gets rich. Bankruptcy sale closes Pat down. Pat goes to Mike. Says, 'How

PAINTING BY ERIC PAETZ



do you stay in business, Man, dealing with all those smart Jews?" Ah! says Mike, and he points to his head. "Sure and begorrah, 'tis easy! All you have to do is to use your *túchtas*!"

Hedgehog was unamused and continued digging. "Don't fancy rabbit," he replied. "It is dishonest to rip off the supermarket. Besides, I'm so slow on my feet, I'd get caught. Vixens hold little attraction for the likes of me, nor am I interested in making a lot of bread."

"Chacun á son goût, Man," Fox said amiably. "But I still don't see why you want to get to the other side?"

"That is the Garden of Eridu," said Hedgehog, digging.

"Far out!" said Fox, for lack of anything better to say. For he considered Hedgehog's reply unsatisfactory, if not deliberately irrelevant. "What is there, then, in this Garden of Eridu that we do not already have on this side?" he asked, mimicking Hedgehog's somewhat stilted syntax.

"The question," said Hedgehog, "is inauspiciously phrased. Ask instead: 'What is there not in the Garden of Eridu that there is on this side?' In the Garden of Eridu there is no Time."

This made Fox stop to think. For just a moment the schemes that were always racing through his head came to a halt. Upon reflection, he wearied of rabbit. There was little luck left in ripping off the supermarket, since the food was full of chemicals and

additives. Vixens? Well, vixens were a problem. But when you came right down to the nitty-gritty, they were all pretty much the same. And the bread was worth less by the year, even if you used your *túchtas*. It looked as if there would soon be a change of climate.

Strange, thought Fox, that though he knew so much, no one had ever mentioned the Garden of Eridu. Nor in all his comings and goings had he ever noticed the long, high wall. "But," he said to Hedgehog, "I'll tell you this, Amigo. You'll never get to the other side by digging. We must find a way over the top. My curiosity has now been aroused. Follow me, and we'll find a way, Man!"

"Cool," said Hedgehog, and he stopped digging long enough to watch Fox leap mightily in the air, hoping to catch the top ledge and hoist himself over. But high as he leaped, he could not even see the top. He vaulted again and again, each time higher, but in vain.

"You see? Not so easy," said Hedgehog, and he began to dig again.

Fox waited till he caught his breath, and immediately he hatched a new scheme.

He trotted over to a builder's merchant and asked the boss for professional advice. Now the boss was something of a jackass and loved to hear himself bray professionally. After a lengthy diagnosis, he recommended a scaling ladder of appropriate height. But Fox declared that carry-

ing a heavy ladder through a public street was an ungentlemanly occupation for a fox. He had an easier solution. And he asked the builder's merchant for a long length of best-quality, groovy-colored nylon rope and some grappling hooks.

Because the boss was a jackass, he turned his back on Fox and went up to the stores to fetch the rope. No sooner had he gone than Fox availed himself of the longest ladder in the shop and trundled it off to join Hedgehog at the wall.

However, despite knowledgeable calculations, Fox had again misjudged the height of the wall. The ladder was nowhere nearly high enough.

Pondering what to try next, Fox was interrupted by the sound of a passing helicopter out on traffic patrol. Immediately Fox had a scheme.

While at the builder's merchant's, he had also managed to acquire a pocketful of handy tools. Now, with screwdriver, pliers, and soldering iron, he swiftly converted the Rewox tape recorder that he always carried with him into a two-way radio, attracted the attention of the chopper pilot, and bedazzled him with a story—a story so eloquent, so plausible, so rich in convincing detail that no one could doubt its veracity.

Briefly Fox claimed that he was a resident of Eridu who, while away on a combined business/pleasure trip, had been accosted by tattooed yobboes on motorbikes (Fox described each yobbo minutely, quoted their tattoos, and cited the engine capacities and makes of their bikes). His passport had been stolen. And now, trying to get back home, he found they had also taken his key. Would he, the chopper pilot, therefore drop a lifeline to him, and give him a hoist over the wall—for an ample remuneration, of course?

But when the pilot looked, he could not see the garden, nor even the wall. At first he tried to discern Fox's motives, which he knew to be invariably ulterior, and then he thought that maybe Fox was just on a bum trip. But he was too busy trying to unsnarl an interminable traffic jam to delve into the matter. He, too, was concerned about atmospheric conditions, and he was anxious to get back to base in time for tea. Cutting Fox off the transmitter, he flew the chopper on its way.

It was finally clear to Fox that neither brute force nor guile nor even creative imagination would get him over the wall. Fox spoke sharply to Hedgehog, who was distracting him by pointing to a tiny chip of concrete that he had at last succeeded in dislodging.

Fox dreamed up another still more audacious scheme. He would resort to magic. He trotted along to a bookshop where he often browsed but seldom made a purchase.

Now this bookshop like all bookshops, could not make money selling literature and it stayed in business only by peddling porn. But the bookstore owner was a shy old



JOSEPH
FARRIS

dog. He knew that if he took his eyes off Fox, even for a minute, to fetch a set of those amazing Dutch playing cards out from under the counter—where the hardcore stuff was kept—Fox would have something else. So he said he was out of stock.

Fox accepted this explanation with typical sangfroid and sauntered over to the kiddies department to chat up the pert little vixen there.

But she had been warned about Fox. So when he told her she had the sharpest, wettest, blackest little nose he had ever seen, and the beadiest eyes, and the bushiest tail in the world, she blushed nicely, but she said, "No way, Man!" She declined his invitation to meet her in the classics department—where nobody ever went.

Lighting a Turkish cigarette in a long, amber holder, and blowing the smoke out in blue streams through his nostrils, Fox begged her to allow him to clear up an evident misunderstanding.

For he was not your everyday, run-of-the-mill Freddy Fox, of whom she should rightly beware, he said. Rather he was your actual Twentieth-Century Fox, in person. "Just call me Twentieth-Century," he said breezily. And he was, he said, out on a reeky, looking for the right someone to star in his new musical version of *Snow White and the Seven Dwarfs*.

This cast the matter in a new perspective. The little vixen knew precisely what Hollywood would do with *Snow White*, and she had no objection to the full frontals. But she hoped that, if she got the part, maybe they'd find a double for the close-up work with the dwarfs. She readily assented to meet Fox after hours for a screen test and to bring along the book of fairy tales he requested so that they could run through some scenes.

She went at the screen test with so much artistry that they did several takes, momentarily distracting Fox. But at last he sent the little vixen packing, giving her a duff check to buy a plane ticket to L.A. and promising her that, with her talent, she would soon be a great star.

He flipped through the fairy-tale book till he came to the one about Jack and the beanstalk. He plucked some seeds from one of the illustrations, then scattered them on the ground in front of the wall.

"Now you just watch this, Man!" he counseled the skeptical Hedgehog.

At first nothing happened. Then Fox watered the seeds with the sweat of Hedgehog's brow, with the tears of his own impatience, and with a bottle of vintage champagne he'd ripped off from the supermarket and was saving for a special occasion. In a trice the beanstalk grew as high as the eye could see. But Fox had no time to stand around admiring the horticulture; there was something in the air. Nimbly he scampered up the beanstalk, oblivious of the jet planes roaring past him.

Fox climbed and climbed. But no matter

how high he climbed, the top of the wall that kept him from the Garden of Eridu was still higher, and out of reach. And as he climbed, he realized that he had been so busy trying at all costs to get to the top that he had quite forgotten his original compelling reason to do so. In a flash of intuition, he understood that climbing was not enough; it was essential to know the reason for climbing as well. And for that he needed Hedgehog's counsel.

Assuming that Hedgehog was climbing right behind him, he looked down, intending to ask why it was that they were there. To his astonishment, Hedgehog was nowhere to be seen.

Squinting, and looking far, far down, Fox could just make out a tiny shape scurrying away at the base of the wall.

The signs to the west were ominous. Fox virtually flew down the beanstalk to where Hedgehog was digging.

With unharmed solemnity Hedgehog explained that he had lost patience with Fox's wild schemes; he had decided that Fox was just up to his usual shenanigans, and he had therefore gone back to doing the only thing he knew how to do, which was to burrow away at the wall.

Fox was beside himself with impatience. "Yes, Man, I'm with you. I know all that! But why the devil do we want to go there in the first place?"

"Go where?" Hedgehog asked, steadily digging.

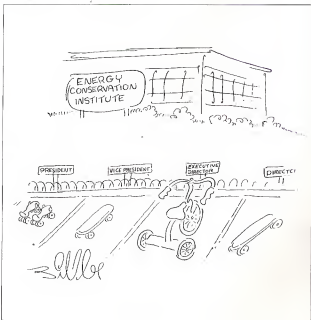
Fox was jumping up and down, he was so exasperated. "Into the garden, Man! Into the Garden of Eridu!"

"How many times do I have to explain it to you," Hedgehog replied, rhetorically, pedantically, unharmed. "Because in the Garden of Eridu there is no Time."

Fox clapped a hand to his forehead histrionically. "Far out! I knew there was a good reason!" he shouted. "Come on, Man, shake it!"

Something was really going on in the distance now, but Hedgehog had launched into a philosophical and psychological explanation of the significance of the Garden of Eridu and of the importance of his quest.

Fox cut him short and, taking him by the paw, led him swiftly up the beanstalk to the top. But as they stepped out onto the wall that separated the garden from where they had always been, Hedgehog balked. He had never been off the ground before, and now he suddenly discovered he was afraid of heights. Before taking the plunge, he wanted to discuss the implications of this newly discovered aspect of his character. Unceremoniously Fox pushed him off the wall and, taking a deep breath, jumped after. And from the timeless safety of the Garden of Eridu they watched as the western sky was rocked by a light that was not lightning, sent by a sound that was not thunder, and clouds from which no rain fell billowed high in the air, completely obscuring the distant horizon. ☐



ALOFT

Weekend "astronauts" fill the skies

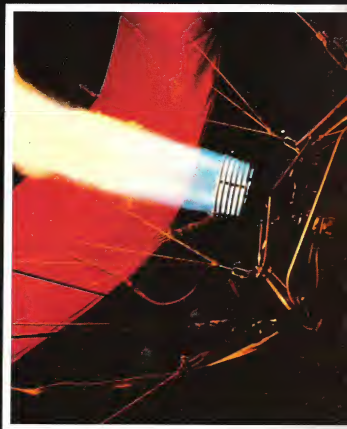
BY NICK ENGLER

Rainbow-colored monsters fill the skies. Flying spheres, eight stories tall, glide serenely downwind. No web of contrails; no whine of engines. Just acres of nylon and the occasional hiss of a propane burner—the dragon's breath that keeps these giants aloft.

PHOTOGRAPHS BY SEBASTIAN BASTEL



• Ballooning is, perhaps,
the closest thing to space travel. The world
seems to turn beneath you. •



Ballooning is, perhaps, the closest thing to space travel. Aloft
in a balloon, you are exhilarated by the view—and
the quiet. You look down from a majestic silence, broken only
by periodic blasts of propellant (maneuvering
rockets?). There is no sense of motion; the world seems to
turn beneath you.

• Slowly the hot air escapes from the envelope, and the balloon sinks to the ground, a writhing, dying dinosaur. •



But if balloon flight is as grand as spaceflight, landing is as undignified. You either splash down or bump down—the same choice you have in a space capsule. The basket hits, bounces, drags, finally stops. Slowly the hot air escapes from the envelope, and the balloon sinks to the ground, a writhing, dying dinosaur.



Modern hot-air ballooning and manned spaceflight began in the same year. In 1961, when astronauts Yuri Gagarin and Alan Shepard lifted off, inventor Ed Yost test-flew the first propane-powered aerosol. Today it's not unusual to see half a dozen balloons in a Saturday morning sky. At the 1978 Albuquerque (New Mexico) International Balloon Fiesta (where these photos were shot), 270 balloons launched simultaneously, the largest assemblage of aerostats ever.

Why this soaring interest in aeronautics? The answer is the same as for astronautics, although there is no rationale of "terrestrial applications." Samuel Johnson put it this way in 1759 as man was about to leave the earth in machines of his own devising: "I have long been of the opinion . . . that the fields of air are open to knowledge, and that only ignorance and idleness need crawl upon the ground."

□□

◉ The fields of air are open to knowledge . . . only ignorance and idleness need crawl upon the ground. ◉

It was radical, it was daring,
but mostly it was cheap

VAGABOND

BY DAVID SEARLS

On March 2, 1970, a rectangular U.S. spacecraft nicknamed "Mariner" went into orbit around Earth's third planet from the sun and our nearest neighbor in the solar system. Over the next several days "Mariner" released three sophisticated probes—one to study the planet's "wet side," one for the "dry side," and an orbiter intended to skim the surface once every few years. This was the very modest Vagabond Mission, the first such exploration of the blue planet and an effort that has since forced scientists to rethink long-held assumptions about the origin and composition of all we know. "It's back to the drawing room," exclaims Dr. Ouzo Zolmog, Vagabond Mission project director at the U.S. Thought Population Laboratory (TPL), prime contractor for the mission. "The old facts are out the window. It will take years of interpretation to replace them." This is hardly what anybody expected before the mission began. Given Dregg's law—that findings increase

PAINTING BY DEAN ELLIS



as the square root of fundings—Vagabond should have produced only a few short jobs and some dull articles in obscure journals.

By the time Vagabond came around to dip from the river of federal funds for planetary exploration, that once-brooding stream had slowed to a trickle. When its cup was filled, Vagabond's budget was a mere \$199,999.99—almost a billion dollars less than the Viking Mission to Mars and \$277,999,800.01 less than the Pioneer Mission to Venus.

"Most of that was for parts," Zolnidrg complains. "We had to cover labor costs with extra hours and grant money for barely related humanities projects."

With so little funding, the TPL was forced to scrap long-established plans for exploring the little-known outer planets and to concentrate on more conventional bodies.

So TPL lowered its horizons. All the way "Earth was about the only choice," Zolnidrg says. "Everything else was too far away and too damned expensive, except maybe the moon. And who wants to go there? We've been there about six times, and it always looks like Winnemucca. Or is it Elko? I forget which."

Despite talent and time as short as the money, Zolnidrg and his associates managed to put together virtually all the mission hardware in a matter of months. Although credit must be given to the mission staff, the project owes much to what must be the most resourceful subcontracting in the history of space exploration.

"Van," the mother orbiter, was developed with assistance from a top-flight southern California custom shop. It was built on a Dodge chassis and came equipped with a 40-channel CB radio.

"Martin," the website probe, followed designs supplied by a consortium of prominent beverage retailers.

"Beans," the dryside lander, was developed almost entirely by American Tourists Corp. (The lander was named after Dr. Zolnidrg's pal of the unfortunate victim of a suitcase-like prototype dropped from an airplane.)

"Rosebud," the stocklike orbiter, was subcontracted entirely to a sixth grade class in Montkums, Idaho.

The entire payload was shipped to Cape Canaveral, where it was assembled on site by volunteer experts from the local Gezebar Lake Rotary Club. The launch vehicle, an Easton Wozzzyv, was an untested 476-stage configuration—the largest and most complex design in Easton's history.

The launching took place on a gray winter dawn from the rarely used Pad 07, actually a reserved parking space specially converted for mission requirements. Minutes later "Van" achieved sky orbit.

After weeks of careful procession, "Martin" dropped through "Van's" trapdoor and descended toward Earth's blue expanse.

It marked the beginning of the end for modern cosmology.

Halfway down, "Martin's" sensitive in-

struments detected yeast in the atmosphere. This was auspicious news. "This indicates the possibility not only of life," Zolnidrg said at the time, "but of food and drink as well."

This likelihood seemed more certain when the probe's transmissions became slanted and incoherent just before plap-down. It seemed all the more convincing when "Martin" detected concentrations of salt and other species on the planet's wet surface. No doubt remained when "Martin's" transmissions ended abruptly.

"Obviously," Zolnidrg says, "Martin was eaten."

Equally striking findings were returned by "Beans," which followed "Martin" out "Van's" trapdoor and into history. After bouncing across half a continent, "Beans" came to rest in the planet's Sun Belt. After checking its instruments to verify that every system had survived the landing, "Beans" smelt its cornets of the surface and took 12 pictures. Only one could be developed.

● Halfway down, sensitive instruments detected yeast in the atmosphere. It was auspicious news. "This indicates the possibility not only of life," said Dr. Zolnidrg, "but of food and drink as well." ●

J. Ralph Sea, president of Potomac Corp., prime subcontractor for the dryside lander, photographic profile claims that the disappointment conforms with mission guidelines.

"Hey, come on," he says. "We did the job for a lousy ninety-two dollars and twelve cents. And we're talking about a camera here. You bounce it across half a continent and you expect perfection? Besides, those crews haven't even paid us yet."

American Tourists Corp., which built "Beans," offers a less vigorous defense. A company memo reads: "Frankly we designed the vehicle to hold clothes and eggs. Cameras are another matter."

The marginal results obtained from the single usable photo were computer-enhanced to supply details missing from the original. The enhancement software was developed by TPL staffers. The \$80-44 cost was paid for by that amount withheld from Potomac Corp. to compensate for the 11 shots that failed to come out.

The enhanced photo shows a stark asphalt-and-gravel plain topped by a vomitike protrusion. Fumes can be seen escaping from the vent, indicating an active surface.

The third probe, "Rosebud," did not follow its compansia directly to the earth's surface. Instead it headed away into space on a highly unusual path that should bring it back within inches of the planet's surface once every nine years if all goes well. The first flyby is scheduled for 1988.

"Rosebud" follows the most severely elliptical orbit in the history of spaceflight, if not in the history of Newtonian physics. Its control calculations are extremely precise. Dr. Dillard Eggborn, chief orbital specialist at TPL, explains: "We're dealing with a very small window here. This baby comes screaming in from space, scoops up some samples, and zooms off into space again. If she comes in too low she can damage the planet, too high, and we're out of business for another nine years. I mean we're talking about Mach twenty at flyby. Couple inches off either way and we're cooked for sure."

Even without "Rosebud's" contributions, the Vagabond Mission has already provided enough information to make scientists take another look at what the world is, what it is made of, and how long it has been around.

In the few short months since "Martin" and "Beans" delivered their startling findings, several new theories have developed concerning the origin, composition, and age of the universe.

Dr. Clark Salloway, famous astronomer and personality from Cornell University and special consultant for media affairs at TPL, summarizes these new cosmologies: "It is clear by now," he says, "that the universe was formed by a baking process, a brewing process, or some combination of both."

Most scientists now hold to the Large Loaf theory. This model assumes that the universe rose from a fortuitous combination of primordial yeast and grain by-products.

A substantial minority believes that the Large Loaf model cannot account for the quantity of alcohol present in the universe. This group instead subscribes to the Big Brew theory, which presumes the a priori existence of alcohol, perhaps as a product of an earlier expired universe. Big Brew proponents believe that the universe began with a giant party and that matter has been having a good time ever since.

"There are some who point to inconsistencies in data returned by both Vagabond probes and by space probes in general. These scientists belong to the Unsteady State school. In the words of one Unsteady State adherent, "We don't know where it came from or where it's going, but we do know that it won't stand still at all."

Whatever the subtle disagreements, all three factors concur on one important point—the true age of the universe. They all place the time of creation at about 400 years ago. While this figure seems at variance with most of accepted history, Salloway sees no problem.

"What we need," he says, "is a theory of history that is consistent with our opinions about the origin of the universe." □

SANDKINGS

CONTINUED FROM PAGE 10

rating in about three weeks.

"And my face? When will they carve my face?"

"Turn on the hologram after about a month," she advised him, "and be patient. If you have any questions, please call. Wo and Shade are at your service." She bowed and left.

Kress wandered back to the tank and lit a joy stick. The desert was stiff and empty. He drummed his fingers impatiently against the plastic and frowned.

On the fourth day Kress thought he glimpsed motion beneath the sand—subtle subterranean strings.

On the fifth day he saw his last mobile, a lone white.

On the sixth day he counted a dozen of them, whites and reds and blacks. The oranges were tardy. He cycled through a bowl of half-decayed table scraps. The mobiles sensed it at once, rushed to it, and began to drag pieces back to their respective corners. Each color group was highly organized. They did not fight. Kress was a bit disappointed, but he decided to give them time.

The oranges made their appearance on the eighth day. By then the other sandkings had begun carrying small stones and eroding crude fortifications. They still did not war. At the moment they were only half the size of those he had seen at Wo and Shade's, but Kress thought they were growing rapidly.

The castles began to rise midway through the second week. Organized battalions of mobiles dragged heavy chunks of sandstone and granite back to their corners, where other mobiles were pushing sand into place with mandibles and tarsi. Kress had purchased a pair of magnifying goggles so that he could watch them work whenever they might go in the tank. He wandered around and around the tall plastic walls, observing. It was fascinating.

The castles were a bit plainer than Kress would have liked, but he had an idea about that. The next day he cycled through some obsidian and flakes of colored glass along with the food. Within hours they had been incorporated into the castle walls.

The black castle was the first completed, followed by the white and red fortresses. The oranges were last, as usual. Kress took his meals into the living room and ate seated on the couch so he could watch. He expected the first war to break out any hour now.

He was disappointed. Days passed, the castles grew taller and more grand, and Kress seldom left the tank except to attend to his sanitary needs and to answer critical business calls. But the sandkings did not war. He was getting upset.

Finally he stopped feeding them.

Two days after the table scraps had ceased to fall from their desert sky four black mobiles surrounded an orange and dragged it back to their maw. They mamed it first, ripping off its mandibles and antennae and limbs, and carried it through the shadowed main gate of their miniature castle. It never emerged. Within an hour more than forty orange mobiles marched across the sand and attacked the black's corner. They were outnumbered by the blacks that came rushing up from the depths. When the fighting was over the attackers had been slaughtered. The dead and dying were taken down to feed the black maw.

Kress, delighted, congratulated himself on his genius.

When he put food into the tank the following day, a three-cornered battle broke out over its possession. The whites were the big winners.

After that, war followed war.

Almost a month to the day after Jaa Wo had delivered the sandkings, Kress turned on the holographic projector and his face materialized in the tank. It turned, slowly around and around, so that his gaze fell on all four castles equally. Kress thought it rather a good likeness. It had his impish grin, wide mouth, full cheeks. His blue eyes sparkled, his gray hair was carefully arrayed in a fashionable side-sweep. His eyebrows were thin and sophisticated.

Soon enough the sandkings sat to work.

Kress fed them lavishly while his image beamed down at them from that sky. Temporarily the wars stopped. All activity was directed toward warship.

His face emerged on the castle walls.

At first all four castles looked alike to him, but as the work continued and Kress studied the reproductions, he began to detect subtle differences in technique and execution. The reds were the most creative, using tiny flakes of slate to put the gray in his hair. The whites added seaweed young and mischievous to him, while the fact shaped by the blacks—although virtually the same, line for line—struck him as wise and benevolent. The orange sandkings, as usual, were last and least. The wars had not gone well for them, and their castle was sad compared to those of the others. The image they carved was crude and cartoonish, and they seemed to intend to leave it that way. When they stopped work on the face, Kress grew quite piqued with them, but there really was nothing he could do.

When all of the sandkings had finished their Kress faces, he turned off the projector and decided that it was time to have a party. His friends would be impressed. He could even stage a war for them, he thought. Humming happily to himself he began drawing up a guest list.

The party was a wild success.

Kress invited thirty people, a handful of close friends who shared his amusements,



a few former lovers, and a collection of business and social rivals who could not afford to ignore his summons. He knew some of them would be discomfited and even offended by his sandkings. He counted on it. He customarily considered his parties a failure unless at least one guest walked out in high dudgeon.

On impulse he added Jala Wo's name to his list. "Bring Shade if you like," he added when he dictated the invitation to her.

Her acceptance surprised him just a bit. "Shade also will be unable to attend. He does not go to social functions. As for myself, I look forward to the chance to see how your sandkings are doing."

Kress ordered a sumptuous meal. And when at last the conversation had died down and most of his guests had gotten silly on wine and joy sticks, he shooked them by personally scraping their table leavings into a large bowl. "Come, all of you," he commanded. "I want to introduce you to my newest pets." Carrying the bowl, he conducted them into his living room.

The sandkings lived up to his fondest expectations. He had starved them for two days in preparation, and they were in a lightning mood. While the guests nixed the tank, looking through the magnifying glasses that Kress had thoughtfully provided, the sandkings waged a glorious battle over the scraps. He counted almost sixty dead mobiles when the struggle was over. The reds and whites, which had recently formed an alliance, came off with most of the food.

"Kress, you're disgusting," Cath in Lane told him. She had lived with him for a short time two years before, until her sappy sentimentality almost drove him mad. "I was a fool to come back here. I thought perhaps you'd changed and wanted to apologize." She had never forgiven him for the time his shambles had eaten an excessively cute puppy of which she had been fond. "Don't ever invite me here again, Simon." She stood out, accompanied by her current lover to a chorus of laughter.

Kress's other guests were full of questions.

"Where did the sandkings come from? they wanted to know. From Wo and Shade, Importers," he replied, with a polite gesture toward Jala Wo, who had remained quiet and apart throughout most of the evening.

"Why do they decorate their castles with his likenesses? Because I am the source of all good things. Surely you know that?" The remark brought a round of chuckles.

"Will they fight again?" Of course, but not tonight. Don't worry. There will be other parties.

Jad Rakkas, who was an amateur entomologist, began talking about other social insects and the wars they fought. "These sandkings are amusing, but nothing really. You ought to read about Simon's soldier ants, for instance."

"Sandkings are not insects!" Jala Wo said sharply, but Jad was off and railing

and no one paid her the slightest attention. Kress smiled at her and shrugged.

Meloba Blane suggested they have a betting pool the next time they got together to watch a war, and everyone was taken with the idea. An animated discussion about rules and odds ensued. It lasted for almost an hour. Finally the guests began to take their leave.

"Jala Wo was the last to depart. "So," Kress said to her when they were alone, "it appears my sandkings are a hit."

"They are doing well." Wo said. "Almost they are larger than my own."

"Yes," Kress said, "except for the oranges."

"I had noticed that," Wo replied. "They seem few in number, and their caste is shabby."

"Well, someone must lose," Kress said. "The oranges were late to emerge and get established. They have suffered for it."

"Pardon," said Wo, "but might I ask if you are feeding your sandkings sufficiently?"

●The attacking
sandkings washed over the
spider Mandibles
snapped shut on legs and
abdomen, and clung
One of them found an eye . . .
nipped it loose . . .
Kress smiled and pointed ●

Kress shrugged. "They diet from time to time. It makes them fierce."

She frowned. "There is no need to starve them. Let them war in their own time, for their own reasons. It is their nature, and you will witness conflicts that are delightfully subtle and complex. The constant war brought on by hunger is artless and degrading."

Kress rasped Wo's frown with interest. "You're in my house, Wo, and here I am the judge of what a degrading I fed the sandkings, as you advised, and they did not fight."

"You must have patience."

"No," Kress said. "I am their master and their god, after all. Why should I wait on their impulses? They did not war often enough to suit me. I have corrected the situation."

"I see," said Wo. "I will discuss the matter with Shade."

"It is none of your concern, or his," Kress snapped.

"I must bid you good-night, then." Wo said with resignation. But as she slipped into her coat to leave, she faced him with a final-disapproving stare. "Look to your

faces, Simon Kress," she warned him. "Look to your faces." And she departed.

Puzzled, he wandered back to the tank and stared at the castles. His faces were still there, as ever. Except—he snatched up his magnifying goggles and slipped them on. He studied the faces for long moments. Even then, exactly what it was, was hard to make out. But it seemed to him that the expression on the faces had changed slightly, that his smile was somehow twisted so that it seemed a touch malicious. But it was a very subtle change—if it was a change at all. Kress finally put it down to his suggestibility, and he resolved not to invite Jala Wo to any more of his gatherings.

Over the next few months Kress and about a dozen of his sweetest got together weekly for what he liked to call his "war games." Now that his initial fascination with the sandkings was past, Kress spent less time around his tank and more on his business affairs and his social life, but he still enjoyed having a few friends over for a war or two. He kept the combatants sharp on a constant edge of hunger. It had severe effects on the orange sandkings, which died readily until Kress began to wonder whether their raw was dead. But the others did well enough.

Sometimes at night when he could not sleep, Kress would take a bottle of wine into the living room, where the red glow of his miniature desert provided the only light. He would drink and watch for hours alone. There was usually a light going on somewhere, when there was not, he could easily start one by dropping some small morsel of food into the tank.

Kress's companions began betting on the weekly battles, as Meloba Blane had suggested. Kress won a goodly amount by betting on the whites, which had become the most powerful and most numerous colony in the tank and which had the grandest castle. One week he stole the corner of the tank top aside, and he dropped the food close to the white castle instead of on the central battleground, where he usually let food fall. So the others had to attack the whites in their stronghold to get any food at all they had. The whites were brilliant in defense. Kress won a hundred standards from Jad Rakkas.

Rakkas, in fact, lost heavily on the sandkings almost every week. He pretended to a vast knowledge of them and their ways, claiming that he had studied them after the first party, but he had no luck when it came to placing his bets. Kress suspected that Jad's claims were empty boasting. He had tried to study the sandkings a bit himself in a moment of idle curiosity, flying in to the library to find out what world his pets originally came from. But the library had no leas for sandkings. He wanted to get in touch with Wo and ask her about it, but he had other concerns, and the matter kept slipping his mind.

Finally, after a month in which his losses totaled more than a thousand standards

Rakiss arrived at the war games. He was carrying a small plastic case under his arm. Inside was a spiderlike thing covered with fine golden hair.

"A sand spider," Rakiss announced. "From Cathaday! I got it this afternoon from Elberian the Pterozel! Usually they remove the poison sacs, but this one is intact. Are you game, Bason? I want my money back. I'll bet a thousand standards, sand spider against sandkings."

Kress studied the spider in its plastic prison. His sandkings had grown—they were twice as large as Wer's, as she'd predicted—but they were still dwarfed by this thing. It was venomous, and they were not. Still, there were an awful lot of them. Besides, the fearless sandking was lately had begun to grow frownsome. The novelty of the match intrigued him.

"Done," Kress said. "Jad, you are a fool. The sandkings will just keep coming until this ugly creature of yours is dead."

"You are the fool, Simon," Rakiss replied, smiling. "The Cathadayan sand spider customarily feeds on burrowers that hide in nooks and crannies and—well, watch—it will go straight into those castles and eat the maws."

Kress stowed amid general laughter. He hadn't counted on that. "Get on with it," he said intently. Then he went to loosen his drink.

The spider was too large to be cycled conveniently through the load chamber

Two other guests helped Rakiss slide the tank top tightly to one side, and Malada Blane handed his case up to him. He shook the spider out. It landed lightly on a miniature dune in front of the red castle and stood confused for a moment, mouth working, legs twitching miserably.

"Come on!" Rakiss urged. They all gathered around the tank. Kress found his magnifiers and slipped them on. If he was going to lose a thousand standards, at least he wanted a good view of the action.

The sandkings had seen the invader. All over the red castle activity had ceased. The small scarlet mobiles were frozen, watching.

The spider began to move toward the dark promise of the gate. From the tower above, Simon Kress's countenance stared down impassively.

At once there was a flurry of activity. The nearest red mobiles turned themselves into two wedges and streamed over the sand toward the spider. More warriors erupted from inside the castle and assembled in a triple line to guard the approach to the underground chamber where the maw lived. Scouts came scuttling over the dunes, scaled to fight.

Bason was jaded.

The attacking sandkings washed over the spider. Mandibles snapped shut on legs and abdomen, and clung. Reds roared up the golden legs to the invader's back. They bit and tore. One of them found an eye

and tipped it loose with tiny yellow tendrils. Kress smiled and pointed.

But they were small, and they had no venom, and the spider did not stop. Its legs flicked sandkings off to either side. Its drooping jaws found others and left them broken and shivering. Already a dozen of the reds lay dying. The sand spider came on and on. It strode straight through the triple line of guardians before the castle. The lines closed around it, covered it, waging desperate battle. A team of sandkings had bitten off one of the spider's legs. Defenders leaped from atop the towers to land on the twitching, heaving mass.

Lost beneath the sandkings, the spider somehow lurched down into the darkness and vanished.

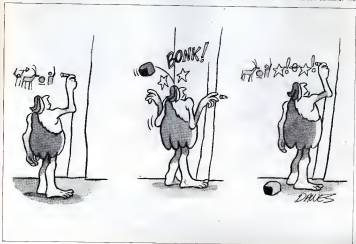
Rakiss let out a long breath. He looked pale. Wonderful someone else said Malada Blane chuckled deep in her throat.

"Look," said old Noredolan, tugging Kress by the arm.

They had been so intent on the struggle in the corner that none of them had noticed the activity elsewhere in the tank. But now the castle was still, and the sands were empty save for dead red mobiles, and now they saw.

Three armies were drawn up before the red castle. They stood quite still, in perfect array, rank after rank of sandkings, orange and white and black—waiting to see what emerged from the depths.

Kress smiled. A carbon samurai, he



said. "And glance at the other castles. If you will, Jax."

Rakkis did, and he swore. Teams of mobles were sealing up the gates with sand and stone. If the spider somehow survived this encounter, it would find no easy entrance at the other castles. "I should have brought four spiders," Rakkis said. "Still, I've won. My spider is down there right now, eating your damned man!"

Kress did not reply. He waited. There was motion in the shadows.

All at once red mobles began pouring out of the gate. They took their positions on the castle and began repairing the damage that the spider had wrought. The other armies dissolved and began to retreat to their respective corners.

Jax, Kress said, "I think you are a bit confused about who is eating whom."

The following week Rakkis brought four slim silver snakes. The sandknaps dispatched them without much trouble.

Next he tried a large black bird. It ate more than thirty white mobles, and its thrashing and blundering virtually destroyed that castle, but ultimately its wings grew tired, and the sandknaps attacked in force whenever it landed.

After that it was a case of insects, armored beetles not too unlike the sandknaps themselves. But stupid, stupid. An allied force of oranges and blacks broke their formation, divided them, and butchered them.

Rakkis began giving Kress preliminary notes.

It was around that time that Kress met Cath m'Latze again, one evening when he was dining in Agard at his favorite restaurant. He stopped at her table briefly and told her about the war games, inviting her to join them. She flushed, then regained control of herself and grew icy. "Someone has to put a stop to you, Simon. I guess it's going to be me," she said.

Kress shrugged and enjoyed a lovely meal and thought no more about her threat.

Until a week later, when a small, stout woman arrived at his door and showed him a police writband. "We've had complaints," she said. "Do you keep a tank full of dangerous insects, Kress?"

"Not insects," he said, furious. "Come, I'll show you."

When she had seen the sandknaps, she shook her head. "This will never do. What do you know about those creatures anyway? Do you know what world they're from? Have they been cleared by the Ecological Board? Do you have a license for these things? We have a report that they're carnivores and possibly dangerous. We also have a report that they are sentient. Where did you put these creatures anyway?"

"From Wo and Shade," Kress replied. "Never heard of them," the woman said. "Probably smuggled them in, knowing our ecologists would never approve them. No Kress, this won't do. I'm going to confiscate

this tank and have it destroyed. And you're going to have to expect a few fines as well."

Kress offered her a hundred standards to forget all about him and his sandknaps.

She asked, "Now I'll have to add attempted bribery to the charges against you."

Not until he raised the figure to two thousand standards was she willing to be persuaded. "It's not going to be easy, you know," she said. "There are forms to be altered, records to be wiped. And getting a forged license from the ecologists will be time-consuming. Not to mention dealing with the complainant. What if she calls again?"

"Leave her to me," Kress said. "Leave her to me."

He thought about it for a while. That night he made some calls.

First he got Itherrane the Patseller. "I want to buy a dog," he said. "A puppy?"

The round-faced merchant gawked at him. "A puppy? That is not like you, Simon."

*When he shoved
her, she looked briefly
startled. She
screamed as she tumbled
down the stairs
"I'm hurt," she called . . .
and shortly afterward
. . . the screaming started.*

Why don't you come in? I have a lovely choice.

"I want a very specific kind of puppy," Kress said. "Take notes. I'll describe to you what it must look like."

Afterwards he punched for Id Noredan. "Id," he said, "I want you out here tonight with your hole equipment. I have a robot to record a sanding battle. A present for one of my friends."

The night after they made the recording, Kress stayed up late. He absorbed a continuous new drama in his aerosolium, fixed himself a small snack, smoked a couple of joy sticks, and broke out a bottle of wine. Feeling very happy with himself, he wandered into the living room, glass in hand.

The lights were out. The red glow of the lantern made the shadows look fushed and feverish. Kress walked over to survey his domain, curious as to how the blacks were doing in the repairs on their castle. The puppy had lit it in rans.

The robotian went well. But as Kress inspected the work through his magnifiers, he chance to glance closely at the face on

the sand castle wall. It startled him.

He drew back, blinked, took a healthy gulp of wine, and looked again.

The face on the wall was still his. But it was all wrong all over! His cheeks were bloated and puffed; his smile was a crooked leer. He looked impossibly malevolent.

Uneasy he moved around the tank to inspect the other castles. They were each a bit different, but ultimately all the same.

The oranges had left out most of the line data, but the result still seemed monstrous: crude, a brutal mouth and mindless eyes.

The rods gave him a satanic, twitching sort of smile. His mouth did odd, untoward things at its corners.

The whites, his favorites, had carved a cruel, dead god.

Kress flung his wine across the room in rage. "You dare," he said under his breath.

Now you won't eat for a week, you damned . . . His voice was shrill. "I'll teach you."

He had an idea. He strode out of the room, then returned a moment later with an antique iron throwing sword in his hand. It was a meter long, and the point was still sharp. Kress smiled, climbed up and moved the tank cover aside just enough to give him working room, exposing one corner of the desert. He leaned down and jabbed the sword at the white castle below him. He waved it back and forth, smashing towers and ramparts and walls. Sand and stone collapsed, burying the scrambling mobles. A flick of his wrist obliterated the features of the incoherent, insulting caricature that the sandknaps had made of his face.

Then he posed the point of the sword above the dark mouth that opened down into the maw's chamber, he thrust with all his strength, meeting with resistance. He heard a soft squishing sound. All the mobles trembled and collapsed. Satisfied, Kress pulled back.

He watched for a moment, wondering whether he had killed the maw. The point of the throwing sword was wet and slimy. But finally the white sandknaps began to move again—fably slowly—but they moved.

He was preparing to slice the cover back into place and move on to a second castle when he felt something crawling on his hand.

He screamed, dropping the sword and brushed the sanding from his flesh. It fell to the carpet, and he ground it beneath his heel, crushing it thoroughly long after it was dead. It had crunched when he stepped on it. After that trembling, he hurriedly sealed the tank up again. He rushed off to shower and inspected himself carefully. He beiled his clothing.

Later, after drinking several glasses of wine, he returned to the living room. He was a bit ashamed of the way he had been terrified by the sanding. But he was not about to open the tank again. From then on the cover would stay sealed permanently. Still, he had to punish the others.



'Hey you guys, we're being transferred to another galaxy!'

He decided to lubricate his mental processes with another glass of wine. As he finished it, an inspiration came to him. He went to the tank and made a few adjustments to the humidity controls.

By the time he fell asleep on the couch, his wine glass sat in his hand, the sand castles were melting in the rain.

Kress woke to angry pounding on his door.

He sat up, groggy, his head throbbing. Wine hangovers were always the worst, he thought. He lurched to the entry chamber. Cath m Lane was outside. "You monster!" she said, her face swollen and puffy and streaked with tears. "I cried all night damn you! But no more, Simon, no more."

"Easy," he said, holding his head. "I've got a hangover."

She swooshed and shoved him aside and pushed her way into his house. The chamber came peering round a corner to see what the noise was. She spat at it and stalked into the living room. Kress trailing ineffectually after her. "Hold on," he said, "where do you... you can't! He stopped, suddenly horror-struck. She was carrying a heavy sledgehammer in her left hand. "No," he said.

"She went directly to the sandkings' tank. You like the little charmers so much, Simon? Then you can live with them."

"Cath!" he shrieked. Gapping the hammer with both hands

she swung as hard as she could against the side of the tank. The sound of the impact set Kress's head to screaming, and he made a low, blubbering sound of despair. But the plastic held.

She swung again. This time there was a crack, and a network of thin lines appeared in the wall of the tank.

Kress threw himself at her as she drew back her hammer to take a third swing. They went down flailing and soiled over. She lost her grip on the hammer and tried to throttle him, but Kress wrenched free and bit her on the arm, drawing blood. They both staggered to their feet, panting.

"You should see yourself, Simon," she said grimly. "Blood dripping from your mouth. You look like one of your pets. How do you like the best?"

"Get out!" he said. He saw the throwing sword where it had fallen the night before, and he snatched it up. "Get out!" he repeated, waving the sword for emphasis. "Don't go near that tank again."

She laughed at him. "You wouldn't dare," she said. She bent to pick up her hammer.

Kress shrieked after and lunged. Before he quite knew what was happening the iron blade had gone clear through her abdomen. Cath m Lane looked at him wondering and down at the sword. Kress fell back whimpering. "I didn't mean... I only wanted..."

She was transfixed, bleeding, nearly dead, but somehow she did not fall. "You

monster," she managed to say, though her mouth was full of blood. And she whiffed, impossibly, the sword in her and swung with her last strength at the tank. The tortured wall shattered, and Cath m Lane was buried beneath an avalanche of plastic and sand and mud.

Kress made small, ritualistic noises and scrambled up onto the couch.

Sandkings were emerging from the mud on his living-room floor. They were crawling across Cath's body. A few of them waddled tentatively out across the carpet. More followed.

He watched as a column took shape, a living, writhing square of sandkings bearing something—something slimy and featureless, a piece of raw meat as big as a man's head. They began to carry it away from the tank. It pulsed.

That was when Kress broke and ran.

Before he found the courage to return home, he ran to his summer and flew to the nearest city, some fifty kilometers away, almost sick with fear. But, once safely away, he found a small restaurant, dined several mugs of coffee and two am-hangover tabs, ate a full breakfast, and gradually regained his composure.

It had been a dreadful morning but dwelling on that would solve nothing. He ordered more coffee and considered his situation with icy rationality.

Cath m Lane was dead at his hand. Could he report it and plead that it had been an accident? Unlikely. He had run her through after all, and he had already told that police to leave her to him. He would have to get rid of the evidence and hope that Cath had not told anyone her plans for the day. It was very unlikely she had. She could only have gotten his gift late last night. She said that she had cried all night, and she was alone when she arrived. Very well, he had one body and one summer to dispose of.

That left the sandkings. They might prove more of a difficulty. No doubt they had all escaped by now. The thought of them around his house, in his bed and his clothes, infesting his food—it made his flesh crawl. He shuddered and overcame his revulsion. It really shouldn't be too hard to kill them, he reminded himself. He didn't have to account for every mobile. Just the four maws, that was all. He could do that. They were large, as he'd seen. He would find them and kill them. He was his god; now he would be their destroyer.

He went shopping before he flew back to his home. He bought a set of skinflints that would cover him from head to foot, several bags of poison pellets for rocklock control, and a spray canister containing an illegally strong pesticide. He also bought a magnalock towing device.

When he landed late that afternoon, he went about things methodically. First he hooked Cath's summer to his own with the magnalock. Searching it, he had his first



piece of luck. The crystal chip with id Noredain's hole of the sandking light was on the front seat. He had worried about that.

When the skimmers were ready, he slipped into his skintirns and went inside to get Cath's body.

It wasn't there.

He poked through the fast-drying sand carefully and there was no doubt of it: the body was gone. Could she have dragged herself away? Unlikely, but Kress searched. A cursory inspection of his house turned up neither the body nor any sign of the sandkings. He did not have time for a more thorough investigation, not with the incoming skimmer outside his front door. He resolved to try later.

Some seventy kilometers north of Kress's estate was a range of active volcanoes. He flew there. Cath's skimmer in tow. Above the glowing cone of the largest volcano he released the maglock and watched the skimmer plummet down and vanish in the lava below.

It was dusk when he returned to his house. This gave him pause. Briefly he considered flying back to the city and spending the night there. He put the thought aside. There was work to do. He wasn't safe yet.

He scattered the poison pellets around the exterior of his house. No one would think this suspicious. He had always had a rocklock problem. When this task was completed, he primed the canister of pesticides and ventured back inside the house.

Kress went through the house, room by room, turning on lights everywhere he went until he was surrounded by a blizzard of artificial illumination. He paused to clean up in the living room, shoveling sand and plastic fragments back into the broken tank. The sandkings were all gone, as he'd feared. The castles were shrunken and distorted, slugged by the watery bombardment Kress had visited upon them, and what little of them remained was crumbling as it died.

He froned and searched further, the canister of pest spray strapped across his shoulders.

Down in the wine cellar he could see Cath m'Lane's corpse.

It appeared at the foot of a steep flight of stairs, the limbs twisted as if by a fall. White mobiles were swimming all over it, and as Kress watched, the body moved jerkily across the hard-packed dirt floor.

He laughed and twisted the illumination up to maximum. In the far corner a squat little earthen castle and a dark hole were visible between two wine racks. Kress could make out a rough outline of his face on the cellar wall.

The body shifted once again, moving a few centimeters toward the castle. Kress had a sudden vision of the white man waiting hungrily. It might be able to get Cath's foot in its mouth, but no more. It was too absurd. He laughed again and started down into the cellar, finger poised on the trigger of the hose that snaked down his

right arm. The sandkings—hundreds of them moving as one—diserled the body and assumed battle formation, a field of white between him and their maw.

Suddenly Kress had another inspiration. He smiled and lowered his firing hand. "Cath was always hard to swallow," he said, delighted of his wit. "Especially for one your size. Here, let me give you some help. What are you for after all?"

He retreated upstairs, returning shortly with a cleaver. The sandkings, patient, waited and watched while Kress chopped Cath m'Lane into small, easily digestible pieces.

Kress slept in his skintirns that night, the pesticide close at hand, but he did not need it. The whites, asted, remained in the cellar, and he saw no sign of the others.

In the morning he finished the cleanup of the living room. When he was through, no trace of the struggle remained except for the broken tank.

He ate a light lunch and resumed his hunt for the missing sandkings. In full daylight it was not too difficult. The blacks had located in his rock garden, where they built a castle heavy with obsidian and quartz. The reds he found at the bottom of his long-dused swimming pool, which had partially filled with wind-blown sand over the years. He saw mobsles of both colors hanging about his grounds, many of them carrying poison pellets back to their maws.

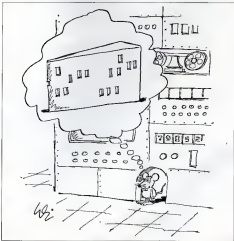
Kress felt like laughing. He decided his pesticides was unnecessary. No use making a fight when he could just let the poison do its work. Both maws should be dead by evening.

That left only the burnt-orange sandkings unaccounted for. Kress circled his estate several times. In an awe-widening spiral, but he found no trace of them. When he began to sweat in his skintirns—it was a hot, dry day—he decided it was not important. If they were out here, they were probably eating the poison pellets, as the reds and blacks were.

He crunched several sandkings under foot, with a certain degree of satisfaction as he walked back to the house. Inside he removed his skintirns, settled down to a delicious meal, and finally began to relax. Everything was under control. Two of the maws would soon be defunct, the third was safely isolated where he could dispose of it after it had served his purposes, and he had no doubt that he would find the fourth. As for Cath, every trace of her was had been obliterated.

His reverie was interrupted when his veevorsean began to blink at him. It was Jad Rakies, calling to brag about some carabid worms he would bring to the war games tonight.

Kress had forgotten about that, but he recovered quickly. "Oh, Jad, my pesticides I neglected to tell you. I grew bored with all that and got rid of the sandkings. Ugly little



things. Sorry, but there'll be no party tonight."

Raikes was indignant. "But what will I do with my worms?"

"Put them in a basket of fruit and send them to a loved one," Kress said, signing off. Quickly he began calling the others. He did not need anyone arriving at his doorstep now with the sandlings alive and infesting the estate.

As he was calling Ida Noneddan, Kress became aware of an annoying oversight. The screen began to clear, indicating that someone had answered at the other end. Kress looked off.

Ida arrived on schedule an hour later. She was surprised to find the party had been canceled but perfectly happy to share an evening alone with Kress. He delighted her with his story of Cath's reaction to the hoop they had made together. While telling it, he managed to ascertain that she had not mentioned the prank to anyone. He nodded, satisfied, and refilled their wine glasses. Only a trickle was left. "I'll have to get a fresh bottle," he said. "Come with me to my wine cellar, and help me pick out a good vintage. You've always had a better palate than I."

She went along willingly enough but balked at the top of the stairs when Kress opened the door and gestured for her to precede him. "Where are the lights?" she asked. "And that smell—what's that peculiar smell, Simon?"

When he showed her, she looked briefly startled. She screamed as she tumbled down the stairs. Kress closed the door and began to nail it shut with the boards and air hammer he had left for that purpose. As he was finishing, he heard Ida groan. "I'm hurt," she called. "Simon, what is this?" Suddenly she squealed, and shortly after that the screaming started.

It did not cease for hours. Kress went to his seminarium and dialed up a juicy comedy to blot it from his mind.

When he was sure the wasp was dead, Kress saw her skimmer north to the volcanoes and discarded it. The magnalock was proving a good investment.

Odd scabbling noises were coming from beyond the wine-cellar door the next morning when Kress went down to check things out. He listened for several uneasy moments, wondering whether he might possibly have survived and was scratching to get out. This seems unlikely, it had to be the sandlings. Kress did not like the implications of this. He decided that he would keep the door sealed, at least for a while. He went outside with a shovel to bury the red and black maws in their own castles.

He found them very much alive.

The black castle was glittering with volcanic glass, and sandlings were all over it, repairing and improving. The highest tower was up to his waist, and on it was a devious caricature of his face. When he ap-

proached, the blacks halted in their labor and formed up into two threatening phalanxes. Kress glanced behind him and saw others closing off his escape. Startled, he dropped his shovel and sprang out of the trap, crushing several mobs beneath his boots.

The red castle was creeping up the walls of the swimming pool. The maw was safely settled in a pit, surrounded by sand and concrete and battlements. The reds crept all over the bottom of the pool. Kress watched them carry a rockpook and a large lizard into the castle. Horrified, he stepped back from the poolside and felt something crunch. Looking down, he saw three mobs climbing up his leg. He brushed them off and stamped them to death, but others were approaching rapidly. They were larger than he remembered. Some were almost as big as his thumb.

He ran. By the time he reached the safety of the house, his heart was racing and he was

*• The heavy door
was still nailed shut, as he
had left it. But
it bulged outward slightly,
as if warped by
some tremendous pressure.
That made Kress
uneasy, as did the silence. •*

short of breath. He closed the door behind him and hurried to lock it. His house was supposed to be pestproof. He'd be safe in here.

A stiff drink steadied his nerve. So poison doesn't faze them, he thought. He should have known. Jaa Wo had warned him that the maw could eat anything. He would have to use the pesticide. He took another drink for good measure, darned his skintails and strapped the canister to his back. He unlocked the door.

Outside, the sandlings were wailing. Two armies confronted him, lined against the common threat. More than he could have guessed. The clamored maws must be breeding like rockpooks. Mobs were everywhere, a creeping sea of them.

Kress brought up the hose and flicked the trigger. A gray mist washed over the nearest rank of sandlings. He moved his hand from side to side.

Where the mist fell, the sandlings twitched violently and died in sudden spasms. Kress smiled. They were no match for him. He sprayed in a wide arc before him and stepped forward confidently over a litter of black and red bodies. The armies

fell back. Kress advanced, intent on cutting through them to the maws.

All at once the retreat stopped. A thousand sandlings surged toward him. Kress had been expecting the counterattack. He stood his ground, sweeping his misty sword before him in great looping strokes. They came at him and died. A few got through; he could not spray anywhere at once. He felt them climbing up his legs then sensed their mandibles biting futilely at the reinforced plastic of his skintails. He ignored them and kept spraying.

Then he began to feel soft impacts on his head and shoulders.

Kress trembled and spun and looked up above him. The front of his house was alive with sandings. Blacks and reds, hundreds of them. They were launching themselves into the air, taring down on him. They fell all around him. One landed on his faceplate, its mandibles scripping at his eyes for a terrible second before he plucked it away.

He swung up his hose and sprayed the air, sprayed the house, sprayed until the airborne sandlings were all dead or dying. The mist settled back on him, making him cough. But he kept spraying. Only when the front of the house was clean did Kress turn his attention back to the ground.

They were all around him on him, dozens of them scouring over his body, hundreds of others hurrying to join them. He turned the mist on them. The hose went dead. Kress heard a loud hiss, and the deadly fog rose in a great cloud from between his shoulders, cloaking him, choking him, making his eyes burn and blur. He felt for the hose, and his hand came away covered with dying sandlings. The hose was severed; they'd eaten it through. He was surrounded by a shroud of pesticide, blinded. He stumbled and screamed and began to run back to the house, pulling sandlings from his body as he went.

Inside, he sealed the door and collapsed on the carpet, rolling back and forth until he was sure he had crushed them all. The canister was empty by then, hissing feebly. Kress stepped off his skintails and showed. The hot spray scalded him and left his skin reddened and sensitive, but it made his flesh stop crawling.

He dressed in his heaviest clothing, thick work pants and leathers, after shaking them out nervously. "Damn," he kept muttering, "damn." His throat was dry. After searching the entry hall thoroughly to make certain it was clear, he allowed himself to sit and pour a drink. "Damn," he repeated. His hand shook as he poured, stopping liquor on the carpet.

The alcohol soothed him, but it did not wash away the fear. He had a second drink and went to the window furtively. Sandlings were moving across the thick plastic pane. He shuddered and retreated to his communications console. He had to get help, he thought wildly. He would punch through a call to the authorities, and pilots would come out with flamethrowers, and

Kress stopped in mid-calf and groaned.

He couldn't call in the police. He would have to tell them about the whites in his cellar and they'd find the bodies there. Perhaps the man might have finished Gath m'Lane by now but certainly not Ili Noredan. He hadn't even cut her up. Besides, there would be bones. No, the police could be called in only as a last resort.

He sat at the console, browsing. His communications equipment filled a whole wall. From here he could reach anyone on Baldir. He had plenty of money and his cunning, he had always prided himself on his cunning. He would handle this somehow.

Finally he considered calling Wo, but he soon dismissed the idea. Wo knew too much, and she would ask questions and he did not trust her. No, he needed someone who would do as he asked without questions.

His frown slowly turned into a smile. Kress had contacts. He put through a call to a number he had not used in a long time.

A woman's face took shape on his newscreen—white-haired, blank of expression, with a long, hooked nose. Her voice was brisk and efficient: "Simon," she said. "How is business?"

"Business is fine, Lissandra," Kress replied. "I have a job for you."

"A removal? My price has gone up since last time, Simon. It has been ten years after all."

"You will be well paid," Kress said. "You

know I'm generous. I want you for a bit of pest control."

She smiled a thin smile. "No need to use euphemisms, Simon. The call is shielded."

"No, I'm serious. I have a pest problem. Dangerous pests. Take care of them for me. No questions. Understood?"

"Understood."

"Good. You'll need—oh, three to four operatives. Wear heat-resistant skinthens, and equip them with flamethrowers, or lasers, something on that order. Come out to my place. You'll see the problem. Bugs, lots and lots of them. In my rock garden and the old swimming pool you'll find castles. Destroy them, kill everything inside them. Then knock on the door and I'll show you what else needs to be done. Can you get out here quickly?"

Her face remained impassive. "We'll leave within the hour."

Lissandra was true to her word. She arrived in a lean, black skimmer with three operatives. Kress watched them from the safety of a second-story window. They were all faceless in dark plastic skinthens. Two of them wore portable flamethrowers, a third carried laser cannons and explosives. Lissandra carried nothing, Kress recognized her by the way she gave orders.

The skimmer passed low overhead first, checking out the situation. The sandlings went mad. Scarlet and ebony mobiles ran everywhere, frenzied. Kress could see the

castles in the rock garden from his vantage point. It stood tall as a man; its ramparts were crawling with black defenders, and a steady stream of mobiles flowed down into its depths.

Lissandra's skimmer came down next to Kress's, and the operatives vaulted out and unlimbered their weapons. They looked inhuman, deadly.

The black army drew up between them and the castle. The reds—Kress suddenly realized that he could not see the reds. He blinked. Where had they gone?

Lissandra pointed and shouted, and her two flamethrowers spread out and opened up on the black sandlings. Their weapons coughed dully and began to roar, long tongues of blue-and-scarlet fire licking out before them. Sandlings snapped and shrieked and died. The operatives began to play the lie back and forth in an efficient, interlocking pattern. They advanced with careful, measured steps.

The black army burned and disintegrated, the mobiles fleeing in a thousand different directions, some back toward the castle, others toward the enemy. None reached the operatives with the flamethrowers; Lissandra's people were very professional.

Then one of them stumbled. Or seemed to stumble. Kress looked again and saw that the ground had given way beneath the man. Tunnels, he thought with a tremor of fear, tunnels, pits, traps



The farmer was sunk in sand up to his waist, and suddenly the ground around him seemed to erupt, and he was covered with scorching sandings. He dropped the flamethrower and began to claw wildly at his own body. His screams were horrible to hear.

His companion hesitated, then saw and fired. A blast of flame swallowed human and sandings both. The screaming stopped abruptly. Satisfied, the second farmer turned back to the castle, took another step forward, and recoiled as his foot broke through the ground and vanished up to the ankle. He tried to pull it back and retreat, and the sand all around him gave way. He lost his balance and stumbled, falling, and the sandings were everywhere a boiling mass of them, covering him as he settled and rolled. His flamethrower was useless and forgotten.

Kress pounded wildly on the window, shouting for attention. "The castle! Get the castle!"

Lissandra, standing back by her skimmer, heard and gestured. Her third operative sighted with the laser cannon and fired. The beam throbbled across the grounds and aloof off the top of the castle. He brought the cannon down sharply, hacking at the sand and stone parapets. Towers fell. Kress's face disintegrated. The laser bit into the ground, searching round and about. The castle crumbled. Now it was only a heap of sand. But the black mobiles continued to move. The maw was buried

too deeply. The beams hadn't touched it.

Lissandra gave another order. Her operative discarded the laser, primed an explosive, and darted forward. He leaped over the smoldering corpse of the first flamer, landed on solid ground within Kress's rock garden, and heaved. The explosive ball landed square atop the ruins of the black castle. White-hot light seared Kress's eyes, and there was a tremendous gout of sand and rock and mobiles. For a moment dust obscured everything. It was rising sandings and pieces of sandings.

Kress saw that the black mobiles were dead and unmoving.

"The pool!" he shouted down through the window. "Get the castle in the pool!"

Lissandra understood quickly. The ground was littered with motionless blacks, but the reds were pulling back, humed and re-forming. Her operative stood uncertain, then reached down and pulled out another explosive ball. He took one step forward, but Lissandra called him, and he sprinted back in her direction.

It was all so simple then. He reached the skimmer, and Lissandra took him aloft. Kress rushed to another window in another room to watch. They came swooping in just over the pool, and the operative pitched his bombs down at the red castle from the safety of the skimmer. After the fourth run, the castle was unrecognizable, and the sandings stopped moving.

Lissandra was through. She had him

bomb each castle several additional times. Then he used the laser cannon, increasing methodically until it was certain that nothing living could remain intact beneath those small patches of ground.

Finally they came knocking at his door. Kress was grinning maniacally when he let them in. "Lovely," he said, "lovely."

Lissandra pulled off the mask of her skin-things. "This will cost you, Simon. Two operatives gone, not to mention the danger to my own life."

"Of course," Kress blurted. "You'll be well paid, Lissandra. Whatever you ask, just so you finish the job."

"What remains to be done?"

"You have to clean out my wine cellar. Kress said. "There's another castle down there. And you'll have to do it without explosives. I don't want my house coming down around me."

Lissandra motioned to her operative. "Go outside and get Raj's flamethrower. It should be intact."

He returned armed, ready silent. Kress led them to the wine cellar.

The heavy door was still nailed shut, as he had left it. But it bulged outward slightly, as if warped by some tremendous pressure. That made Kress uneasy, as did the silence that reigned about them. He stood wild away from the door while Lissandra's operative removed his nails and planks. "Is that safe in here?" he found himself muttering, pointing at the flamethrower. "I don't want a fire, either you know."

"I have the laser," Lissandra said. "Well, use that for the kill. The flamethrower probably won't be needed. But I want it here just in case. There are worse things than fire, Simon."

He nodded.

The last plank came free of the cellar door. There was still no sound from below. Lissandra snapped an order, and her underling fell back, took up a position behind her, and leveled the flamethrower squarely at the door. She stooped her mask back on, held the laser steady forward, and pulled the door open.

No motion. No sound. It was dark down there.

"Is there a light?" Lissandra asked.

"Just inside the door," Kress said. "On the right-hand side. Mind the stairs. They're quite steep."

She stepped into the doorway, shifted the laser to her left hand, and reached up with her right, lurching inside for the light panel. Nothing happened. "I feel it," Lissandra said, "but it doesn't seem to..."

Then she was screaming, and she stumbled backward. A great white sanding had clamped itself around her wrist. Blood welled through her skin-things where its mandibles had sunk in. It was fully as large as her hand.

Lissandra did a horrible little jig across the room and began to smash her hand against the nearest wall. Again and again and again. It landed with a heavy mealy thud. Finally the sanding fell away. She



whimpered and fell to her knees.

"I think my fingers are broken," she said softly. The blood was still flowing freely. She had dropped the laser near the cellar door.

"I'm not going down there," her operative announced in clear firm tones.

Lissandra looked up at him. "No," she said. "Stand in the door and flame it all. Clear it. Do you understand?"

He nodded.

Kross moaned. "My house," he said. His stomach churned. The white landing had been so large. How many more were down here? "Don't," he continued. "Leave it alone. I've changed my mind."

Lissandra misunderstood. She held out her hand. It was covered with blood and greenish-black ichor. "Your little friend bit clean through my glove, and you saw what it took to get it off. I don't care about your house, Simon. Whatever is down there is going to die."

Kross hardly heard her. He thought he could see movement in the shadows beyond the cellar door. He imagined a white army bursting out, each soldier as big as the sandking that had attacked Lissandra. He saw himself being lifted by a hundred tiny arms and being dragged down into the darkness, where the mice waited hungrily. He was afraid. "Don't!" he said.

They ignored him.

Kross darted forward, and his shoulder slammed into the back of Lissandra's operative just as the man was bracing to fire. The operative grunted, lost his balance, and pitched forward into the black. Kross listened to him fall down the stairs. Afterwards there were other noises—scuffings and scrape and soft squeaking sounds.

Kross swung around to face Lissandra. He was drenched in cold sweat, but a sizzly kind of excitement possessed him. It was almost sexual.

Lissandra's calm, cold eyes regarded him through her mask. "What are you doing?" she demanded as Kross picked up the laser she had dropped. "Simon?"

"Making a peasee," he said, giggling. "They won't hurt you, no not so long as you are good and generous. I was cruel. Stunned them. I have to make up for it now you see."

"You're insane," Lissandra said. It was the last thing she said. Kross burned a hole in her chest big enough to put his arm through. He dragged the body across the floor and rolled it down the cellar stairs. The noises were louder—chintinous clackings and scabbings and echoes that were thick and liquid. Kross rapped up the door once again.

As he fled, he was filled with a deep sense of contentment that coated his hair like a layer of syrup. He suspected it was not his own.

He planned to leave his home, to fly to the city and take a room for a night, or perhaps for a year. Instead he started drinking. He was not quite sure why. He drank steadily for hours and redoubled it all up violently on

his living-room carpet. At some point he fell asleep. When he woke, it was pitch-dark in the house.

He covered against the couch. He could hear noises. Things were moving in the walls. They were all around him. His hearing was extraordinarily acute. Every little creek was the footstep of a sandking. He closed his eyes and waited, expecting to feel their lambic touch, afraid to move lest he brush against one.

Kross sobbed and then was very still. Time passed, but nothing happened. He opened his eyes again. He trembled. Slowly the shadows began to soften and dissolve. Moonlight was filtering through the high windows. His eyes adjusted.

The living room was empty. Nothing there, nothing, nothing. Only his drunken fears.

Kross steeled himself and rose and went to a light.

Nothing there. The room was deserted. He listened. Nothing. No sound. Nothing in the walls. It had all been his imagination; his fear.

The memories of Lissandra and the thing in the cellar returned to him unbidden. Shame and anger washed over him. Why had he done that? He could have helped her burn it out, kill it. Why... he knew why. The mouse had done it to him, had put fear in him. We had said it was psychic, even when it was small. And now it was large, so large it had leashed on Cath and Iol, and now it

had two more bodies down there. It would keep growing. And it had learned to like the taste of human flesh, he thought.

He began to shake, but he took control of himself again and stopped. It wouldn't hurt him. He was god; the whites had always been his favorites.

He remembered how he had stabbed it with his throwing sword. That was before Cath came. Damn her anyway.

He couldn't stay here. The maw would grow hungry again. Large as it was, it wouldn't take long. Its appetite would be terrible. What would it do then? He had to get away back to the safety of the city while the maw was still contained in his wire collar. It was only plaster and hard-packed earth down there, and the mobs could dig and tunnel. When they got free, Kross didn't want to think about it.

He went to his bedroom and packed. He took three bags. Just a single change of clothing, that was all he needed, the rest of the space he filled with his valuables, with jewelry and art and other things he could not bear to lose. He did not expect to return to the place ever again.

His shambler followed him down the stairs, staring at him from its baleful, glowing eyes. It was gaunt. Kross realized that it had been ages since he had fed it. Normally it could take care of itself, but no doubt the packings had grown iron of late. When it tried to clutch at his leg, he craned at it and kicked it away and it scurried off.



obviously hurt and offended.

Carrying his bags awkwardly, Kress slipped outside and shut the door behind him.

For a moment he stood pressed against the house, his heart thudding in his chest. Only a few meters between him and his skimmer. He was afraid to take those few steps. The moonlight was bright, and the grounds in front of his house were a scene of carnage. The bodies of Lissandra's two farmers lay where they had fallen, one twisted and burned, the other swollen beneath a mass of dead sandlings. And the mobiles, the black and red mobiles, they were all around him. It took an effort to remember that they were dead. It was almost as if they were simply waiting, as they had waited so often before.

Nonsense, Kress told himself. More drunken feasts. He had seen the cañitas blown apart. They were dead, and the white maw was trapped in his cellar. He took several deep and deliberate breaths and stepped forward onto the sandlings. They crunched. He ground them into the sand savagely. They did not move.

Kress smiled and walked slowly across the background, listening to the sounds, the sounds of safety.

Crunch, crackle, crunch.

He lowered his bags to the ground and opened the door to his skimmer.

Something moved from shadow into light. A pale shape on the seat of his skimmer. It was as long as his forearm. Its mandibles clicked together softly, and it looked up at him from six small eyes set all around its body.

Kress wet his pants and backed away slowly.

There was more motion from inside the skimmer. He had left the door open. The sandling emerged and came toward him, cautiously. Others followed. They had been hiding beneath his seats, burrowed into the upholstery. But now they emerged. They formed a ragged ring around the skimmer.

Kress locked his lips, turned, and moved quickly to Lissandra's skimmer.

He stopped before he was halfway there. Things were moving inside that one, too. Great moon-goo things half-seen by the light of the moon.

Kress whimpered and retreated back toward the house. Near the front door, he looked up.

He counted a dozen long, white shapes creeping back and forth across the walls of the building. Four of them were clustered close together near the top of the unused balcony where the cannon hawk had once roosted. They were carving something. A face. A very recognizable face.

Kress shrieked and ran back inside. He headed for his liquor cabinet.

A sufficient quantity of drink brought him the easy oblivion he sought. But he woke. Despite everything, he woke. He had a terrific headache, and he drank, and he was hungry. Oh, so very hungry! He had never been so hungry.

Kress knew it was not his own stomach hurting.

A white sandling watched him from atop the dresser in his bedroom, its antennae moving faintly. It was as big as the one in the skimmer the night before. He tried not to shrink away. "I'll feed you," he said to it. "I'll feed you." His mouth was horribly dry, sandpaper-dry. He licked his lips and fled from the room.

The house was full of sandlings; he had to be careful where he put his feet. They all seemed busy on errands of their own. They were making modifications in his house, burrowing into or out of his walls, carving things. Twice he saw his own likeness staring out at him from unexpected places. The faces wore wistful, twisted, lived-with-fear expressions.

He went outside to get the bodies that had been rotting in the yard, hoping to appease the white maw's hunger. They were gone, both of them. Kress remembered how easily the mobiles could carry things many times their own weight.

It was terrible to think that the maw was still hungry after all of that.

When Kress reentered the house, a column of sandlings was wending its way down the stairs. Each carried a piece of his chamber. The head seemed to look at him reproachfully as it went by.

Kress emptied his drawers, his cabinets, everything, piling all the food in the house in the center of his kitchen floor. A dozen whites waited to take it away. They avoided the frozen food, leaving it to thaw in a great puddle, but carried off everything else.

When all the food was gone, Kress felt his own hunger pangs abate just a bit, though he had not eaten a thing. But he knew the respite would be short-lived. Soon the maw would be hungry again. He had to feed it.

Kress knew what to do. He went to his communicator, "Maacra." He began casually when the first of his friends answered, "I'm having a small party tonight. I realize this is timely short notice, but I hope you can make it. I really do."

He called Jax, Bekka next, and then the others. By the time he had finished, five of them had accepted his invitation. Kress hoped that would be enough.

Kress met his guests outside—the mobiles had cleaned up remarkably quickly, and the grounds looked almost as they had before the battle—and walked them to his front door. He let them enter first. He did not follow.

When four of them had gone through, Kress finally worked up his courage. He closed the door behind his latest guest, ignoring the startled exclamations that soon turned into shell gibbering, and sprinted for the skimmer the man had arrived in. He slid in safely, thumbed the



"The administration unveiled its new economic policies today, but, fortunately, no one paid any attention and no harm was done."

startle, and swore. It was programmed to lift only in response to its owner's thumbprint, of course.

Rakks was the next to arrive. Kress ran to his skimmer as it set down and seized Rakks by the arm as he was climbing out. "Get back in, quickly," he said, pushing. "Take me to the pty Hury Jad. Get out of here!"

But Rakks only stared at him and would not move. "Why, what's wrong, Simo? I don't understand. What about your party?"

And then it was too late, because the loose sand all around them was sifting and the red eyes were staring at them, and the mandibles were clacking. Rakks made a choking sound and moved to get back in his skimmer, but a pair of mandibles snapped shut about his ankle and suddenly he was on his knees. The sand seemed to boil with subterranean activity. Rakks thrashed and cried ferribly as they tore him apart. Kress could hardly bear to watch.

After that, he did not try to escape again. When it was all over, he cleaned out what remained in his liquor cabinet and got extremely drunk. It would be the last time he would enjoy that luxury, he knew. The only alcohol remaining in the house was stored down in the wine cellar.

Kress did not touch a bite of food the entire day, but he fell asleep feeling bloated, satiated at last, the awful hunger vanquished. His last thoughts before the nightmares took him were about whom he could ask out tomorrow.

Morning was hot and dry. Kress opened his eyes to see the white sanding on his dresser again. He shut his eyes again quickly, hoping the dream would leave him. It did not, and he could not go back to sleep, and soon he found himself staring at the thing.

He stared for almost five minutes before the strangeness of it dawned on him; the sanding was not moving.

The mobiles could be preternaturally still, he was sure. He had seen them wait and watch a thousand times. But always there was some motion about them. The mandibles clacked, the legs twitched, the long fine antennae stirred and swayed.

But the sanding on his dresser was completely still.

Kress rose, holding his breath, not daring to hope. Could it be dead? Could something have killed it? He walked across the room.

The eyes were glassy and black. The creature seemed swollen, somehow as if it were soft and rotting inside, filling up with gas that pushed outward at the plates of white armor.

Kress reached out a trembling hand and touched it.

It was warm, hot even, and growing hotter. But it did not move.

He pulled his hand back, and as he did, a segment of the sanding's white exoskeleton fell away from it. The flesh beneath was the same color but softer-looking,

swollen and feverish. And it almost seemed to throb.

Kress backed away and ran to the door.

Three more white mobiles lay in his hall. They were all like the one in his bedroom.

He ran down the stairs, jumping over sandlings. None of them moved. The house was full of them, all dead, dying, comatose, whatever. Kress did not care what was wrong with them. Just so they could not move.

He found four of them inside his skimmer. He peered them up, one by one, and threw them as far as he could. Damned monsters. He slid back in on the rained half-eaten seats and thumbed the startplate.

Nothing happened.

Kress tried again and again. Nothing. It wasn't far. This was his skimmer. It ought to start. Why wouldn't it? He didn't understand.

Finally he got out and checked, expecting the worst. He found it. The sandings had torn apart his gravity grid. He was trapped. He was still trapped.

Grindy Kress marched back into the house. He went to his gallery and found the antique ax that had hung next to the throwing sword he had used on Ceth m'Lane. He set to work. The sandings did not stir even as he chopped them to pieces. But they splattered when he made the first cut, the

bodies almost bursting inside was awful, strange half-formed organs, a viscous reddish ooze that looked almost like human blood, and the yellow star.

Kress destroyed twenty of them before he realized the futility of what he was doing. The mobiles were nothing, really. Besides, there were so many of them. He could work for a day and night and still not kill them all.

He had to go down into the wine cellar and use the ax on the mob.

Rakks! He started toward the cellar. He got within sight of the door then stopped. It was not a door anymore. The walls had been eaten away, so that the hole was twice the size it had been and round. A pit that was all. There was no sign that there had ever been a door nailed shut over that black abyss.

A ghastly choking, feid odor seemed to come from below.

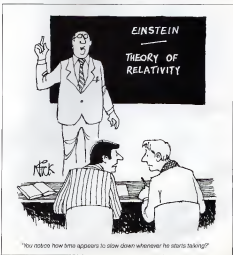
And the walls were wet and bloody and covered with patches of white fungus.

And worst, it was breathing.

Kress stood across the room and felt the warm wet wash over him as it exhaled, and he tried not to choke, and when the wind reversed direction, he fled.

Back in the living room he destroyed three more mobiles and collapsed. What was happening? He didn't understand.

Then he remembered the only person who might understand. Kress went to the



"You notice how time appears to slow down whenever he starts talking?"

communicator again, stepped on a sanding in his haste, and prayed fervently that the device still worked.

When Jax Wo answered, he broke down and told her everything.

She let him speak without interruption, no expression save for a slight frown on her pure, pale face. When Kress had finished she said only "I ought to leave you here."

Kress began to blubber. "You can't! Help me, I'll pay—"

"I ought to," Wo repeated, "but I won't." "Thank you," Kress said. "Oh, thank—"

"Quiet," said Wo. "Listen to me. This is your own good. Keep your sandings well and they are courtly nice warrens. You turned yours into something else, with starvation and torture. You were their god. You made them what they are. That made your collar so sick, still suffering from the wound you gave it. It is probably insane. Its behavior is unusual."

"You have to get out of there quickly. The mobiles are not dead. Kress, they are dormant. I told you the escalation falls off when they grow larger. Normally in fact, it falls off much earlier. I have never heard of sandings growing as large as yours, while still in the insectoid stage. It is another result of crippling the white maw. I would say that does not matter."

What matters is the metamorphosis your sandings are now undergoing. As the maw grows, you see, it gets progressively more intelligent. Its psychic powers strengthen, and its mind becomes more sophisticated, more ambitious. The armored mobiles are useful enough when the maw is toy and only semi-sentient, but now it needs better servants, bodies with more capabilities. Do you understand? The mobiles are all going to give birth to a new breed of sanding. I can't say exactly what it will look like. Each maw designs its own to fit its perceived needs and desires. But it will be biped, with four arms and opposable thumbs. It will be able to construct and operate advanced machinery. The individual sandings will not be sentient. But the maw will be very sentient indeed.

Kress was gaping at Wo's image on the wescreeen. "Your workers," he said, with an effort. "The ones who came out here, who installed the tank."

Wo managed a faint smile. "Shade," she said.

"Shade is a sanding," Kress repeated numbly. "And you sold me a tank of . . . of . . . infants, ah."

"Do not be absurd," Wo said. "A last-stage sanding is more like a sperm than like an infant. The maw is temper and control them in nature. Only one in a hundred reaches the second stage. Only one in a thousand achieves the third and final plateau and becomes like Shade. Adult sandings are not sentimental about the small maws. There are too many of them, and their mobiles are pests." She sighed.

"And all this talk wastes time. That white sanding is going to waken to full sentience soon. It is not going to need you any longer,

and it hates you, and it will be very hungry. The transformer is a lie. The maw must eat enormous amounts both before and after. So you have to get out of there. Do you understand?"

"I can't," Kress said. "My skimmer is destroyed, and I can't get any of the others to start. I don't know how to reprogram them. Can you come out for me?"

"Yes," said Wo. "Shade and I will leave at once, but it is more than two hundred kilometers from Asgard to you, and there is equipment that we will need to deal with the damaged sanding you've created. You cannot wait there. You have two feet. Walk. Go due east as near as you can determine as quickly as you can. The land out there is pretty desolate. We can find you easily with an aerial search, and you'll be safely away from the sandings. Do you understand?"

"Yes," Kress said. "Yes, oh, yes." They signed off, and he walked quickly toward the door. He was halfway there when he heard the noise, a sound he knew

*Something moved
from shadow into light.
A pale shape on
the seat. . . . It was as long
as his forearm.
Its mandibles clicked
together softly . . .
Kress slowly backed away.*

between a pop and a crack.

One of the sandings had split open. Four tiny hands covered with pinkish-yellow blood came up out of the gap and began to push the dead skin aside.

Kress began to run.

He had not counted on the heat!

The hills were dry and rocky. Kress ran from the house as quickly as he could. His unit felt his ribs ached and his breath was coming in gasps. Then he walked, but as soon as he had recovered, he began to run again. For almost an hour he ran and walked, ran and walked, beneath the fierce, hot sun. He sweated freely and wished that he had thought to bring some water, and he watched the sky in hopes of seeing Wo and Shade.

He was not made for this; it was too hot and too dry and he was in no condition. But he kept himself going with the memory of the way the maw had breathed and the thought of the wriggling little things that by now were surely crawling all over his house. He hoped Wo and Shade would know how to deal with them.

He had his own plans for Wo and Shade

It was all their fault, Kress had decided, and they would suffer for it. Lissandra was dead, but he knew others in her profession. He would have his revenge. This he promised himself a hundred times as he struggled and sweated his way eastward.

At least he hoped it was east. He was not that good at directions, and he wasn't certain which way he had run in his initial panic, but since then he had made an effort to bear due east, as Wo had suggested. When he had been running for several hours, with no sign of rescue, Kress began to grow certain that he had miscalculated his direction.

When several more hours passed, he began to grow afraid. What if Wo and Shade could not find him? He would die out here. He hadn't eaten in two days, he was weak and lightened, his throat was raw for want of water. He couldn't keep going. The sun was sinking now and he'd be completely lost in the dark. What was wrong? Had the sandings eaten Wo and Shade? The fear was on him again, biting him, and with it a great thirst and a terrible hunger. But Kress kept going. He stumbled now when he had to run, and twice he fell. The second time he scraped his hand on a rock and it came away bloody. He sucked at it as he walked, and he worried about infection.

The sun was on the horizon behind him. The ground grew a little cooler, for which Kress was grateful. He decided to walk until last light and settle down for the night. Surely he was far enough from the sandings to be safe, and Wo and Shade would find him come morning.

When he topped the next rise, he saw the outline of a house in front of him.

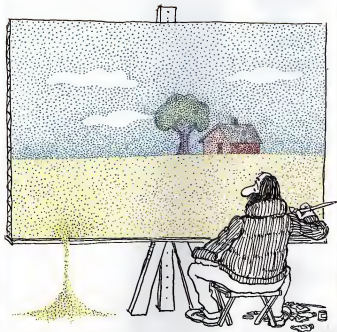
It wasn't as big as his own house, but it was big enough. It was habitation, safety. Kress shouted and began to run toward it. Food and drink, he had to have nourishment, he could taste the meal already. He was aching with hunger. He ran down the hill toward the house, waving his arms and shouting to the inhabitants. The light was almost gone now, but he could still make out a half-dozen children playing in the twilight. "Hey there," he shouted. "Help, help."

They came running toward him.

Kress stopped suddenly. "No," he said, "oh, no, oh, no." He had misstepped, slipped on the sand, got up, and tried to run again. They caught him easily. They were ghostly little things with bulging eyes and dusky orange skin. He struggled, but it was useless. Smell as they were, each of them had four arms, and Kress had only two.

They came him toward the house; it was a sad shabby house, built of crumbling sand, but the door was quite large and dark, and it breathed. That was terrible, but it was not the thing that set Simon Kress screaming. He screamed because of the others, the little orange children who came crawling out of the castle, and watched impassively as he passed.

All of them had his face. **OO**



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WHITE DWARFS

CONTINUED FROM PAGE 49

of observational astronomers in Mesopotamia and in Alexandria in the preceding centuries—to say nothing of the Chinese and Korean astronomical schools—and it would be astonishing if they had noticed nothing. (The ancient Egyptian phrase for the planet Mars translates to the red Horus; Horus being the imperial falcon deity. Thus Egyptian astronomers noted remarkable coloration in celestial objects. But the description of Sirius mentions nothing notable about its color.)

The Dogon have knowledge impossible to acquire without the telescope. The straightforward conclusion is that they had contact with an advanced technical civilization. The only question is, Which civilization—mesopotamian or European?

Far more credible than an ancient extraterrestrial educational toy among the Dogon might be a comparatively recent contact with scientifically literate Europeans who conveyed to the Dogon the remarkable European myth of Sirius and its white dwarf companion or a myth that has all the superficial earmarks of a splendidly inventive tall story. Perhaps the Western contact came from a European visitor to Africa, or from the local French schools, or perhaps from contacts in Europe by West Africans, induced to fight for the French in World War I.

The likelihood that these stories arose from contact with Europeans instead of with extraterrestrials has been increased by a recent astronomical finding. A Cornell University research team, led by James Elliot, employing a high-altitude airborne observatory over the Indian Ocean in 1977 discovered that the planet Uranus is surrounded by rings—a finding never hinted at by ground-based observations. Advanced extraterrestrial beings viewing our solar system upon approach to Earth would have little difficulty discovering the rings of Uranus. But European astronomers in the nineteenth and early twentieth centuries would have had nothing to say in this regard. The fact that the Dogon do not talk of another planet with rings beyond Saturn suggests to me that their informants were European, not extraterrestrial.

In 1844 the German astronomer F. W. Bessel discovered that the long-term motion of Sirius itself (Sirius A) was not straight but rather wavy against the background of more distant stars. Bessel proposed that there was a dark companion to Sirius whose gravitational influence was producing the observed sinusoidal motion. Since the period of the wiggles was 50 years, Bessel deduced that the dark companion had a 50-year period in the joint motion of Sirius A and Sirius B about their common center of mass.

Eighteen years later Alvan G. Clark, during the testing of a new 18.5 inch refracting telescope, accidentally discovered the

companion, Sirius B, by direct visual observation. From the relative motions, Newtonian gravitational theory permits us to estimate the masses of Sirius A and B. The companion turns out to have a mass just about the same as the suns. But Sirius B is almost 10,000 times larger than Sirius A, even though their masses are about the same and though they are just the same distance from the earth. These facts can be reconciled only if Sirius B has a much smaller radius or lower temperature.

But in the late nineteenth century it was believed by astronomers that stars of the same mass had approximately the same temperature, and by the turn of the century it was widely held that the temperature of Sirius B was not remarkably low. Spectroscopic observations by Walter S. Adams in 1915 confirmed this contention. Hence, Sirius B must be very small.

We know today that it is only as big as the earth. Because of its size and color it is called a white dwarf. But if Sirius B is much smaller than Sirius A, its density must be very much greater. Accordingly the concept of Sirius B as an extremely dense star was widely held in the first few decades of this century.

The peculiar nature of the companion of Sirius was extensively reported in books and in the press. For example, in Sir Arthur Eddington's book *The Nature of the Physical World*, we read: "Astronomical evidence seems to leave practically no doubt that in the so-called white dwarf stars the density of matter far transcends anything of which we have terrestrial experience; in the Companion of Sirius, for example, the density is about a ton to the cubic inch. This condition is explained by the fact that the high temperature and correspondingly intense agitation of the material breaks up (ionizes) the outer electron system of the atoms, so that the fragments can be packed much more closely together." Within a year of its 1929 publication, this book saw ten printings in English. It was translated into many languages, including French.

The idea that white dwarfs were made of electron degenerate matter had been proposed by R. H. Fowler in 1925 and was quickly accepted. On the other hand, the proposal that white dwarfs were made of "relativistically degenerate" matter was first made in the period 1931 to 1934, in Great Britain, by the Indian astrophysicist S. Chandrasekhar; the idea was greeted with substantial skepticism by astronomers who had not grown up with quantum mechanics. One of the most vigorous skeptics was Eddington. The debate was covered in the scientific press and was accessible to the intelligent layman. All this was occurring just before Gracile encountered the Dogon Sirius legend.

In my mind's eye I picture a Gallic visitor to the Dogon people in what was then French West Africa, in the early part of this century. He may have been a diplomat, an explorer, an adventurer or an early an-

thropologist. Such people—for example, Richard Francis Burton—were in West Africa many decades earlier.

The conversation turns to astronomical lore. Sinus is the brightest star in the sky. The Dogon regard the visitor with their Sinus mythology. Then, smiling politely but suspiciously they inquire of their visitor what his Sinus myth might be. Perhaps he refers, before answering, to a well-worn book in his baggage. The white dwarf companion of Sinus being a current astronomical sensation, the traveler exchanges a spectacular myth for a routine one.

After the leaves, his account is remembered, retold, and eventually incorporated into the corpus of Dogon mythology—or at least into a collateral branch (perhaps filed under "Sinus myths, bleached peoples account"). When Graube made mythological inquiries in the 1930s and 1940s, he had his own European Sinus myth played back to him.

The full-cycle return of a myth to its culture of origin through an unwary anthropologist might sound unlikely if there were not so many examples of it in anthropological lore. I here recount a few cases.

In the first decade of the twentieth century a neophyte anthropologist was collecting accounts of ancient traditions from Native American populations in the Southwest. His concern was to write down the traditions: almost exclusively oral, before they vanished altogether. The young Native Americans had already lost appreciable contact with their heritage and the anthropologist concentrated on elderly members of the tribe. One day he found himself sitting outside a Hogan with an aged but lively and cooperative informant.

"Tell me about the ceremonies of your ancestors at the birth of a child."

"Just one moment."

The old Indian slowly shuffled into the darkened depths of the Hogan. After a 15-minute interval he reappeared with a remarkably useful and detailed description of postpartum ceremonies, including rituals connected with breast presentation, afterbirth umbilical cord, first breath, and first cry. Encouraged and writing feverishly the anthropologist systematically went through the full list of rites of passage, including puberty marriage, childbearing, and death. In each case the informant disappeared into the Hogan and emerged a quarter hour later with a rich set of answers.

The anthropologist was astonished. Could this be, he wondered, a yet older informant, perhaps infirm and bedridden, within the Hogan? Eventually he could resist no longer and summoned the courage to ask his informant what he did at each retreat into the Hogan. The old man smiled and withdrew for the last time and returned, clutching a well-thumbed volume of the Dictionary of American Ethnography, which had been compiled by anthropologists in the previous decade. The poor white man,

he must have thought, is eager, well-meaning, and ignorant. He does not have a copy of the marvelous book, which contains the traditions of my people. I shall tell him what it says.

My two other stories recount the adventures of an extraordinary physician, Dr. D. Carleton Gajdusek, who for many years has studied kuru, a rare viral disease among the inhabitants of New Guinea. For this work he was the recipient of the 1976 Nobel Prize for medicine. I am grateful to Dr. Gajdusek for taking the trouble to check my memory of his stories, which I first heard from him many years ago. New Guinea is an island where the mountainous terrain separates almost completely one valley people from another. As a result there is a great variety of cultural traditions.

In the spring of 1957 Gajdusek and Dr. Vincent Zipes, a medical officer with the Public Health Service of what was then called the Territory of Papua and New Guinea, traveled with an Australian administrative patrol officer from the Pusasa Valley through the ranges of the South Fore cultural and linguistic group region to the village of Agakamata on an exclavatory west into "uncontrolled territory." Stone implements were still in use, and there remained a tradition of cannibalism within each living group. Gajdusek and his party found cases of kuru, which is spread by cannibalism (but most often not through the digestive tract) in the most remote of the South Fore villages.

They decided to spend a few days, moving into one of the large and traditional wai, or men's houses (the music from one of which, incidentally, was sent to the stars on the Voyager phonograph record). The windowless, low-ceilinged, smoky hatched house was partitioned so that the visitors could neither stand erect nor stretch out. It was divided into many sleeping compartments, each with its own small fire, around which men and boys would huddle in groups to sleep and keep warm during the cold nights at an elevation of more than 6,000 feet, an altitude higher than Denver's. To accommodate their visitors the men and boys gleefully lay out the inferior structure of half of the ceremonial men's house, and during two days and nights of pouring rain Gajdusek and his companions were housebound on a high, windwapt, cloud-covered ridge.

The young Fore initiates wore bark strands braided into their hair, which was covered with pig grease. They wore huge nose pieces, the pendants of pigs as amulets, and the genitalia of opossums and tree-climbing kangaroos as pendants around their necks.

The hosts sang their traditional songs all through the first night and on through the following rainy day. "To enhance our rapport with them," as Gajdusek says, "we began to sing songs in exchange"—among them such Russian songs as "Och'-chorny and 'Mor Astyl' or 'Lutskaya ostan'." "This was received very well, and the

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* This was received very well, and the

Agakemess villagers requested many copies of expositions in the smoky South Fore longhouse to the accompaniment of the driving ransam.

Some years later Gadusek was engaged in the collection of indigenous music in another part of the South Fore region and asked a group of young men to run through their repertoire of traditional songs. To Gadusek's amazement and amusement, they produced a somewhat altered but still clearly recognizable version of "Och chomye." Many of the singers apparently thought the song traditional, and later still Gadusek found the song exported over farther afield, with none of the singers having any idea of its source.

We can easily imagine some sort of word-ethnology survey going to an exceptionally obscure part of New Guinea and discovering that the natives had a traditional song that sounded in rhythm, music, and words remarkably like "Och chomye." If they were to believe that no previous contact with Westerners had occurred, a great mystery could be posited.

Later that same year Gadusek was visited by several Australian physicians, eager to understand the remarkable findings about the transmission of kuru from patient to patient by cannibalism. Gadusek described the theories of the origin of many diseases held by the Fore people who did not believe that illnesses were caused by the spirits of the dead or that malicious deceased relatives, jealous of the living, inflicted disease on those of their surviving kin whom they offended them, as the pioneering anthropologist Bronislaw Malinowski had recounted for the coastal peoples of Melanesia. Instead, the Fore attributed most diseases to malicious sorcery which they offended and avenging male, young or old, could execute without the aid of specially trained sorcerers.

There was a special sorcery explanation for kuru, but also for chronic lung disease, leprosy yaws, and so on. These beliefs had been long established and firmly held, but as the Fore people witnessed yaws yielding entirely to the penicillin injections of Gadusek and his group, they quickly agreed that the sorcery explanation of yaws was in error and abandoned it. It has never resurfaced in subsequent years. (I wish Westerners would be as quick to abandon obsolete or erroneous social ideas as were the Fore of New Guinea.) Modern treatment of leprosy caused the sorcery explanation to disappear as well, although more slowly, and the Fore people today laugh at these early opinions on yaws and leprosy.

But the traditional views on the origin of kuru have maintained themselves, since the Westerners have been unable to cure or explain in a manner satisfactory to them the origin and nature of the disease. Thus, the Fore people remain intensely skeptical of Western explanations for kuru and retain firmly their view that sorcery is the cause.

One of the Australian physicians, visiting an adjacent village with one of Gadusek's

native informants as translator spent the day examining kuru patients and independently acquiring information. He returned the same evening to inform Gadusek that he was mistaken about people not believing in the spirits of the dead as the cause of disease, and that he was further in error in holding that they had abandoned the idea of sorcery as the cause of yaws. The people held, he continued, that a dead body could become invisible and that the unseen spirit of the dead person could enter the skin of a patient at night through an imperceptible break and induce yaws. The Australian informant had even sketched with a stick in the sand the appearance of these ghostly beings. The villagers had carefully drawn a circle and a few squiggly lines within. Outside the circle they explained, it was black, inside the circle, bright—a sand portrait of malevolent and pathogenic spirits.

Upon inquiry of the young translator Gadusek discovered that the Australian

• Can you be sure natives are not humoring you or pulling your leg? If a stranger came into town and asked where babies come from, I'd be tempted to talk about storks and cabbages. •

physician had conversed with some of the older men of the village who were well known to Gadusek and who were often his house and laboratory guests. They had attempted to explain that the shape of the "germ" producing yaws was spiral—the spirochete form they had seen many times through Gadusek's dark-field microscope. They had to admit it was invisible—a could be seen only through the microscope—and when pressed by the Australian physician on whether this represented the dead person, they had to admit that Gadusek had stressed that it could be caught from close contact with yaws lesions, as, for example, by sleeping with a person with yaws.

I can still remember the first time I looked through a microscope. After focusing my eyes up near the ocular only to examine my eyelashes, and then peering farther into the pitch-black interior of the barrel, I finally managed to look straight down the microscope tube to be dazzled by an illuminated disk of light. It takes a little while for the eye to train itself to examine what is in the disk. Gadusek's demonstration to the Fore people was so powerful—after all, the af-

firmatives entirely lacked so concrete a reality—that many accepted his story apart from his ability to cure the disease with penicillin. Perhaps some concluded the spirochete in the microscope an amusing example of white-man myth and minor magic, and when another white man arrived querying the origin of disease they politely returned to him the idea they believed he would be comfortable with. Were Western contact with the Fore people to cease for 50 years, it seems to me entirely possible that a future visitor would discover to his astonishment that the Fore people somehow had knowledge of medical microbiology despite their largely pre-technological culture.

All three of these stories underline the almost insurmountable problems encountered in trying to extract from a "primitive" people their ancient legends. Can you be sure that others have not come before you and destroyed the pristine state of the native myth? Can you be sure that the natives are not humoring you or pulling your leg?

Malinowski thought he had discovered a people in the Tokara Islands who had not worked out the connection between sexual intercourse and childbirth. When asked how children were conceived, they supplied him with an elaborate mythic structure prominently featuring celestial intervention. Amazed, Malinowski asserted that was not how it was done at all; he supplied them instead with the version so popular in the West today—including a nine-month gestation period. "Impossible," replied the Melanesians. "Do you not see that woman over there with her six-month-old child?" Her husband has been on a voyage to another island for two years.

Is it more likely that the Melanesians were ignorant of the begetting of children or that they were partly chiding Malinowski? If some peculiar-looking stranger came into my town and asked me where babies came from, I'd certainly be tempted to tell him about storks and cabbages. Pre-scientific people are people. Individually they are as clever as we are. Field interrogation of informants from a different culture is not always easy.

I wonder whether the Dogon, having heard from a Westerner an extraordinarily inventive myth about the star Sirius—a star already important in their own mythology—did not carefully play it back to the visiting French anthropologist. Is this not more likely than a visit by extraterrestrial spacefarers to ancient Egypt, with one cluster of hard scientific knowledge, in striking contradiction to common sense preserved by oral tradition over the millennia, and only in West Africa?

There are too many hypotheses, too many alternative explanations, for such a myth to provide reliable evidence of past extraterrestrial contact. If there are extraterrestrial beings, I think it much more likely that unmanned planetary spacecraft and large radio-telescopes will prove to be the means of their detection. ☐

WIZARDS

CONTINUED FROM PAGE 58

and direct research at Stanford.

In 1968, after leaving Syntex, Zeffaroni started Alza Corp., which is putting into practice his novel ideas about drug delivery. Zeffaroni has always felt that methods of dispensing medications have not progressed much since the time of the ancient Egyptians. So Zeffaroni set out with some novel ideas: delivering drugs through the skin via impregnated patches, developing a birth control device that releases tiny amounts of progesterone inside the uterus for a whole year, delivering drug reservoirs akin to microminiaturized spaceships that, after being swallowed like pills, become anchored inside the body to release finely controlled amounts of medication.

Alza has also produced an imaginative offshoot: Dynalop Corp., which is developing another of Zeffaroni's ideas—food additives and preservatives so structured that they harmlessly pass through the stomach without entering the bloodstream to cause possible damage. This is done by "leashing" the smaller additive and preservative molecules to harmless inert molecules that are too big to penetrate the walls of the stomach.

Meganthris, Ogyrese & Zeecon—from the Greek word *zoe* ("life") and *con* for control—began to explore the fascinating idea of synthetically imitating the growth-regulating hormones that are naturally present in insects. The idea was to use these as novel insecticides—harmless to humans and other vertebrates but deadly to specific insects. Zeecon has created a number of successful products, already being marketed, including an insect-growth regulator that keeps mosquitoes and flies from maturing into destructive adults from their harmless larval stages. The same product, applied differently, prolongs the life of the silkworm, thereby inducing it to produce higher yields of silk. This was Zeecon's first product to be introduced in Japan. Another of the company's projects is aimed at developing insect pheromones, or sex attractants, as possible lures for use on sticky traps.

Federal regulations have been a barrier to more rapid progress in wider applications of hormonal insecticides. Instead of encouraging the American farmer to use something as cleverly contrived and as safe as synthetic copies of the insects' own hormones, government regulatory agencies have been creating excessive and sometimes arcane obstacles in the way. Similarly, Alza has been delayed in the introduction of some of its devices. [Both Zeecon and Alza are now subsidiaries of larger companies. Alza is a subsidiary of Ciba Geigy. Zeecon is part of Occidental Petroleum. Zeffaroni and Ogyrese continue to head their respective companies.]

Not one to be deterred by small setbacks, Zeffaroni predicts a great future for

NEXT OMNI



ILLUMINATOR



ZERO-G



FOOD



LIFE

THE MASTER ILLUMINATOR—Dick Edgerton is an MIT professor with one of the most famous names in photography and photographic technology. He is the prototypical photographer's cut-throat—inventor of the strobe light, industrialist, explorer, distinguished academic. Edgerton introduced ultrahigh-speed photography, developed high-speed motion pictures, took the first films of atomic explosions, developed side-scanning sonar, took the first close-ups of the Loch Ness monster and turned Jacques Cousteau on to underwater photography. Next month *Omni* reveals the genius. The master image-maker and presents a portfolio of the pictures he helped make possible—a combination that will serve to illuminate.

FOOD FOR ZERO-G—Everybody knows that Tang is the breakfast drink of astronauts, but man does not live on synthetic orange juice alone. So next month we'll take you on a cook's tour of outer space, where you'll be introduced to thermostable frankfurters, canned-60 hour steaks, and exploding chili. The less the NASA is preparing for the shuttle and other spacecraft is more than just a curiosity, however, because food for zero-g will soon be coming down to Earth. You may soon find some of them on supermarket shelves. writes Debra Szokol in the September *Omni*.

LIFE FORMS—What? No green men? No ammonia-breathing silicon creatures? When we finally meet extraterrestrials, like, they won't be it. Not according to writer Gene Byrnsky. Humans evolved to fit conditions probably not duplicated off Earth. And silicon doesn't form the chemical bonds that make life possible. Only carbon can do that. So forget about life on Jupiter-style gas giants. We'll find neighbors only on planets that have plenty of carbon and liquid water. In the next *Omni*, Byrnsky examines chemistry and evolution for a glimpse of the fringe but may avail us among the stars. Artid Wayne McLoughlin illustrates the possibilities.

WITH SARASWATI IN THE BRONX—Explore one of the leading research centers of the world, where the competition is brutal and the rewards are great. No, it's not Harvard or Stanford, but rather a high school in the Bronx, New York. Students like Anas Bose have the ability and the brains to shape our future—if they choose to. Read Bill Stuckey's fascinating profile of triumph and travel at Bronx High School of Science—a breeding ground for tomorrow's Nobel laureates—in the September *Omni*.

the applications of the new biology. "It's difficult right now to see the future applications, because we are at the beginning of the recombinant DNA technology," he says. "It was difficult to map out the products created by the transistor. But the applications will be far far wider."

The first things people can see right now to do with this new technology are to produce agents used in pharmacology therapy vaccines—produce all the rare chemicals that are in the body develop plants with higher abilities to fix nitrogen or with higher protein levels. These are the simplest ideas. If you want to let yourself go further out, who is to say we can't construct biological memories—DNA memories? The way biological memories are constructed is most fantastic, in very small space.

But there is a problem. It's not easy to anchor the technology by patents, since the basic work is coming out mainly from the universities. This makes it hard for the new industry to develop a capital base.

A DELICATE BALANCE

And this is one of the paradoxes of the Valley of the Giants. The scientist-businessman just as often as the academic-industrialist must continually strive to balance pure research with practical realities. Djerassi probably has been the most successful high wire walker. "I'm one of the few people at Stanford, maybe

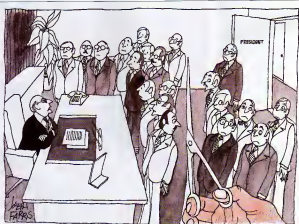
anywhere," he says, "where for twenty years I've led a completely begamous life. All that time serving as a professor of chemistry with a very large research group, and not just teaching courses, and at the same time being either a vice-president at Syntex or a president here at Zocor. I think it was worthwhile for both pieces. I became a much better academician and a much better government advisor by spending part of each day running a high-technology industrial enterprise. And I became a much better and more innovative corporate executive by being primarily a scientist, which is more difficult to learn than business. Business you can learn on the job. Science you cannot."

It's unlikely that Djerassi could have led that kind of life anywhere else. Liberal-minded universities that encourage professors to participate in company building and to serve as consultants are the exception rather than the rule. Attempts abroad to duplicate the valley's remarkable company-formation process have scored only the most moderate successes. Undaunted, foreign investors have decided to settle for second best and have already begun pouring funds into Silicon Valley. Plots of West Germans can be seen etching into local fabric on vests to semiconductor companies in which they now have substantial interests. The Japanese have gone further, setting up advanced companies staffed by American engineers and

scientists. From these pioneering companies, the Japanese then pump the newest technology into their own burgeoning industries. This has led some inhabitants of the valley to fear that their peaceful abode will someday become a battleground between those two antithetical World War II allies.

The failure to clone Silicon Valley abroad is not really surprising. If we look back on the starting developments that have sprouted from the fertile center it would be a mistake to underestimate the creative influence and spirit of entrepreneurship that a few outstanding individuals—men like Terman, Shockley, and Djerassi—have generated in their wake. Their ability to transform new ideas into successful and innovative products undoubtedly has been a major force in attracting young talent to the valley, making it a remarkable breeding ground for new industries within less than a century's span. The history that they have helped to create and Silicon Valley's unique environment cannot instantly be duplicated.

Whatever the future holds, the technological revolution that flared up in Silicon Valley shows few signs of sputtering out. Judging from the myriad new companies started in the last few years, only the first harvest has been reaped from the valley. Time will tell, but one thing is certain: The footsteps of that Palo Alto fly already have resounded around the world many times over. □



Gentlemen, we've hired efficiency experts to cut out some of the dead wood.

leases: No, I don't think so. But we don't have to define all the safe areas of the sea, only a few of them. Obviously, one doesn't want to put nuclear wastes in some place where, in the next thousand or so years, they will suddenly be subject to volcanic activity that will melt them and spew them out. One doesn't want to use a place where there will be tectonic faulting. Nor does one want an area that's subject to upwelling. For instance, one wouldn't store such materials in the bottom of the Red Sea or the Gulf of California, which are newly active places—new features of the plate tectonics—where the continents are beginning to split apart. Or where there is clearly new subcrustal material coming up and new land being formed. It's too uncertain.

Greif: Despite what we know about plate tectonics, is there still some risk?

leases: Zero risk is unobtainable. You can make the argument that twelve hundred people die every year of leukemia in the absence of a law requiring us to live under three feet of concrete to protect ourselves from cosmic rays. You can argue that a person can be killed by falling from a five-meter wall. Yet we don't require all walls to be less than fifty centimeters high. Nor do we require that all bathing be done in ten liters of water because it can be shown that drowning is possible in one hundred liters. We tolerate all sorts of conventional hazards.

Greif: But there have been suggested alternatives to nuclear storage. Do you believe that deep-subbottom storage is safer than burial in the earth?

leases: The ocean becomes a very powerful barrier between these materials and the biosphere. There are many reasons for this. We know what's going to happen in the deep ocean basins for the next million years. And there are great advantages to placing those wastes down deep under sea-floor sediments. The sediments probably have an immense capacity for ion exchange; they're rich chemically and the ultimate barrier is isotopic dilution of the radioactive materials. It makes a great deal of difference whether radioactive iodine-129 is released in these sediments or in, say, an outdoor chemical environment like Wisconsin. There's so much normal iodine in the ocean that the radioactive isotope is strongly diluted. Another advantage is the extremely high pressure at those depths, which prevents the formation of expanding steam or gases within any container. Also, there are no fresh groundwater supplies that might be contaminated. The protection of such water supplies is an important criterion in present plans. Submerged storage is not often considered for the ironic reason that there are no fresh groundwater supplies to protect.

Greif: How deep below the sea floor are we talking about?

leases: About a kilometer and under six kilometers of water. We'd convert the wastes into a glasslike form or cement or ceramic or something of that nature. The wastes can be largely emulsified and put down in containers with sufficient spacing so that the heat generated by them cannot cause convection in the sediments. In the proper combination, we'd have a land repository that might generate power for twenty years while the wastes cool down.

Greif: This source of energy—nuclear power—is only one of many marine sources that you and the Institute of Marine Resources have been studying. Can you touch on some of the others?

leases: Well, of course there are the ones we're already utilizing, the fossil fuels that ocean sediments hold. In addition to these, the five natural forms of energy in the sea that have the greatest promise are waves and swell, tides, currents, salinity gradients and thermal gradients (including ice). There are also geothermal springs

related to energy-intensive uses, funneling directly into electrical grids, for instance? **leases:** No, they could be used for other purposes. Although salinity-gradient energy is a very large potential source, ranking in both total magnitude and energy density well above most sources other than chemical and nuclear fuels, we aren't certain that it can be utilized with practical effectiveness. Yet it could be employed internally to desalinate brackish water. Thermal-gradient power can produce fresh water with power or air conditioning as a by-product. Tidal flow can be directed to "cottage" situations. Waves and current of course, can be employed directly for ship propulsion.

Greif: In a recent paper, "Power from the Sea—Forms and Prospects," you stated that "an Antarctic iceberg, melted for water in tropical oceans, should yield some thousands of megawatt-years of energy." Your "iceberg towing proposal" generated considerable interest and newspaper coverage. Were you dead serious?

leases: (laughing) Of course, everything I do is in dead seriousness. I have no humor or irreverence in my soul at all.

Greif: But no one is yet towing icebergs up from Antarctica, despite their potential for supplying great quantities of fresh water and power. Why not?

leases: Well, it was only twenty-five years ago that I first suggested it. I could spend my life on a single case like that, getting into all the complexities and difficulties of it. If anyone wants to take the idea and run with it, I'm happy. But it really got started the wrong way. It was too far out for the "developed nations," so I suggested the Arabs will be first to do it, although the "leaky" laws would be to the arid regions of the Southern Hemisphere: Australia, South Africa, or Chile.

Greif: You've been deeply interested in aquaculture as another oceanic resource. What do you see as the best potential "crops" from the sea?

leases: I've written a few articles on that subject. It seems to me that the limiting nutrient of the human race is probably protein. Caloric foods are plentiful on the market, but proteinaceous foods are generally much rarer and more expensive. I think aquaculture will be an important source for such luxury foods, but not for the bulk of our diet.

Admittedly very few exceptions, luxury marine foods are awfully expensive to manage in aquaculture because they are all animals and you have to feed them something you could have eaten yourself. No society in the world ever attempted to feed itself on oysters. It takes too many cows; it's more sensible to eat the cows.

Greif: Has your long experience with terrestrial animal husbandry helped with the development of aquaculture?

leases: Yes, but in general, whatever has always done in terrestrial animal husbandry is to stick to herbivores. That's not to say that domestic animals don't get a little

◀ Essentially, all man does is take things out of the ocean, and, unlike any other member of the marine food web, he does not put back things that are able to regenerate life ▶

Greif: What about harnessing the energy of the Gulf Stream with underwater turbines?

leases: That idea costs, but the energy density is really very low. It's so practical, then, instead of building dams, why hasn't anyone anchored paddle wheels in the Mississippi River? Or the Amazon? It's a lot easier to do there than in the fast currents of the Gulf Stream.

Greif: And what about the project now under way to attempt to extract methane from the fermentation of kelp plants harvested from the southern California coast?

leases: I'm not so sure about that. If that project were mine, my first experiment would be to go to the southern bays and see how much methane I could extract from the fermentation of the water hyacinths there. They're harvested here. Those hyacinths are a nuisance, and every year a few million tons are cleared and thrown away. Hyacinths may be as valuable as kelp, because both have the same general properties. At least, it would be a good place to start.

Greif: The various forms of potential marine energy you've mentioned—are they all

meat, after all, while cattle graze, they get an aphid now and then. Chickens eat a few insects. But cows and chickens are primarily herbivores. Now when you get to the ocean it turns out that our principal foods are high-level predators, such as tuna or salmon. But there are some exceptions. There are the filter feeders, creating the miracle of taking very fine particulate material—the phytoplankton and detritus—and turning it into organisms big enough to make one hungry. The filter feeders occupy a feeding niche that doesn't exist on land, except perhaps vaguely and tentatively. Filter feeders put all their pumping water, the ocean brings the food to them, and they filter it out. That way they convert very fine microscopic organisms into large-size food in one step. So we—the humans—don't suffer the losses from all of the inefficiencies of the ordinary marine food web.

We could raise scallops or mussels—both filter feeders. Mussel culture is very important in some parts of the world, and some of the most productive husbandry in the world is mussel culture. But not here in the United States, because there are some strange regulations concerning that oddity. The law says that at certain times of the year mussels are poisonous and can be used only as fish bait, whether they are toxic or not. We don't like to eat fish bait.

There's another excellent prospect the abalone. It's a strict herbivore and a luxury item. Its use in the United States is a curiosity because we don't eat snails very much.

But if we are going to harvest the ocean, what do we do? The ocean is mainly a desert-blue. Blue is the color of oceanic deserts. Blue water is poor. Very little lives in it. The really rich pastures are the coastal waters, which are brown or green and not very transparent, and they are rare. How do we overcome this handicap? We choose some sort of preferred herbivore, send it forth into the sea, let it range for itself, and then bring it back for harvest. And, of course we can improve the range by predator control and by anchoring it also. In some of the ways we've already discussed. **Orrin:** In effect, sea ranching?

Isaacs: Yes, one chooses some sort of anadromous fish (one that "homes" in rivers or estuaries) and ranches it. Such a habit has considerable advantages. One of the few equivalents on land is the reindeer; you send it forth, and it comes back on a migratory path, on its own.

Orrin: What species would be ideal for sea ranching?

Isaacs: The shad, perhaps, or any fish that runs upriver. You simply raise the young in a pond and release them; they range out to sea, using their own energies, grow and then come back. It's exactly like a round-up, except you don't use up a lot of costly energy because the fish choose to feed, grow and return on their own.

Orrin: Is sea ranching a long-range future possibility, or is it close to reality?

Isaacs: Well, we're already doing it, to a limited extent, with salmon. But salmon are

not primitive feeders. They're high-level predators. You could raise a lot more shad or catfish or smelt.

Orrin: What else does that intractable mind of yours wonder about?

Isaacs: Regrettably, wonder is probably the right verb all right! And I hope you are equating insatiable with hungry rather than with unfeeling. I am presently working, at least on paper, on a number of ideas or questions, some so far outside my field that I may not be blinded by the traditional scientific dogma. So I am working on "up-side-down" migration for waterlogged or saline agricultural soils, on halophytes (salt-tolerant plants) on new kinds of marine food-web models, on thermophilic (heat-loving) bacteria that start the cooling of seawater-cooled power plants, measuring ocean currents by aerial photographs of waves, and asking some naive questions, such as Why are there so few strongly rotating storms that fall between the dimensions of hurricanes and tor-

● *There are regions in the deep North Pacific, far from active zones, where we could store nuclear wastes far beneath the sediments and nothing would crack them open for ten million years.* ●

nadoes? Or are some chronic diseases (coronary disease, cancer, arteriosclerosis) the result of our suppressing natural physical conditions, such as exercise, fever and the frequent loss of blood?

I also wonder about black holes and whether the space-time relationships have not perhaps been extended further than the limits to which they represent the universe. Perhaps they are just what they seem to be, bodies with sufficient mass and gravity to prevent the escape of light, and not some strange angularity transported into another universe.

I wonder about inflation and whether the sadly fragmented field of economics is not overlooking some such dominating simple rule as: "The more resources are expended to no purpose, the more money approaches nothing as a value." I wonder also how Ecclesiastes, Aeschylus, Solomon, Lao-tzu, Leonardo da Vinci, Galileo, Dante, Oeaka, or Franklin understood so much of the physical universe and man, and possessed such sharp foresight and prescience. And I wonder in these far more enlightened times, at the deep and unbridged gulf in communication that now

divides our vast fund of knowledge and understanding from those who create policy and lead events—one of the most tragic and frightening syndromes of our times.

Orrin: I suspect that your nagging curiosity has helped you get where you are today. Were you as curious in your days as a fisherman, when you started out?

Isaacs: Well, I wasn't a fisherman first. I started out in the merchant marine and then went into the hotel service. I found a lot of things that were interesting. I also found that lay people know a lot. They may not be able to express themselves, but they understand a great deal. But our system degrades lay knowledge. It's a part of the alienation, isn't it, between the academic and the politician? Why this is so perplexes me.

Anyway, I kept going back to school. I always got good grades, but I also grew bored and restless. So I left school. I fished for a few years as a commercial fisherman on my own boat. I got to wondering what was going on around me. I said a lot. I learned a little bit about coxipods and about phytoplankton. Then I became curious about the phenomenology of the ocean currents, water circulation, rotation. I kept writing letters to Scripps (Institution of Oceanography) and they sent back such relevant answers I decided they really needed help. I applied for a job. It took me ten years to get paid, but here I am. **Orrin:** In the years since you have developed a personal philosophy. **Isaacs:** Indeed I have. I even wrote some of it down once. A useful philosophy should be internally inconsistent. Otherwise one might start to believe it to be complete. Mine qualifies. Here is a relatively consistent part of it:

Man contains his thinking into rigorously definable compartments. However, the oceans, and all of nature, are oblivious to the artificial compartments in which man pursues knowledge; and its creatures, its elements, its forces and energies act and interact with such complexity as to constitute a superb testing ground of man's full unconstrained and uncompartimented intellectual capacity. The ocean presents to man the challenge of understanding the expression of great natural laws—including those of himself—in a foreign, indeed in an inconceivable, medium.

In solving these problems and those of employing the oceans to fill man's practicable, aesthetic, recreational, and adventurous needs, we may find that we have reencountered natural philosophers—uncompartimented, unskilled, and eclectic minds—ranging across, and interlarding, the sciences. We may also create new sciences, cultural practices, art, philosophy, nature, law and lay understanding with only due (not exclusive) regard for the questionable and a dominant and powerful regard for the conceptual. Then perhaps we can more meaningfully approach the microcosm of unquantifiable man and what he indubitably is and can be. □

QUIETUS

CONTINUED FROM PAGE 78

to witness a corpse, to preserve it. The Egyptians would have nothing on us then, he thought.

"Don't," said a husky voice from the door. It was MaryJo, his eyes red-rimmed, her face looking sleep in.

"Don't what?" Mark asked her. She didn't answer just glanced down at his hands. To his surprise, Mark noticed his thumbs were under the lip of the coffin lid, as if to lift it.

"I wasn't going to open it, it's dead—"
"Come upstairs," MaryJo said.
"Are the children asleep?"

He had asked the question innocently, but her face was immediately heated with pain and grief and anger.

"Children?" she asked. "What is this? And why tonight?"

He leaned against the coffin in surprise. The wheeled table moved slightly under the weight of his body.

"We don't have any children," she said.

And Mark remembered with horror that she was right. After the second miscarriage, the doctor had tied her tubes, because any further pregnancies would risk her life. There were no children, none at all and it had devastated her for years. It was only because of Mark's great patience and dependability that she had been able to stay out of the hospital. Yet when he came home tonight, he tried to remember what he had heard when he came home. Surely he had heard the children running back and forth upstairs. Surely.

"I haven't been well," he said.
"If it was a joke, it was sick."

"It wasn't a joke. It was—!" But again he couldn't, or at least didn't, tell her about the strange memory lapses at the office, even though this was even more proof that something was wrong. He had never had any children in his home. MaryJo and her brothers and sisters had all been discreetly warned not to bring children around her poor wife, who was quite distraught—to us—the Old Testament word—barnet.

And all evening he had talked about having children.

"Honey I'm sorry," he said, trying to put his whole heart into the apology.

"So am I," she answered, and she went upstairs.

Surely she isn't angry at me, Mark thought. Surely she realizes something is wrong. Surely she'll forgive me.

But as he climbed the stairs after her taking off his shirt as he did, he again heard the voice of a child.

"I want a drink, Mommy." The voice was plaintive, with the sort of whining only possible to a child who is comfortable and sure of love. Mark turned at the landing in time to see MaryJo passing the top of the stairs on the way to the children's bedroom, a glass of water in her hand. He thought nothing of it. The children always wanted extra attention at bedtime.

The children. The children. Of course there were children. This was the urgency he had felt in the office, the reason he had to get home. They had always wanted children, and so there were children. Topworth always got what he sat his heart on.

"Asleep at last," MaryJo said wearily when she came into the room.

Despite her weariness, however, she kissed him goodnight in the way that told him she wanted to make love. He had never been at much about sex. Let the readers of Reader's Digest worry about how to make their sex lives fuller and richer, he always said. As for hers, sex was good, but not the best thing in his life, just one of the ways that he and MaryJo responded to each other. Yet tonight he was disturbed, worried. Not because he could not perform, for he had never been troubled by even temporary impotence except when he had a fever and didn't feel like sex, anyway. What bothered him was that he didn't exactly care.

He didn't not care, either. He was just going through the motions as he had a thousand times before, and this time suddenly it all seemed so silly, so ridiculous of peeing in the backseat of a car. He felt embarrassed that he should get so excited over a little stroking. So he was almost relieved when one of the children cried out. Usually he would say to ignore the cry, would insist on continuing the lovemaking. But this time he pulled away from her, put on a robe, and went into the other room to quiet the child down.

There was no other room.

Not in this house. He had, in his mind, been heading for the room filled with a crib, a changing table, a dresser, mobiles and cheerful wallpaper. But that room had been years ago, when they were full of hope, in the small house in Sandy, not in his home in Federal Heights, with its magnificent view of Salt Lake City, its beautiful shops, and its decoration that spoke of taste and showed off wealth and sophisticated family of loneliness and grief. He leaned against a wall. There were no children. There were no children. He could still hear the child's crying in his mind.

MaryJo stood in the doorway to their bedroom, naked but holding her nightgown in front of her. "Mark," she said. "I'm afraid."

"So am I," he answered.

But she asked him no questions, and he put on his pajamas, and they went to bed. And as he lay there in darkness, listening to his wife's faint rasping breath, he realized that it didn't matter as much as it ought. He was losing his mind, but he didn't really care. He thought of praying about it, but he had given up praying years ago, though of course it wouldn't do to let anyone else know about his loss of faith, not in a city where it's good business to be an active Mormon. There it'd be no help from God on the one, he knew. And not much help from MaryJo, either, for instead of being strong, as she usually was in an emergency, she

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time she would be, as she had said aloud.

Well, so am I, Mark said to himself. He reached over and stroked his wife's shadowy cheek, realized that there were some creases near the eye, understood that what made her afraid was not his specific ailment, odd as it was, but the fact that it was a hint of aging, of a frailty of imminent separation. He remembered the box downstairs, like death appointed to watch for him until at last he consented to go. He briefly resisted them for bringing death to his home, for so indelicately imposing on them. Then he ceased to care at all—about the box, about his strange lapses in memory about everything.

I am at peace, he thought as he drifted off to sleep. I am at peace and it's not at that pleasant

"Mark," said MaryJo, shaking him awake. "Mark, you cheated."

Mark opened his eyes, mumbled something so the shaking would stop, then rolled over to go back to sleep.

"Mark," MaryJo insisted.

"I'm tired," he said in protest.

"I know you are," she said. "So I didn't wake you any sooner. But they just called. There's something of an emergency or something—"

"They can't flush the toilet without someone holding their hands."

"I wish you wouldn't be crude, Mark," MaryJo said. "I sent the children off to school without letting them wake up by kissing you good-bye. They were very upset."

"Good children."

Mark, they're expecting you at the office.

Mark closed his eyes and spoke in measured tones. "You can call them and tell them I'll come in when I damn well feel like it, and if they can't cope with the problem themselves, I'll fix them all."

MaryJo was silent for a moment. "Mark, I can't say that."

Wow for funny I'm tired. I need a rest. My mind is doing funny things to me. And with that, Mark remembered all the illusions of the day before, including the illusion of having children.

There aren't any children, he said.

Her eyes grew wide. "What do you mean?"

He almost shouted at her, demanded to know what was going on, why she didn't just tell him the truth for a moment. But the wrathful and disinterested clamped down and he said nothing, just rolled back over and looked at the curtains as they drifted in and out with the air conditioning. Soon MaryJo left him, and he heard the sound of machinery starting up downstairs: The washer, the dryer, the vacuum cleaner, the dishwasher, the garbage-disposal unit. It seemed that all the machines were going at once. He had never heard the sounds before. MaryJo never ran them in the evenings or on weekends when he was home.

At noon he finally got up, but he didn't

feel like showering and shaving, though any other day he would have felt dirty and uncomfortable until those mounds were done with. He just put on his robe and went downstairs. He planned to go in to breakfast, but instead he went into his study and opened the lid of the coffin.

It took a bit of preparation, of course. There was some pacing back and forth before the coffin, and much stroking of the wood, but finally he put his thumbs under the lid and lifted.

The corpse looked stiff and awkward. A man, not particularly old, not particularly young. Hair of a determinedly average color. Except for the grayness of the hair color, the body looked completely natural and so utterly nondescript that Mark felt sure he might have seen the man a million times without remembering he had seen him at all. Yet he was unmistakably dead, not because of the cheap satin lining the coffin rather slowly, but because of the hunch of the shoulders, the jut of the chin.

And so he sat and stared at the coffin for two hours and had no dinner and did not notice when MaryJo came downstairs and lay down on the sofa and wept.

The man was not comfortable.

He smelled of embalming fluid.

Mark was holding the lid open with one hand, leaning on the coffin with the other. He was trembling. Yet he felt no excitement, no fear. The trembling was coming from his body, not from anything he could find within his thoughts. He was trembling because he was cold.

There was a soft sound or absence of sound at the door. He turned around abruptly. The lid dropped behind him. MaryJo was standing in the doorway wearing a filthy house dress, her eyes wide with horror.

In that moment years fell away and to Mark she was twenty, a shy and somewhat awkward girl who was forever being surprised by the way the world actually worked. He waited for her to say, "But, Mark, you cheated him." She had said it only once, but ever since that he had heard the words in his mind whenever he was closing a deal. It was the closest thing to a conscience he had in his business dealings. It was enough to win him a reputation as a very honest man.

"Mark," she said softly as if struggling to

keep control of herself. "Mark, I couldn't go on without you."

She sounded as if she was afraid something terrible was going to happen to him and her hands were shaking. He took a step toward her. She lifted her hands, came to him, clung to him, and cried in a high whimper into his shoulder. "I couldn't, I just couldn't."

"You can't have to," he said, puzzled.

"I'm just not the kind of person," she said between sobs, "who can live alone."

But even if I—swan if something happened to me, MaryJo, you'd have them? He was going to say "children." Something was wrong with that, though, wasn't there? They loved no one better in the world than their children, no parents had ever been happier than they had been when their two were born. Yet he couldn't say it.

"I'd have what?" MaryJo asked. "Oh, Mark, I'd have nothing."

And then Mark remembered again (What's happening to me?) that they were childless, that to MaryJo, who was old-fashioned enough to regard motherhood as the main purpose for her existence, the fact that they had no hope of children was God's condemnation of her. The only thing that had pulled her through after the operation was Mark, was fussing over his meaningless and sometimes invented problems at the office or telling him endlessly the weeks of her lonely days. It was as if he were her anchor to reality and only he kept her from going drift in the eddies of her own fears. No wonder the poor girl (for at such times Mark could not think of her as completely adult) was distraught as she thought of Mark's death and the damned coffin in the house did no good at all.

But I'm in no position to cope with this, Mark thought. I'm taking apart. I'm not only forgetting things, I'm remembering things that don't happen. And what if I die? What if I suddenly had a stroke like my father had and died on the way to the hospital? What would happen to MaryJo?

She'd never look for money. Between the business and the insurance, even the house would be paid off, with enough money left over for her to live like a queen on the island. But would the insurance company arrange for someone to hold her apartment while she crept out her fears? Would they provide someone for her to waken in the middle of the night, when nameless terrors haunted her?

Her sobs lunged into frantic hicups and her fingers dug more deeply into his back, though the soft fabric of his robe. See how she clings to me, he thought. She'll never let me go. And then the blackness came again, and again he was falling backward into nothing, and again he did not care about anything. Did not even know there was anything to care about.

Except for the fingers pressing into his back and the weight he held in his arms. I do not mind losing the world, he thought. I do not mind losing even my memories of the past. But these fingers. This woman. I

cannot lay this burden down, because there is no one who can pick it up again if I release her she is lost!

Yet he longed for the darkness, resented her need that held him. Surely there is a way out of this, he thought. Surely a balance between two hungers that leaves both satisfied. But still the hands held him. All the world was silent, and the silence was peace except for the sharp, insistent fingers, and he cried out in frustration. And the sound was still ringing in the room when he opened his eyes and saw MaryJo standing against a wall, leaning against the wall, looking at him in terror.

"What's wrong?" she whispered.
"I'm losing," he answered. But he could not remember what he had thought to win.

And at that moment a door slammed in the house and Amy came running with little loud feet through the kitchen and into the study flinging herself on her father and bellowing about the day at school and the dog that chased her for the second time and how the teacher told her she was the best reader in the second grade but Demei had spilled milk on her and could she have a sandwich because she had dropped hers and stepped on it accidentally at lunch—

MaryJo looked at Mark cheerfully and winked and laughed. "Sounds like Amy's had a busy day doesn't it, Mark?"

Mark could not smile. He just nodded as MaryJo straightened Amy's disheveled

clothing and led her toward the kitchen.

"MaryJo," Mark said. "There's something I have to talk to you about."

"Can it wait?" MaryJo asked, not even pausing. Mark heard the cupboard door opening, heard the lid come off the peanut butter jar, heard Amy giggle and say, "Mommy not so tick."

Mark didn't understand why he was so confused and terrified. Amy had a sandwich after school ever since she had started going—even as an infant she had had seven meals a day and never gained an ounce. It wasn't what was happening in the kitchen that was bothering him; it couldn't be. Yet he could not stop himself from crying out, "MaryJo! MaryJo, come here!"

"Is Daddy mad?" he heard Amy ask softly.

"No," MaryJo answered, and she bustled back into the room and impatiently said, "What's wrong, dear?"

"I just need—just need to have you in here for a minute."

"Really, Mark, that's not your style, is it? Amy needs to have a lot of attention right after school. It's the way she is. I wish you wouldn't stay home from work with nothing to do. Mark, you become quite impossible around the house." She smiled to show that she was only half-serious and left again to go back to Amy.

For a moment Mark felt a terrible stab of jealousy that MaryJo was far more sensitive

to Amy's needs than to his.

But that jealousy passed quickly like the memory of the pain of MaryJo's fingers pressing into his back and with a tremendous feeling of relief Mark didn't care about anything at all, and he turned around to the coffin, which fascinated him, and he opened the lid again and looked inside. It was as if the policeman had no face at all. Mark realized. As if death stole faces from people and made them anonymous even to themselves.

He ran his fingers back and forth across the seat, and it felt cool and inviting. The rest of the room, the rest of the world, faded. Only Mark and the coffin and the corpse remained, and Mark felt very tired and very hot, as if life itself were a terrible friction making heat within him, and he took off his robe and pajamas and awkwardly climbed on a chair and stepped over the edge into the coffin and knelt and then lay down in the coffin. There was no corpse to share the slight space with him, nothing between his body and the cold satin, and as he lay on it, it didn't get any warmer because at least the friction was slowing, was cooling, and he reached up and pulled down the lid. The world was dark and silent, and there was no odor and no taste and no feel but the cold of the sheets.

"Why is the lid closed?" asked little Amy, hiding her mother's hand.

"Because it's not the body we must remember," MaryJo said softly, with careful control, "but the way Daddy always was. We must remember him happy and laughing and loving us."

Amy looked puzzled. "But I remember he spanked me."

MaryJo nodded, smiling, something she had not done recently. "It's all right to remember that, too," MaryJo said, and then she took her daughter from the coffin back into the living room, where Amy, not realizing yet the terrible loss she had sustained, laughed and climbed on Grandpa.

David, his face serious and horrified because he did understand, came and put his hand in his mother's hand and held tightly to her. "We'll be fine," he said.

"Yes," MaryJo answered. "I think so."
And MaryJo's mother whispered in her ear, "I don't know how you can stand it so bravely, my dear."

Tears came in MaryJo's eyes. "I'm not brave at all," she whispered back. "But the children. They depend on me so much. I can't let go when they're leaning on me."
"How terrible it would be," her mother said, nodding wisely. "If you had no children."

Inside the coffin, his last need fulfilled, Mark Tapscott heard it all but could not hold it in his mind, for in heaven there was space and time for only one thought, consent. Everlasting consent to his life, to his death, to the world, and to the everlasting absence of the world. For now at last there were children. **DD**



"The test results are now final. Everything causes cancer."

CIRCLES

CONTINUED FROM PAGE 22

destroy the "economy of scale" arguments of the mega-industrialists by showing that small was cheaper and more efficient than big—that it just requires more of your sweat and brains.

Hess found he could supply much of the neighborhood with protein by raising rainbow trout in plywood tanks in apartment basements (for about a dollar a pound in costs). Using empty rooftops, he also raised bumper crops of hydroponically grown tomatoes. The "community technology" involved here was learning that a few cups of vacant-lot soil in the trout tanks produced bacteria that removed destructive ammonia from trout waste that de-carated washing machines provided fine water-recirculation systems, and that the colicite chips available in any garden store were perfect for filters.

"A typical basement in the neighborhood could produce about three tons annually [emphasis mine] at costs substantially below grocery store prices," Hess wrote in *Community Technology*.

Who, then, needs supermarkets or a Department of Agriculture?

He group also built solar collectors out of oil-food cans, which, mounted on rooftops, were capable of heating household air to about 49°C. Another group developed a self-contained bacterial toilet, which suggested that any neighborhood could hook from the city sewerage system and avoid its inefficiency and pollution. Plans were begun for an electrically driven platform to handle heavy neighborhood moving tasks, a peanut-sized chemical factory to make household cleaners, disinfectants, and—get this—aspirin, and a methanol plant to convert garbage into a gasoline-like fuel.

Hess's accomplishments were cheered with "Right on!" at Adams-Morgan's town-hall-like assembly. But no one moved to copy them or push the neighborhood forward even more imaginative forms of independence. Welfare doctors were easier and more familiar; Hess concluded bitterly (noting also that when Chicago's Rev. Jesse Jackson went to Washington to urge Hess-like self-reliance among blacks, "he was almost chased out of town").

So Hess left Adams-Morgan and built a beautiful solar house in the side of a hill, mostly with banded materials and services, at a total cost of \$11,000. He is helping to convert the Charlottesville, West Virginia, area into one of his independent dream communities through such novel schemes as convincing the local vocational school to design area-appropriate systems to bring freedom from sewerage districts, utility companies, supermarkets, giant transportation and equipment firms, etc. Hess remains the prototypical Little Brother, by not paying the IRS and by living almost entirely by bartering his skills

"Liberty is knowledge-intensive," he told me. "You can't get away from the bastards if you merely nest on 'rights' from above and don't use your head and the technology lying all around you to ensure your own rights and survival."

"If I were elected president, I'd close all the schools so kids could learn something," he said as I was leaving. "I'd end the licensing of all professionals, from doctors to cosmeticians, so people would learn how to solve their own problems. I would require that every American child, at birth, be given a kit composed of a three-quarter-inch drill, a complete set of screwdrivers and wrenches, the Reader's Digest Complete Do-It-Yourself Manual, and a thirty-eight special with ammo. Naturally, I would legalize firearms for everyone except the police."

Okay, all this is funny and colorful and clever and highly inventive, but I don't see the Pentagon/Exxon Aes and their Big Brother aces doing anything but suppress-

• I would require that every American be given a kit composed of a three-quarter-inch drill, a complete set of screwdrivers and wrenches, a Reader's Digest Do-It-Yourself Manual, and a thirty-eight special •

ing the potential side of community utopias patterned on Hess's proposals. Nor do I see scientists surrendering federal grants or leaving International Physics in droves in order to build parole accelerators out of cattle guards in Roswell, New Mexico. Unless

•A savvy rational political figure moves quickly to weld the little brothers into a cohesive 180 vote. The world might not yet be ready for the radical and revolutionary Hessian Way to Independence (but by 1984 it might be among the best ways to avoid centralized Orwellian institutions of control), although a continued public endorsement of something like Mark Hatfield's "Neighborhood Corporation" bill might give an imaginative presidential hopeful a solid voting bloc. Although his "liberal Republican" record is one of the most thoughtful the Senate has produced in years, Hatfield notes that "the Republican party wouldn't nominate me for sergeant-at-arms—the Helms-Reagan people seem to want to chase all the real Republicans out." Other measures he advocates will make Hatfield a principal statesman of the little brothers. He is co-

sponsor of the "National Initiative" bill, which could make the national referendum a major and lobby-crushing influence in Washington. Also, he has proposed an extremely simple income-tax form, with no loopholes. Hatfield is just too sane to be taken seriously now.

•The same savvy candidate must realize that this is not just another ninky-dink, single-issue anti-abortion/like group. These little brothers They represent a complete philosophy of control reborn—get me out of the data banks, my social security number is none of your business. I'll take care of myself until you find a way to make government and corporations and all the other monsters efficient and nonpredatory. The many arguments against an America of technologically and governmentally independent neighborhoods—Balkanization, destruction of American influence abroad, its back to the caves—should be thoroughly considered by the little-brother candidate and be aired publicly. Big Brother will be calling him a crank and a crackpot, so he'd better keep his arguments clear, solid—and dramatically appealing.

•If our little-brother man man is really clever, he'll seize upon that demon that arch-enemy of humanity, the cheap computer as the little brothers' best friend. Why should the agencies and the multinational have the monopoly on bugging? With the home-computer terminal, and the appallingly cheap (and dropping) cost of micro-processors and related technologies, why shouldn't the little brothers fight for access to all those data banks—including President Carter's unclassified ones? (Official Circles will explore this further in a future column.)

•Balkanization? If America becomes a federation of 100,000 or so neighborhoods, the cheap computer gives each of these access to the information, problem-solving techniques, and helpful statistics of all the others. It could be a much more unifying instrument—of the American culture, please understand, not just the Polonaise nation-state—than anything ever to hit political science.

•A proper little-brother leader would probably want to redirect much of government toward increasing the skills, general suitability and independence of individuals and neighborhoods. Why shouldn't construction men, service workers, gardeners and other holders of useful skills also be teachers for their fellow neighborhooders?

Ask the average congressman whether he thinks there is any science or technology issue sure enough to influence the 1980 campaign, and he'll probably say that, besides Three Mile Island and nuclear power's future, the folks just seem to fuss over. Look closer: It's possible that technology and Mother Science will become the only political issues—even inflation can be blamed on misuse or mispricing of technology—of the future. ☐

HOW WRONG WE WERE!

STARS

By Patrick Moore

Some years ago—I think it was in 1964—I gave a public lecture about the planet Mars. Several hundred people attended, and I summarized for them what we knew and suspected about the Red Planet. I made a series of 12 statements, every statement backed up by the best available scientific evidence—and every one was wrong!

The lecture, I repeat, was given less than two decades ago. Yet it preceded the first successful Mars probe, *Marsner 4*, which made its fly-by later and sent back information that turned all our preconceived ideas upside down. Before *Marsner 4*, we thought Mars had a fabled surface, at most undulating slightly, that its atmosphere was composed chiefly of nitrogen, with a ground pressure of at least 90 millibars, that its dark areas were covered by low vegetation, and that the white polar caps were layers of hoely mineral about a centimeter in depth. Though no one had much faith in the age-old idea of enigmatic Martians, it was still believed that the celebrated "canals" had a basis in reality.

The probes, beginning with *Marsner 4* have shown otherwise. The Martian atmosphere is mainly carbon dioxide, with a ground pressure below ten millibars. The dark regions are not due to living organisms; they are merely "isbedo features," differing from their surroundings only in their darker hue. The residual polar caps are of ordinary ice and are extremely thick. There is also some solid carbon dioxide, which persists for part of the Martian year (687 of our days). There are no canals. The spider's-web network beloved of the older observers was purely imaginary. Finally, Mars is a world of craters, mountains, valleys, dry riverbeds and towering volcanoes.

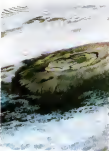
We were wrong even about the color of the sky. Most people expected it to be dark blue. In fact, it is salmon pink.

Why were we so wrong? Because, of course, we had been observing Mars across a distance of at least 54.7 million kilometers, and our knowledge was bound to be incomplete at best.

We made enormous errors even in the

case of our nearby moon. During the 1950s a strange theory, supported by some eminent astronomers, notably Cornell's Dr. Thomas Gold, held that the "bees" were deep dust drifts and that any spacecraft that would land on them would all once sink deep into them. Mind you, most practical observers could see flaws in this theory, and I had no faith in it myself. But it was taken very seriously in the United States and was not finally disproved until the Soviet automatic probe *Luna 9* made a controlled landing and failed to sink out of view.

What, then, about Venus? Here we were even more gravely at fault: D. H. Menzel, F. L. Whipple, and many followers believed the planet's surface was covered mainly by water, surrounded by clouds of water vapor. It was known that the atmosphere was rich in carbon dioxide, so the water would presumably have been fouled by dissolved gas. If the marine theory had been correct, there would have been ample soda water on Venus, though the chances of finding any whiskey to mix with it seemed regrettably slight.



24-kilometer-high Olympus Mons was Voyager 1's most dramatic discovery on Mars.

In 1962 we discovered that the Venusian surface temperature is not far short of 350°C. Water cannot remain in the liquid state at such a temperature, and the clouds contain sulfuric acid. Venus is by no means the friendly welcoming world that some people expected.

Of the more remote planets, Jupiter has provided plenty of surprises. Even after World War I, astronomers still believed Jupiter to be a kind of miniature sun. The idea was not disproved until the theoretical work of Sir Harold Jeffreys in the 1920s. In reality, Jupiter is composed chiefly of liquid hydrogen, with a gaseous surface. The Red Spot is not a solid floating "island," as was popularly believed until a decade or so ago.

In the innermost of the large Jovian satellites, we have given us some real shocks. On it we have detected the first active volcanoes ever seen beyond Earth. Few astronomers would have expected anything of the kind. Once again, automated probes, in this case the *Voyagers*, have upset all our theories.

Stellar astronomy has undergone equally startling revisions. Red giant stars such as Antares, were once believed to be youthful. They have turned out to be well advanced in their life histories. As recently as 1920 Dr. Harlow Shapley, one of the greatest astronomers of all time and the man who first accurately estimated the size of our Milky Way system, was still stoutly defending his opinion that the objects then known as spiral nebulas were parts of our own galaxy rather than independent galaxies in their own right.

The point to be made here is that all these mistakes—and many more like them—were made on the basis of the best available scientific evidence. By the year 2000 we may find that many of today's ideas are equally wild or the mark.

Of course, there have also been many theories based on scientific ignorance. These fall into a completely different category and I propose to say more about them shortly. Meanwhile, it is just as well to remember that our knowledge is still far from complete. We must be prepared for a full quota of surprises in the years ahead. **CC**

EXPLORATIONS

By Michael Cassutt

Many of us still think of Arizona as the last frontier: the home of gunfighters, ghost towns, and settler forts, but it's time to let that outdated image bite the dust. Today's Arizonans have their eyes on the high frontiers of astronomy, biology, geology, and archaeology. The state is home to both the L-5 Society and the Aerial Phenomena Research Organization (APRO), as well as to numerous museums, Indian ruins, zoological and botanical gardens, laboratories, and observatories. Arizona also offers a staggering variety of landscapes, from the rugged mountains, buttes, canyons, and petriated forests of the Kaibab Plateau, to the cotton fields and cacti of the Sonoran Desert.

Parts of the state have a unique starkness that brings to mind strange and alien worlds. In the late 1960s and early 1970s the Apollo astronauts were frequent visitors to the U.S. Geological Survey's Center for Astrogeology, at Flagstaff, where the surrounding area resembles the lunar landscape. As a prelude to their stroll on the moon, the astronauts studied

and took long excursions across the rocky terrain. One moon-walker, Dr. Harrison Schmitt, now a U.S. senator from neighboring New Mexico, once worked full-time at the center. There are no tours as such, but the center's exhibits are open to the public. See their presentation on geologic mapping of the moon or the one on crater formation.

Visitors to the Center for Astrogeology don't have to travel far to find an actual crater. About 60 kilometers east of Flagstaff is the famed **Barringer Meteor Crater**, where 50,000 years ago, the impact of a meteorite ripped a hole in the earth almost 2 kilometers across and 180 meters deep. (For more on the Barringer Crater, see *Explorations* in our June issue.)

By far the most spectacular landmark in Arizona is the **Grand Canyon**, which cuts 350 kilometers across the Kaibab Plateau in the northern third of the state. The canyon was carved by the rushing waters of the Colorado River. Geologists estimate that this process began over a billion years ago, before life existed on the young planet Earth. Thus the colorful walls of the

canyon bear the scars of countless ancient upheavals and hold numerous fossils. It's a magnificent guide to our planet's history.

The floor of the Grand Canyon is, in places, as much as 2 kilometers below sea level. It's a long way down on foot or horseback, especially since that distance seems greatly enhanced by the number and the size of branch canyons and cliffs. Descending toward a tiny Colorado River on ancient switchback trails is an unforgettable experience.

Visitors to the canyon can choose between the relatively limited accommodations of the North Rim and those of the South Rim, which are more extensive and have the added advantage of being open all year round. Be sure to plan ahead, because the only way from one rim to the other is the long way around.

The underworld of Arizona is just as rich and varied as it appears from the lowering cliffs of the Grand Canyon. At Arizona **Mineral Museums** in Phoenix, you will see displays of such gems as a fossilized mammoth's tooth, a meteorite, and quartz crystals, in addition to samples of all the many ores and minerals found throughout the state. There are also working models that demonstrate techniques that have been used over the years to extract these minerals. Arizona's economy depends in large part on the mining industry. You'll see why.

Any journey to the center of the earth should rightly begin at **Colossal Cave**, situated in the southern part of the state, near Tucson. Although you won't travel quite as far as those celebrated explorers James Mason and Paul Boone, Colossal Cave is the largest known dry cavern in the world. Its true extent remains a mystery to this day. In its past, the cave has served as a refuge for Indians and a hideout for outlaws. More recently it has attracted the attention of people looking for lost treasure—an activity that is not encouraged. You will enjoy exploring the cave's two-kilometer-long trail, and you can walk in relative comfort since the temperature is a constant 22°C (72°F). No special boots or clothes are necessary.



Peace. Solar's city of the future. Residents will be solar-powered and have no automobiles.

It is possible that plants and animals native to Arizona are as alien to most of us as Martians here might be. They have a right to their strangeness. Desert life has to be tough enough to survive falling heat and drought, flash floods, and freezing temperatures. Members of the hardy crew, from cacti to coyotes, put on their best show at the **Arizona-Sonora Desert Museum**, a modern zoological garden that sprawls in the desert west of Tucson. The format should be instantly familiar to anyone who's ever seen a Western movie: The Desert Museum is the backdrop to Old Tucson, the renowned movie location.

Amid this plethora of multicolored saguaro cacti you'll find more than 350 examples of desert plants and animals, all in their native habitats. You can stand face to face with a kit fox or a mountain lion or watch the mad dash of a roadrunner, a member of the cuckoo family. And you are certain to learn the difference between a cholla and a prickly pear. There are even glass-walled aquatic exhibits displaying some familiar and some not-so-familiar fish and reptiles. The entire complex is designed to permit access for explorers in wheelchairs or strollers.

The Phoenix area boasts an equally impressive showcase of natural life. At the **Desert Botanical Garden**, some 50 varieties of plants are on display in a walk-through garden, which has the added attraction of such rare desert birds as the turkey vulture and the sparrow hawk. Up town, the **Tropic Garden Zoo** emphasizes small animals of warm climates, including Arizona, but not exclusively. That explains the wallabies and mini-goats, not to mention the enthusiastic family of monkeys that roam free on the shaded walks. Explorers with children might find the **Topsoil Garden Zoo** especially attractive.

To the east of Phoenix, near the town of Superior, you can see botanical research in progress at the **Boyce Thompson Southwestern Arboretum**. Mergered jointly by the Arizona Parks Board and the University of Arizona, the arboretum was the first institution in the Rocky Mountain area to be devoted to plant study when it opened in 1929. Today it features several hundred different southwestern plants, including about 100 members of the cactus family alone. The five-kilometer trail takes you from desert to mountain environments and back again, as the arboretum is seated on the abrupt border between the Superstition Mountains and the Sonoran Desert.

The ghost of Arizona's former self (i.e. before the West was won) is still strongly felt today. Though it was the last of the continental territories to join the Union, in 1912 the state has been continuously inhabited by Native American tribes for thousands of years. Even at present, nearly 30 percent of the state's area remains Indian land. This is where the Spanish conquistadores searched for the Seven

Cities of Gold. It's also a land of ancient cliff dwellings and sacred mountains. Many of the surviving dwellings are its remote arbas, and some aren't open to the public (there's a lot of active archaeological research going on in the state), but you can visit some sites. Perhaps the best known are **Montezuma Castle** and its companion site, **Montezuma Well**. It's here that you'll get a vivid idea of how ancient peoples adapted to a harsh environment.

Located some 60 kilometers south of Flagstaff, Montezuma Castle is a Snagay Incan cliff dwelling that has survived virtually intact for over 500 years. The steep climb up to the top of the cliff is certainly worth the effort, even though visitors are no longer permitted inside the "rooms" themselves. The well, several kilometers to the north, is in fact an artificial lake built by the Snagayas in the 1400s as part of an ingenious irrigation system. There are explanatory exhibits at both sites. You may be surprised to see just how much technology these early Americans possessed.

For that matter, the ruins of a fourteenth-century astronomical observatory still stand near **Casa Grande**, an hour's drive south of Phoenix. The four-story tower was built by a tribe called the Hohokam, and, like the observatories of such other ancient American peoples as the Aztecs, it shows a development of astronomical knowledge almost entirely different from that of contemporary Europe, but valuable nonetheless. Guided tours are available.

Arts and crafts of America's natives are preserved in the **Heard Museum**, in downtown Phoenix. Originally a private art collection, the museum has evolved into an extensive display of southwestern silver work, baskets, pottery, textiles, and artifacts, including the Goldwater collection of kachinas (pinnate Indian ceremonial dolls). The Heard Museum also features exhibits on prehistoric life in the Southwest and offers lectures.

The past and the future coexist in Arizona. Not far from the Heard Museum is the Coarati Foundation, home of visionary architect Paolo Soleri. Soleri is currently building a "city of the future," 75 kilometers north of Phoenix at a site on the Agua Fria River. It is called **Arcosanti**, from the Italian word meaning "before things." Here Soleri is constructing a prototype "arology," a city of 2,500 human beings who will live in harmony with their surroundings, rather than in exploitation of them. Arcosanti will be a city without automobiles, a towering structure consisting living quarters, shops, and playgrounds, heated by the sun and fed from a huge terraced greenhouse on the hillside below. Only a fraction of the planned complex is complete, but what exists is open to the public. It is a remarkable sight and, oddly enough, one quite reminiscent of the cliff dwellings of the Snagay. **CC**

THE ARIZONA EXPERIENCE

Arcosanti

Cordes Junction, Arizona, north of Phoenix on I-17. For information, contact Cosenti, 6433 Doubletree Road, Scottsdale, Arizona 85223. Phone 602-948-6145. Admission fee: —

Arizona-Sonora Desert Museum

Twenty kilometers east of Tucson on Speedway Boulevard. For information, call 602-883-1080. Open from 8:30 A.M. to sunset. Admission fee: —

Arizona Mineral Museum

Nineteenth Avenue and McDowell on the State Flagplains in downtown Phoenix. Phone 602-255-8791. Open from 8:00 A.M. to 5:00 P.M. Monday through Friday; weekends from 1:00 to 5:00 P.M. No admission fee.

Batting's Motor Crier

East of Flagstaff, Arizona, on U.S. 40. Open every day from dawn to dusk. Admission fee: —

Boyce Thompson Southwestern Arboretum

On U.S. 60 west of Superior, Arizona. For information, call 602-689-2811. Open from 8:30 A.M. to 4:30 P.M. Small admission fee.

Casa Grande Ruins

South of Phoenix, near Casa Grande on I-10. Open daily from 8:00 A.M. to 5:00 P.M. There is a charge for tours.

Colossal Cave

Thirty-two kilometers east of Tucson on Old Spanish Trail. Open Monday through Saturday from 8:00 A.M. to 6:00 P.M.; Sunday and holidays from 8:00 A.M. to 7:00 P.M. Admission fee: —

Desert Botanical Garden

Phoenix Park, Tempe, Arizona. Phone 602-947-2800. Open daily from 9:00 A.M. to sunset. Admission fee: —

Grand Canyon National Park Lodges

Grand Canyon Village, Arizona 86023. For information, call 602-638-2651.

Heard Museum

22 East Monte Vista, Phoenix, Arizona. Open Monday through Saturday from 10:00 A.M. to 5:00 P.M.; Sunday from 1:00 to 5:00 P.M. Admission fee: For information, call 602-252-8848.

Tropic Garden Zoo

6232 North Seventh Street, Phoenix, Arizona. Open from 9:30 A.M. to 5:00 P.M. every day. Phone 602-278-8707. Admission fee for adults, none for children.

U.S. Geological Survey

2256 North Gemini Drive, Flagstaff, Arizona. Phone 602-779-3311, ext. 1455. Open from 9:00 A.M. to 5:00 P.M. weekdays. No admission fee.

CONTINUED FROM PAGE 28

are reasonable—fifty cents to a dollar a sheet.

As a printing tool of remarkable efficiency the color copier's practical applications are apparently limitless: Christmas cards, menus, personalized stationery, homemade books, and book jackets. But the real fun begins when you treat "visual images," just as record engineers fiddle with sound on their studio consoles. Lay down a variety of images and your color collage will smooth out any traces of layering. Copy a black and white photo and you'll get an artificially tinted image according to how you balance the color filtration. Move your original while the machine is scanning and your copy will be stretched or blurred. Make copies of copies of copies ad infinitum and watch the ultrafaded image gradually lose definition, degenerating toward mechanical impressionism.

One of the most elementary techniques, discovered by Sonia Sheridan, is the thermal image. "I was copying sheets of paper," she says, "and I discovered that you can put objects like lace or plants directly on the machine, so in a sense I discovered the thermogram the way Man Ray discovered the photogram. You know that Shroud of Turin they say might have Christ's image on the cloth? I think that's very possibly a thermogram done by nature."

More advanced methods—often the result of interfering the copier with other machines—are being discovered faster than they can be documented. "Anything is possible," Sheridan believes. "I used to sing and talk into the telecopier. [This involves sending audibly encoded images over a telephone wire. Some artists like to fool with the signal before decoding it, thus altering the visual result.] I designed some fabrics for people, just by saying their name over and over very softly, but you can't sing into the present machines. They're more complicated, so if you sing, they turn right off!" Besides the telecopier, lookups have included computerized scanning cameras, computer-animating films, and video systems.

Firpo's principal interest is the heat-transfer process by which images can be fused on special paper and then ironed onto a variety of surfaces—furniture, lamps. "It's like pillows, ties," he also discovered that if you overprint with oils on top of your heat transfer—which is basically an acrylic polymer—you get separation when the oils dry, which produces the crackly, almost Raminbrandy Old World look. As you stumble onto things, they become part of your repertoire. Accidents only lead to discoveries of bigger and better things."

Stephen Sprouse is a young but highly regarded New York City artist who combines art with commerce to support his experiments. "I'm using technology to make art," he says. "I can draw and paint,

but it gets boring. The day I started this Party Heist was approached, so I made a color Xerox copy of the New York Post's front page, then photostated it, blew it up, and videotaped it. Then I photographed the monitor to get the scanning lines and lose the sense of the typeset."

To support his art, Sprouse has designed a collection of silk-chiffon dresses derived from Xerox-colored scanning lines that create optical effects as the wearer moves. (Debby Harry of the rock group Blondie, wife one while hosting TV's *Midnight Special*.) He also designs record-album covers, which he calls "art for the masses." One Blondie mock-up features a green Xerox image monitored from Debby's appearance on the *800e* Douglas Show and magnified lettering cut out of a computerized grocery-store receipt. His current project, an *Itchy* Pop portrait, uses the Xerox 6600 to transfer a photo onto Dayglo paper. "I put some orange Dayglo paper into the machine, and it came out great, but when I tried pink Dayglo paper, the machine caught fire."

Public recognition of copy art seems to be budding but inevitable. "This is just like electronic printing," says Firpo. "The machine doesn't do anything on its own; input is controlled by the individual. Eastman House in Rochester is doing a retrospective of the copy process, and the Museum of Modern Art [in New York] is buying pieces of copy art."

Sheridan says, "There's a time lag going on. The critics are not educated; if they don't recognize something's form and it hasn't been written about, they find it very hard to appreciate. Right now I have fourteen pieces in a 'Photo in the Sewenties' show. They're flowers, so they're easy to look at, but in color that's never been seen before. The artist has to be at a level above and beyond just the making of pictures and images."

Unfortunately for all their imagination, artists have been limited by the machine's design, which caters to model-sized files and forms. They look forward to a wider selection of color, increased precision from laser scanners, and paper on rolls or larger than the current 8½-by-11- or 8½-by-14-inch standard. Sheridan envisions small copy systems similar to pocket calculators, which already have little thermal tapes in them. "Meanwhile, she'd like to go on television to teach basic imaging systems to the population at large, just as Julia Child teaches cooking. The more people are interested, the more rapidly it will develop."

"It's all on its way," says Firpo. "Once you've found the secret, the modification is just around the corner. If Chester Carlson were around today, he'd be delighted that a machine he designed for one purpose is being used for multiple purposes because he was truly a man of vision, in the latter part of his life he turned to Zen Buddhism. His wife believes very much in reincarnation, you know—she talks to him all the time." ☐

ANSWERS TO GAMES (page 144)

Nine Card and Hot are both strategically identical with to-tee-toe. In Nine Card, if we list all the triplets of distinct digits from 1 to 9 that sum to 15, they can be arranged in the familiar Magic Square (below) so that every row, column, and main diagonal

2	9	4
7	5	3
6	1	8

adds up to 15. Memorize this Magic Square and the Hot grid (below) on which every row, column, and main diagonal has a single letter in common, and you will be unbeatable. Drawing a card in either

HOT	FORM	WOES
TANK	HEAR	WASP
TIED	BRIM	SHIP

game is equivalent to making a move in the corresponding cell of a to-tee-toe board.

If you can play a perfect game of to-tee-toe, you can play a perfect game of Hot or Nine Card. You can always force at least a draw against any player and have a distinct advantage over an opponent who is not aware that he is playing a disguised version of to-tee-toe.

ANSWERS QUOTES QUIZ

1. Pride goeth before destruction. (Not 'a fall')
2. To paint the lily. (Not 'glid')
3. A little learning is a dangerous thing. (Not 'knowledge')
4. A penny for your thought. (Not 'thoughts')
5. Music hath charms to soothe a savage breast. (Not 'The savage breast')
6. Imagination is the sincerest of flattery. (Not 'form')
7. Ask me no questions, and I'll tell you no lies. (Not 'lies')
8. Give him an inch, he'll take an ell. (Not 'a mile')
9. Variety is the very spice of life. (Not 'space')
10. The love of money is the root of all evil. (Not 'money')
11. Water wear everywhere, nor any drop to drink. (Not 'les')
12. I only regret that I have but one life to lose for my country. (Not 'give')
13. Beggars should be no choosers. (Not 'can')
14. Winning isn't everything, but wanting to win is. (Not 'It's the only thing'). That's what Lombard said in a 1960 interview with Robert Riger. ☐

compete with condors in goring at the giant corpses of that period's megafauna. I was the condor then, that waited on musical wings for mammoths and glyptodonts and chlamytheres to die. They watched Megatherium, the giant ground sloth, and Tapirus, the giant tapir, as those antediluvian creatures struggled in the La Brea tans, and sometimes they landed and became trapped themselves. They broke off their scoring and dove to invade preys by their giant Pleistocene cousin Teratornis, a supercondor weighing 23 kilograms, perhaps the largest bird ever to fly. Teratornis died out with the Pleistocene. Gymnogyps had the last laugh.

In historical times the California condor ranged as far north as British Columbia, as far south as Baja California. Today their domain has shrunk to several counties in southern California.

Forty years ago Carl Koloford began studying condors. Then the population was 60 birds, he estimates. A subsequent study showed that in the period 1948-1963 the number fell by a third—40 birds survived. The most recent study estimates 30. The condor appears to be going the way of Teratornis.

In February of this year the U.S. Fish and Wildlife Service (USFWS), after consultation with the National Audubon Society, circulated a draft proposal for meeting the condor crisis. Its first recommendation was that "all free-living condors should be trapped, individually marked and fitted with radio transmitters." A number of the trapped birds would be bred in captivity, and their offspring would be returned to the wild.

"It's absolutely unnecessary and probably harmful and may wipe these birds out far sooner than would happen without interference," Koloford says. Condors live 30 to 40 years, he notes, and so there is no danger of their immediate disappearance. There is reason to hope that the condors will recover naturally, he believes. The use of DDT has diminished recently, as a consequence the brown pelican, for one, is coming back from the edge of extinction. Use of compound 1080 to poison mammals is decreasing in the condor's range, and there are fewer deer hunters. Koloford notes that the USFWS itself estimates that there are 6 or 7 immature birds among the 30 survivors—an encouraging increase over the 4 immatures estimated in 1974. Capture will be traumatic for the birds, both physically and psychically. There is no guarantee that they will breed in captivity or that zoo-propagated birds will be knowledgeable enough about the subtleties of condorhood to survive in the wild. We have time enough, he thinks, to take several more appropriate steps before resorting to measures so drastic and untried.

"There is a great deal of learned behavior

in condors," he says. "How are those released birds going to know about avoiding storms and attacks by eagles, and how will they compete with other birds at the carcass? There's no precedent to suggest they can do it. I keep ducks; if I put a new duck in with three other ducks, sometimes they kill it. Or like hatchery raised trout. Trout raised in a hatchery don't act like other trout. They're in the wrong part of the stream; they're eating the wrong food. A released bird is only half a bird."

The USFWS and the Audubon Society dismiss Koloford's objections. They are convinced that the condor's plight is desperate and requires desperate efforts at salvation. The dismissal of Koloford would be a simpler matter if only he were something other than the world's foremost expert on this small tribe of huge birds. But that is exactly what he is. His book *The California Condor* remains the major work in the field and nearly the only one.

When Koloford was twenty-four, at an age

There is a great deal of learned behavior in condors. How will a released bird know how to compete with other birds at a carcass? A released bird is only half a bird.

when he should have been drinking beer with his buddies and running around in Model-A's, he was living instead in a cave half a mile from the caves where the condors lived. He was shooting horses to see whether the condors were interested in the cadavers. He was traveling the solitudes of upper and lower California, questioning vaqueros about condors they had seen. He was photographing the remains of animals after condors had finished with them.

Mostly, for three years of his life, he was watching. He watched the pensive, hopping run of condor take-off, one foot striking the ground slightly ahead of the other; the bird covering 5 to 12 meters before it was airborne. He watched condors in flight, the double dip they execute to prevent stalling or losing altitude; the flex glide in which the dihedral angle of the wings diminishes or becomes negative while the bird gains speed. He watched immature birds sit their tails too frequently, overcontrolling. He saw them nearly turn themselves over in attempting turns. He watched birds descending, and he would note how early their landing gear came

down—the feet dropping ten minutes and 300 meters above the ground. He watched the characteristic yawn of condors on landing. He watched them stretch themselves, like joggers, before taking off in the morning, and he noted that they seldom stretched during the rest of the day.

A rare thing happens about 20 pages into *The California Condor*—something especially rare in scientific monographs. Koloford's descriptions of condor anatomy and behavior are lean, clear-eyed, free of jargon, instantly visualizable. The bird comes alive. If the day ever comes when all that remains of condor flesh and feathers lies on museum trays, then all of condor movement and culture will lie between the covers of Koloford's book.

I know what I felt about the bold USFWS plan for condors before I met Koloford, before hearing his wistful alternatives, his emotion-charged views on the bird with which he spent his youth. I knew he was right.

The line "All free-living condors should be trapped and fitted with radio transmitters" was enough for me. I did not have to read further to the part about laparotomies that would be performed on the birds and other indignities they would suffer.

Koloford's view of what a condor is, is the subtlest and most complex of all the views offered by birdmen, and thus, I think, he has the best chance of being right.

Often something seems to happen to men for whom wildlife becomes a profession. The USFWS and Audubon people have become so concerned with the problem of the condor that they have lost sight of what a bird is. What use to us is a great scissor that has been handled, marked, laparotomized, peeped by zoo crowds, and radio-tagged? What use is such a bird to itself?

Having dreamed up a neat bit of technology with an application to biology—a miniature transmitter—we are compelled to try it out. It is neat, but it will never tell us as much about condors as the human eye with a patient brain behind it, can tell us. [Those were the instruments that Koloford used in 1939.]

Along with Koloford, I suspect that capture will do more harm than good. That condors can breed themselves better than humans can breed them. To think otherwise is another instance of hubris in the species that has brought condors low.

And what if nothing can bring the birds back? What if Gymnogyps, watching Los Angeles sprawl toward its last hills, has simply decided it is time to go? Perhaps feeding on ground squirrels, for a bird that once led on meadowlarks, is too steep a fall from glory. It is time for the condor to follow Teratornis: it should go out unburdened by radio transmitters.

Depending, the condors might do us a final service, in the manner of mineshaft canaries. They might open our eyes. When the vultures watching your civilization begin dropping dead from their snags, it is time to pause and wonder. **OO**

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Power Base

I was greatly pleased by the presentation of my article "Industry Goes to Space" in the April 1979 issue. The photography was outstanding. Of course we will be using composite plastics instead of aluminum in beam machines, but that didn't detract from the attractiveness of the layout.

I was disturbed by Frederick Pohl's article "Power Play" (April 1979). I have known and respected Fred for many years. However he is far off base in the article as a result of oversimplification and perhaps a desire to sensationalize. The answer to the energy problem is not to stop right now, we cannot for many valid reasons. And there are solutions. The size, complexity and effectiveness of our social institutions are dependent upon the energy that we have available to support them. I grow very disturbed when a futurist of high reputation such as Fred simply throws up his hands, throws in the towel, and tells us that we are doomed. It bothers me when human beings give up and quit instead of using their brains to solve the problem. It angers me when somebody does it for the overt purpose of sensationalism and perhaps the covert purpose of leading us into a cannitally controlled bureaucratic collectivism.

G. Harry Sline
Phoenix, AZ

It is disturbing to read articles on energy such as "Power Play" by Frederick Pohl, which are full of inaccuracies and misconceptions.

With respect to my interest, hydroelectric power, this article indicated that there is essentially very little remaining potential for development. This is incorrect. At present there are approximately 59.2 million kilowatts of conventional developed capacity and plants which will produce 7.5 million kilowatts, under construction. Existing hydroelectric projects save the equivalent of more than 458 million barrels of oil each year. It is estimated that, potentially, the United States could develop an additional 102 million kilowatts, capable of generating the energy equivalent of 626 million barrels of oil annually. In addition, there are in this country over 47,000 dams that do not have hydroelectric power plants. Use of these dams alone could provide over 54 million kilowatts.

The statements indicating that hydroelectric projects cannot last forever because their reservoirs will fill with silt are incorrect. Because the power plant's water intakes must be located significantly below the normal reservoir level, for hydraulic reasons, silt can only accumulate to the lower lip of the intakes. Any silt that enters the reservoir either accumulates to the intake level (as with any river) or is flushed downstream through the power plant, providing an upper limit to silt accumulation.

Ronald A. Corso
Federal Energy
Regulatory Commission
Washington, D.C.

Touch of Class

I'm so disappointed in you! Why did you do it? How could you include "God is an Iron in your May issue? You have so much to choose from that is exciting and interesting in science today. Why would you choose to print such a base story as that? There are other science-fiction outlets for issues of this caliber. Not you! You have too much class for that story. Have some pride in yourself!

L. Adams
New York, NY

De gustibus non est disputandum, but "God is an Iron" is indeed a classy story in the opinion of the editors. Not every science-fiction tale involves spaceships, ray guns, robots or jet-powered heroes. Spider Robinson writes adult fiction; with real human emotion and strong story values. —Ed

From Russia with Love

Because of the slowness of the APC mail system, I first received the January issue of *Omni* in late February. Since that time I have read every article in that issue and subsequent ones (the April issue arrived in April for some strange reason). For the first time I can say that there is now a magazine that I can read cover to cover, nonstop, enjoy each article, and at the same time learn something from each article.

I especially enjoy the Games section and the Continuum articles. Also, I have been a UFO follower/believer for a long time and enjoyed the April issue's occasional immaturity.

My issues of *Omni* get extremely good mileage here; there are many people in my office, as well as scattered throughout the embassy who await the arrival of the next issue as much as I do. I believe that many subscriptions are forthcoming.

Keep up the supreme quality of the magazine and don't change a thing!

Glenn A. Miller
U.S. Embassy
Moscow, USSR

Spinoza's God

I was puzzled by the inclusion of the Einstein quotation "I shall never believe that God plays dice with the world," which appeared in the Continuum section of April.

Had Einstein known that that brief utterance was destined to be thought about with such vigor and so often by those determined to project an image of a "religulous" Einstein, he would never have made the statement. The fact is that Einstein did not believe in revealed religion. Once he was asked outright whether he believed in God, His reply: "I believe in Spinoza's God, who reveals Himself in the orderly harmony of all that exists, not in that God who concerns Himself with fates and actions of human beings."

Roy A. Gilbert
Rangley, Maine

SPACE

CONTINUED FROM PAGE 41

pressure on its surface is at least as high as Earth's atmospheric pressure. Iapetus seems to have one dark side, reflecting little light, and one bright side, a much better reflector. Cassini himself noted a change of brightness and even suggested the cause was a difference in reflectivity.

The famous rings of Saturn are one of the spectacular sights of the solar system. The planet has been deprived of its status as the only ringed planet, for Uranus has some small dark rings, and the Voyager spacecraft found a very small ring system around Jupiter last spring. Saturn's rings are certainly the most glorious.

There are three or four rings, perhaps more. The two brightest rings are separated by Cassini's Division. A faint inner ring, sometimes called the Crepe Ring, lies closer to the planet, and perhaps there is even a fainter ring inside that. Occasional observations have spotted an obscure outer ring, perhaps extending twice as far from the planet as the bright rings.

While the trajectory of Pioneer was being planned, the notion naturally came up of flying inside the rings. The decision was finally made and executed with the spacecraft's midcourse maneuver in 1977 to play it safe and remain outside the ring system. We know the rings are made of rocks, boulder-sized, covered with ice—possibly even made of ice. Shooting inside the visible ring system was asking for a collision, some scientists said. Others were willing to risk it to get a closer view.

Pioneer 11 was launched from Earth in 1973, a little after Pioneer 10. Both headed for Jupiter. Pioneer 11 got there and sent back photographs in December 1974. With an assist from Jupiter—which swung it around at high velocity and threw it back across the solar system—Pioneer 11 headed for Saturn. Pioneer 10 is following a course outside the solar system.

The mission—including both space vehicles—cost about \$414 million, or about \$2 for each U.S. citizen, spread over more than ten years of the project. If you think this is a huge sum, think again. It is about one thirty-fifth the amount spent for tobacco in the United States in 1976 alone. In addition to their planetary missions, both spacecraft continue to send back valuable data on the interplanetary environment, they continue to return interest on our investment in them.

As you read this, Pioneer 11 is sending back so-called far-encounter photographs. When we see those close-ups, it will be with a sense of achievement and of anticipation. When we recall how much better the Voyager photographs of Jupiter were, compared with those of the Pioneer, and that the Voyagers will arrive at Saturn in a few years, we can hardly wait.

We can begin reading the books on September 1, but stay tuned to this planet. ☐

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COMPETITION

By Scott Morns

This contest called not for true originality or creativity but for an eagle eye and a sense of the absurd. We were looking for passages and titles that would cause a reader to do a double-take.

Considered off the mark were: (1) obvious misspells ("FOR SALE: Two bedrooms catan with naughty pane walls"); (2) absent-minded headlines ("World's Largest Galaxy" [John Wayne Deuceses His Life with Barbara Walters]); (3) newspaper double entendres from sloppy (or silly) proofreading ("Grandmother of Eight Makes Hole in One" and "Club Hours Vegetable Talk 1"); (4) the gorms of overworked headlines when ("Beetles Bug Bread Bakers and Bog Down Biologists"); and (5) passages clearly intended as satirical ("Write down everything you have forgotten" from "The Complete Memory Test" March 1981; "a running man travels faster than a walking man," from "Static Gravity," April 1981).

What we enjoyed most was "laughing in church." A passage is far funnier in the setting of a stuffy scientific journal, a textbook, or an official government report than it is in a newspaper or a magazine. For serious collectors of such scientific silliness, we heartily recommend *The Journal of Inreproducible Results*, official organ of the Society for Basic Inreproducible Research, P.O. Box 234, Chicago Heights, Illinois 60411.

GRAND PRIZE: WINNER (\$100)

"Port Noise Complaints: Verbal and Behavioral Reactions to Airport-Related Noise" (Fred E. Fiedler and Judith Fiedler, *Journal of Applied Psychology*, 1975, 60, 4, 488-506).

—Jack Feldman, Gainesville, Fla.

RUNNERS-UP (\$25 EACH)

"The Doppler effect can be demonstrated by passing a whistle in the end of a long piece of rubber tubing, and whirling the tube in a horizontal circle above the head while blowing the whistle." (From *Advanced Level Physics*, Third Edition, by M. Nelson and P. Parker, 628).

—Stephen Burridge, London, England

"An Instance of the Pichils Prevalent in Greyward Research." (R. J. Myers, *Bonnettes*, 1963, 19, 643-50).

—David Rudderow, Wilmington, Del.

"The Unsuccessful Self-Treatment of a Case of 'Whier n Block.'" (*Dierma Upper Journal of Applied Behavior Analysis*, 1974, 7, 497. The article contains no text and no references, but is accompanied by "Comments by Reviewer A," calling it "the most concise manuscript I have ever seen—yet it contains sufficient detail to allow other investigators to replicate Dr Upper's failure," along with the reviewer's recommendation that it be published without revision.)

—Ken Levasseur, Ashwell, N.H.

"Members of the group holding lesser academic rank were encouraged to capture and hold open the mouths of the two alligators while the more experienced members obtained bacterial cultures." (From *Journal of the American Medical Association*, 1971, 218, 255).

—Jeff Doerner, Los Angeles, Calif.

"NOTE: Complaints of discrimination because of age will be accepted only from persons who are at least 40 and not over 65 years of age at the time the alleged discriminatory act occurred." (*Notice in VA Employee Newsletter*, December 2, 1974).

—E. Ailyn Young, Danville, Ind.

"Mental Travel: Some Reservations" (Article by Charles L. Richman, David B. Mitchell, and J. Steven Reusick, *Journal of Experimental Psychology: Human Perception and Performance*, 1979, 5, 1).

—Andrew J. Rdzsa, Tallahassee, Fla.

"Abdominal migraine—diagnosis and therapy" (P. O. Lundberg, *Headache*, July 1975, 15 (2), 122-25).

—Beva Carter, Medical Lake, Wash.

"Stimulus Selection and Tracking During Limitation: Auto-shaping Directed Behavior with Tact Targets" (R. K. Sragoll, *J. Appl. Behavior Anal.*, 1977, 10, 205).

—Richard P. Kanask, Saratoga, Calif.

"Becco Milk Amplifier/Real Chocolate Flavored Syrup/Artificially Flavored" (Label on a jar of chocolate-milk mix).

—James Hermquist, Tallahassee, Fla.

HONORABLE MENTION

"The concept of the bladder as an inert container of urine no longer holds water" (*Conclusion in Lancet*, 1973, 2, 1425).

—Evan Rudderow, Wilmington, Del.

"The Contribution of the Mule to Scientific Thought" (Article by R. V. Short, *J. Reprod. Fert., Suppl.*, 1975, 23, 358-64).

—Terry Ashley, Durham, N.C.

"Penile Prostate: An Unbrosese Hazard of Jogging" (Melvin Hershkowitz, M.D., in *New England Journal of Medicine*, January 20, 1977).

—Richmond C. Frelund, Ann Arbor, Mich.

"Environmental Conditions Inside a Burning Cigarette" (Richard R. Baker, *Analytical Calorimetry*, 1977, 4, 193-202).

—Bryan R. Brown, Columbus, Ohio

"Plants in Heat" (By Roger M. Knutson in *Natural History*, March 1979, 42).

—Lesley Wilay, Hampden Highlands, Maine, and Bobby Woody, Blountville, Tenn.

"Scheduled plane crash near New Hope Ga." (Entry in *Accident Facts*, 1978 Edition, by the National Safety Council).

—G. N. Prudeaux, New York, N.Y.

"Air Pollution in Art and Literature" (By P. Bumblescombe and C. Ogden, *Weather*, 1977, 32 (8), 288-91).

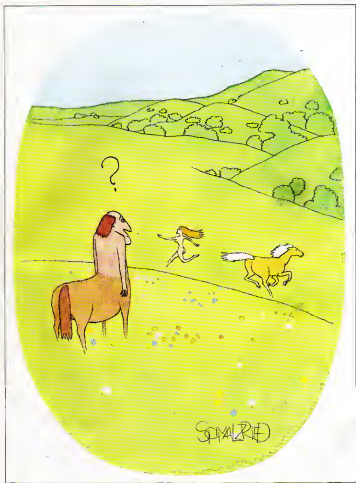
—Peter Wellner, New Berlin, N.Y.

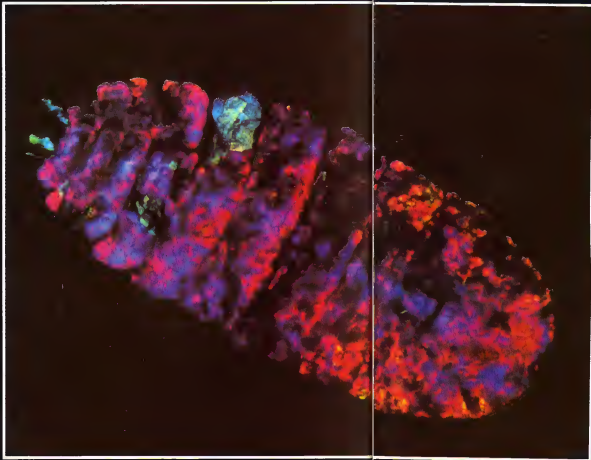
"Boys Who Menstruate and Later Become Pregnant" (Archive of *Environmental Health*, 1970, 20, 302).

—Richard P. Kanask, Saratoga, Calif.

"The Telescope pupfish has been removed from the endangered species list because it is extinct." (From the *Waterbury Republican*, March 11, 1970).

—Susan Murray, Waterbury Conn. **DD**





PHENOMENA

Australia's Great Barrier Reef is the home of the copepod, a crustacean of the genus *Stapphira*, here showing its distinctive protective coloration. One of the most common characteristics of the animal world, protective coloration can be used to mimicry, to advertise inedibility, poisons, spines, or some other harmful trait. Or it can elicit the "fight or flight" mechanism in predators.

The copepod's outer body is composed of minute platelets that contain miniature grids, which act much like a diffraction grating. In certain positions the animal appears transparent; in others, the light hits these grids in such a way as to show its warning colors.

Peter Parks, of Oxford Scientific Films, took this photograph on a specially constructed optical bench, using a Nikon camera body with special Zeiss optics, custom-made tungsten lamps, and Kodak Ektachrome film. □□

TELEVISION

CONTINUED FROM PAGE 24

spaceships. In the *Filices* the concept was unknown. "We didn't think of it. We were working with artists and designers who were still strapped to earthbound design conceptions: streamlining and soft edges to cut down on wind resistance. All we had to go by was the current thought of the time, the Collier's articles. We took things a little beyond that, but not much.

Man in Space started off with an audience crash course in the history of rockets. The approach was light since, if you're dealing with history, you can generally teach more if you keep people interested. Space medicine was explained by Dr. Haber. "What would happen to a man in space?" Then Willy Ley showed how the first satellite would be put into space and why it would stay there... When we actually made our first manned trip into space, Von Braun took over. President Eisenhower saw the show and called "Well, personally, I'd assest to have a print for the Pentagon."

"This was all before Sputnik, of course, and the pressures to beat the Russians into space were enormous for Von Braun. When we started to work on our next show, *Man and the Moon*, I was sent a Russian magazine, showing how man was going to land on the moon. I put it up on my wall, and Von Braun saw it one night. He read the scientific article that had come with the picture and turned to me rather anxiously. 'Ward,' he said, 'looks like we'd better get started,' talking about the show but really meaning that if we didn't do something soon, they'd beat us to the moon.

"On our *Man and the Moon* show we took the same approach in the opening, giving a history of our relationship with it. Stories about the moon, legends, old wives' tales. So the humor brought people in to listen. Then we went on to the problems of constructing a space conveyor that would take man on the first trip around the moon. That's where Von Braun came in again. We were really getting into the hardware aspects of constructing the first space wheel flying parts up into orbit and assembling it in the vacuum of space. Then we flew around the backside of the moon, which no one had ever actually seen, and ended up coming back to the space wheel.

"The inside of the ship wasn't quite as scientific as the outside, because theory didn't go that far yet. We just rented a lot of hobby instruments from a guy in Hollywood and did our best, all with Von Braun's approval, of course. When the show was made, it was thought that a rocket wouldn't be able to carry enough fuel for the round trip to the moon and back to Earth, but "developments in horsepower and motors went by leaps and bounds afterwards, far beyond what even Von Braun thought.

"The high point of the show was an EVA, a walk in space, which wouldn't be repeated in real life for more than a decade. "I knew

we had to have a crisis, or the whole thing'd be just a goddamn documentary. So we had the spacecraft punctured by a meteorite. Shot the escaping fuel by mixing some kind of red petroleum liquid into water. Our knowledge and tricks weren't as developed as they are now. Von Braun wanted to use a bottle suit—a mini-rocket ship that had its own motors, arms, and so forth. They wouldn't have an umbrella cord to the ship, or even a lifeline. The little thing would have its own small servomotor or rocket at the bottom and a variety of bolts that could snap on for various purposes.

"The third picture, *Mars and Beyond*, is my favorite. It deals with more than space; it covers the origins of life. Brought up in a Protestant family where Heaven was up in the sky and the whole universe revolved around us, especially Americans, who are better than anyone else, I never bought that. I got a long letter after the first two shows, berating me about our views, as though space and what was up there were reserved for God alone. We got back from all over, but we kept right on ahead.

"In *Mars and Beyond* we started out again with a prelude of cartoons showing what everybody had said about the possibility of life on other planets, from La Fontaine to H. G. Wells. Then we got a little more serious, showing what people had thought about the other planets, ending up with Mars as the likeliest place to find other life forms. We went to the Lowell Observatory and looked through the facts there. When it came to determining how we might get to Mars, Von Braun suggested Dr. Ernst Stuhlinger, who'd been working on atomic-particle rockets. We showed what it would be like getting there, how long it would take, and so on, based on their calculations. When we finally made a landing, we wondered what we might find. Well, we were proved wrong by time, because the thrust system and the rocket actually used to get to Mars were totally different and when we got there, the surface was just nothing like what we expected. Nobody ever thought that the place would be covered with craters.

"When we were working on the show a few of us went out one night to look at Mars through a big nine-inch refractor telescope. There was Von Braun and Willy Ley and me and the guy who owned the telescope, Rex Bulhannon. And it was the first time Von Braun had seen Mars that close up. We had about ten minutes when the cloud cover broke and we could see everything. Dark spots. The polar caps. Everyone was excited and shouting, and Von Braun was so fascinated and thrilled that he almost was jumping up and down. And then the computers started going in his head and he got the faraway look in his eyes. He started asking ways of being able to photograph Mars without the distortion of a telescope, like from space itself. As we drove back to the hotel, we'd talk to him and he'd answer, but he'd be looking over his shoulder at Mars as he did it." ☐

FILM

CONTINUED FROM PAGE 26

he others. What they didn't reckon on was the amazing success of *Star Wars*, which helped every film in the summer of 1977, and Bond more than others. With a larger-than-average effects budget, spectacular scenery and Moore now settled into the role, *The Spy Who Loved Me* made over \$100 million.

"We really worked hard on that one," Meddings remarked. "There was that opening parachute gateway of Bond's from the mountain, the supertanker's sailing of the submarines, and our marvelous Lotus underwater car. On the Bond pictures everything is supposed to be done for real. So whatever we can manage it, we shoot it as it happens. But there are some situations that are impossible to re-create or that are too risky to try. That's where the term optical effects comes in. It's Meddings and John Dystra (*Star Wars*) and Douglas Trumbull (*Close Encounters of the Third Kind*, *Silent Running*) making audiences think something is really happening when it's being done through miniatures or other tricks of the trade.

After *Law of Star Wars* and *Close Encounters*, I lay awake at night trying to work out how I would have done them. When I finally came up with the way in the end, it was totally different, but I aimed at the same sort of thing.

"For instance, the original script called for a centrifuge. We were going to do it as a miniature, but there was a lot of action planned to take place around it. We ended up building a full-size working model. It couldn't go as fast as a real centrifuge because we couldn't risk killing Moore. But with camera speeds we got a terrific exciting sequence out of it."

The centrifuge sequence may be exciting, but Moonraker's frayed tops, anything ever done in the Bond series. "Bond manages to get aboard Drax's space station by knocking out a guard and stealing a shuttle," Meddings said. "He's up there fighting off the Drax fighters, when the American marines come to rescue him. It's like the cavalry arriving when the Indians are just about to get the upper hand. Well, the mainline approach in their shuttle and pour out to meet Drax's men, who launch themselves from the space station like parachutists. Except, of course, they don't drop, they just float out to the action. There's a big bottle in space, with men leaping in and being shot to pieces. You're going to enjoy this one. You really are."

"Some people say, 'Well, what was the story about in the last Bond film, or this one?' I just have to laugh because everyone should know by now that you're not going to see a story. It's the same mad plot in every Bond film. With these, you're not going to learn the secret of life. You're going to have your head and your eyes filled up with magic." ☐

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GAMES

By Scot Morris

"It's as simple as tic-tac-toe,
three-in-a-row, and as easy as playing
hokey. I should hope we can find a way
that's a little more complicated than that
Huck Finn."

—Mark Twain, *The Adventures of
Huckleberry Finn*

We have used the word game rather
loosely in deciding what directions to
include in this column. This month we stick
to the strict sense of the word—games as
contests. Here are some simple two-
person arenas in which to test your powers
of strategic reasoning.

THE TIC-TAC-TWO-TWO AND Other Two-Person Games

You probably played your last tic-tac-toe
game many years ago. Once you worked
out the optimal strategy and realized that
two intelligent players must always draw
the game, lost its challenge and appeal. So
you're unbeatable at ordinary tic-tac-toe.
Big deal! Here are seven variations on the
old three-in-a-row to give you a new
perspective.

TOE-TAC-TIC The first player to get three
in a row loses.

WILDCARD TIC-TAC-TOE Instead of
having one mark X and the other O, let
players choose either sign, whichever is
to their advantage on a turn. The winner is
the first to place three in a row of
either kind.

WILDCARD TOE-TAC-TIC A combination
of the above. Players can mark either X or
O on any move, and the first to place three
in a row loses. In this variation other player
can force a draw if he knows the right
moves.

DRAWBRIDGE The standard tic-tac-toe
rules apply but one player tries to achieve
a draw while the other wins if either of
them bridges three in a row.

MOVABLE MARKERS Players have three
counters each—pennies vs. dimes, for



example—and take turns placing them on
the 3-by-3 grid. If neither has won after all
six counters are down, players may begin
moving counters. The movement rules can
vary in strictness—only orthogonal
adjacent square moves may be allowed or
moves along the grid's major diagonals
or moves to any diagonal square. A
free-for-all game allows moves to any
vacant cell.

BOUNDLESS TIC-TAC-TOE Instead of
confining moves to a 3-by-3 square,
players place their marks on a larger
grid—a chessboard, for example—and
allow moves to expand in all directions.
They still aim to place their marks in a
vertical, horizontal, or diagonal row.
The first player has an easy win if the object
is to place two, three, or four counters in a
row, but if the goal is five in a row the game
is no longer trivial and begins to take some
unexpected shifts. This is an ancient
Oriental game that the Japanese call
Go-moku ("five stones"), which they play
on the intersections of a Go board. A
recent version of this game has been cast
in plastic and is marketed as
"Pyramid—The Game of the Ages."

HOT Canadian mathematician Leo Moser
designed this game in which each word is
printed on a card. **HOT, HEAR, TIED,**



FORM, WASH, BRIM, TANK, SHIP, WOE'S
The cards are placed face up on the table
and players take turns withdrawing cards
from the pile. The first person to hold three
of the same letter is the winner. Picking a
card to prevent one's opponent from get-
ting three of the same letter is, of course,
part of a wise strategy. Can you discover
a "system" for playing Ho? If both
players make their best possible moves,
is the game a win for the first player,
a win for the second player, or a draw?

NINE-CARD Select nine playing cards
with ranks from ace to nine and place
them face up on the table. Players
alternate picking cards with the object of
being the first to get three cards that add
up to 15. Is there an optimal strategy? Can
you find a significant conceptual similarity
between this game and Ho? (Answer
page 133.)

SITHER Another paper-and-pencil game
for two players. First draw 30 dots in a 5-by-6
rectangular matrix. Players take turns



connecting orthogonal dots (no diag-
onals). Once the sithering line is started,
you may add a segment to either end,
always forming a continuous line. The
player who is unable to make a move is the
loser. The illustration shows the end of a
typical game where no further moves are
possible. So far, a winning strategy for
Sither has eluded us. It seems that games
are won about equally often by players
who move first and by those who move
second.

MASTERWORDS The tremendously successful game *Mastermind* is now available in pocket-sized travel versions, deluxe professional models, and even electronic solitary versions. The name and the colored-peg arrangement are new, but the principle of the game is centuries old: In one paper-and-pencil variant, each player writes down a secret four-letter word, then tries to determine what the other player's word is before his own is guessed. Players alternate guessing four-letter English words and respond to each other's guesses by saying 1) how many letters in the guessed word are also in the target word and 2) how many of those are "hits" (i.e., appear in the same position in both words). For example, if my word is *mind* and you guess *game*, I would say "One letter." If you guessed *dme*, I would say "Three letters, one hit." If you guessed *good*, I would say "No letters." Combining this information with what you learned from your first guess, you would know that the one correct letter in *game* is either the *m* or the *e*.

Players alternate guesses and record each other's responses. The first to determine the opponent's word wins, though the round continues until both have guessed correctly. Total the number of guesses taken over several rounds to determine the overall winner. You can make up for a devastating loss on one round by achieving a few narrow wins later. Subtract three guesses from your score any time your opponent has given you incorrect or incomplete information after a guess.

This game has an advantage over the plastic version in that both players are simultaneously active. With only one *Mastermind* set the code has nothing to do but wait to respond to the seeker's next guess. Also there is more strategy in thinking up a good code word consisting of infrequently guessed letters. Players of different skill levels can compete by handicapping. While the beginner is trying to guess a three- or four-letter word, the experienced player can be trying to unravel a five-letter word. Time limits can be imposed depending on players' sensitivity

GOOD MATCH Start with 15 matches in a pile. Players alternate removing matches either one, two, or three per turn. The object is to be holding an odd number of matches after the pile has been divided up. It makes no difference which player takes the last match.

THE WORLD'S HARDEST QUOTES QUIZ

The results of our competition for unusual quotes and titles appear on page 138. Below are some quotes that may look more familiar. Fill in the blank with the original quotation. Scoring: 0 correct = average, 1 correct = good, 2 = excellent, 3 or more = superb!

Good luck. May the spirit of St. Basil be with you!

- 1 "Pride goeth before _____." (Proverbs, 16:18)
- 2 "to _____ the lily" (Shakespeare, *King John*)
- 3 "A little _____ is a dangerous thing." (Pope, *An Essay on Criticism*)
- 4 "A penny for your _____." (Heywood, *Proverbs*)
- 5 "Music hath charms to soothe _____." (three words) (Congreve, *The Mourning Bride*)
- 6 "Imitation is the sincerest _____." (Coulton, *The Lacon*)
- 7 "Ask me no questions, and I'll tell you no _____." (Goldsmith, *She Stoops to Conquer*)
- 8 "Give him an inch, he'll take _____." (Ray, *English Proverbs*)
- 9 "Vanity is the _____ of life" (Covener, *The Task*)
- 10 "_____ is the root of all evil" (1 Timothy, 6:10)
- 11 "Water, water, everywhere _____ drop to drink." (Coleridge, *Rime of the Ancient Mariner*)
- 12 "I only regret that I have not _____ for my country." (Nathan Hale)
- 13 "Beggars _____ choosers" (Heywood, *Proverbs*)
- 14 "Weaving isn't everything, _____." (Vincent Lombardi, to interviewer) (Answers, page 132)

COMPETITION #6 FUTURE BRANDS

Who would have believed, a century ago, that someday Americans would buy a soybean imitation of *Older Bash*, known to all as *Bea o' Bies*? Or that there would be a sleep-inducing pill called *Nyto*? Or that a service for leasing underground pipes would be offered under the trade name *Roto Rooter*?

In the twenty-first-century supermarket there will be products whose uses we can hardly imagine, but whose brand names, no doubt, will have that familiar Madison Avenue ring. The brand name for an adolescent-inhibiting capsule will be as carefully chosen and as closely guarded as *Luna*, *Coca-Cola*, and *Kaerex* are today.

Space hucksters will give testimonials for *Rockaway* and *Sans-a-Beit*, two competing brands of asteroid repellent. When they feel lads and weighed down after a long day on Jupiter, they'll crack open a bottle of *Grewtinos*, the hard-sell drink that lightens their load with anti-g bubbles.

Some other products we expect to see in the twenty-first-century supermarkets:

- *Suspended-Animation-Eze*—a long-term sleeping pill
- *Computer Tutor*—a training program for underschieving robots
- *Paving-Pops*—vitamin C on a stick
- *Check Mate*—a computer-controlled chess partner
- *Easy Reader*—automatic page-turning machine
- *Eucalizer*—space-straightening spray
- *Reposition R*—a lubricant for robots
- *Decipue Pylax*—glass breasts for sucking test-tube babies

The Competition Send two brand names for products that will be available in the twenty-first century. Postcards only, with two entries per card, postmarked by August 15, 1979. All entries become the property of *Omni* and will not be returned. First prize winner will receive \$100. Runners up (2-10) will receive \$25 each. Send entries to: **OMNI Competition #6**, 909 Third Avenue, N.Y., N.Y. 10022. **CC**

THE RESTLESS ROACH

LAST WORD

By Joyce McWilliams

News item: "One study indicates that restlessness in cockroaches can foreshadow an earthquake."

If earthquakes can be predicted by observing the "restlessness" of cockroaches, it might be well for us to examine in detail in what manner cockroaches exhibit their restlessness. We should ask ourselves the following questions: When a cockroach is restless, does it stare moodily out of the window? Does it pace back and forth and sigh? Does it switch channels on the television set every three minutes? Does it wring its little feelers? Does it scuffle to the medicine cabinet to get a Valium tablet? Does it experience difficulty sleeping?

We do not have answers to any of these questions yet, but the news item is worth looking into for anything that can alert us to an impending earthquake can save splintered crockery, shattered real estate and broken heads. Therefore, trying to establish rapport with a cockroach may be more rewarding than rapping with a dolphin. What, after all, would one say to a dolphin?

However, one of the difficulties of examining the changing moods of cockroaches for scientific purposes (or for any purpose, for that matter) is that cockroaches are principally nocturnal. This means that we will have to make our observations at night, when the cockroaches are up and about.

We could cheat and set up an artificial environment for observing the restlessness of cockroaches, i.e., we could keep the lights on them all night so they would think it is daytime, and we could keep them in a little box that has little windows and miniature shades that can be pulled down in the daytime so that we could study them when we do awake. This might not work to our advantage, however; it might leave the cockroaches sleepy, irritable, and listless, and we wouldn't be able to tell when they were restless and consequently wouldn't know when an earthquake was coming.

Perhaps an examination of the cockroach in song and story could give us clues as to how to approach this elusive

bug. The chorus of "La Cucaracha," the Mexican folk song, translates like this: "The cucaracha, the cucaracha, doesn't want to walk/because she hasn't got no, she hasn't got marijuana to smoke."

Cucaracha is Spanish for "cockroach," but there is some disagreement as to the meaning of this song. Some say it doesn't mean "cockroach," it means "the little dancer." And other authorities suggest it means "a little, dried-up old maid." Still others say it means as much as "Marjorie Doats, does. There may be some truth to the theories that women are involved here (though why is a dried-up old maid "smoking marijuana? Conversely why not?) because out of the song's eight verses, six deal with women. There is also a story that cockroach races in Mexico are held in bars.

It is quite possible that cockroaches are somehow connected with marijuana. The roach clip, for example, is the well-known doherpike device that is used to snuff a joint down to the end. It could be that in the past marijuana was tested on cockroaches (in bars) before it was used for human consumption and that it was learned that marijuana, if it was not combined with saccharin, was not harmful to cockroaches. You never know.

In literature we have Franz Kafka's short story "Metamorphosis," a tale of the bovine and the grotesque (you probably wouldn't feel so smug if you wore a cockroach) whose first line is: "As Gregor Samsa awoke one morning from a troubled dream, he found himself changed in his bed to some monstrous kind of vermin." Poor Gregor, through no fault of his own, was metamorphosed into a cockroach overnight. You can imagine the problems Gregor faced. So he chose to solve his problems by dying. The only other things necessary to know about Kafka are that "everything is a illusion" (we are all cockroaches?) and that "Metamorphosis" will probably never be made into a musical play.

Then, we find the cockroach archie in Don Marquis's archie and madhabe! archie (no capital letters because when a cockroach uses a typewriter, it does not

have enough strength to use the shift key) was once a human, a lyric poet, but he died, and his soul migrated into a cockroach's body archie, among other things a philosopher says: "alas, exclamation point! the paradox of ugliness is only perceived by us cockroaches of the world." If you are moved by this, friends, perhaps you will hesitate the next time you want to crush a cockroach underfoot. Be kind to a cockroach, for it might be another Rod McKuen.

Also, archie expresses his pride in his heritage as a cockroach when he says "insects were insects/when man was only a burbling whistler." Here we have found the crux of the matter. Once more, literature has shown us the way. The cockroach goes back 300 million years. The cockroach was around before flies and mosquitoes, to say nothing of people. And in these 300 million years the cockroach has not seen fit to change one bit. Cockroaches lived in the dank forests primeval and, showing great powers of adaptation, moved on into the tract houses when the forests primeval were cut down and changed into \$150,000 four-bedroom three-bath-plus-family-room primeval estates.

It boggles the mind, doesn't it, when one thinks that the cockroach has lived through it all—the rise and the fall of the dinosaurs, the invention of the wheel and the skateboard, the French Revolution, the Industrial Revolution, the Sexual Revolution. The cockroach crested around under the great tree ferns so long ago there wasn't even any television. It would follow, therefore, that the cockroach knows something that we don't know. It knows what to do with its spare time. And it knows how to survive. By keeping its antennae to the ground, it knows such elementary things as when an earthquake is about to occur. So it becomes restless. Hence, we have only to observe it closely and when we notice that it won't eat, that it is taking naps at night, and that it is staying up all hours of the day, it is time we take the ching off the shelves and move to Wyoming. **DD**