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## CONTENTS

Reader's Department: EDITORIAL: AIMING HIGH—OR LOW? by Stanley Schmidt

Serial: TO CLIMB A FLAT MOUNTAIN, PART I OF II by G. David Nordley

Science Fact: ROCK! BYE-BYE, BABY by Edward M. Lerner

Novelette: AMABIT SAPIENS by Craig DeLancey

Short Story: FOREIGN EXCHANGE by Jerry Oltion

Reader's Department: THE ALTERNATE VIEW: LESSONS FROM THE LAB by Jeffery D. Kooistra

Short Story: THANKSGIVING DAY by Jay Werkheiser

Novelette: JOAN by John G. Hemry

Reader's Department: THE REFERENCE LIBRARY by Don Sakers

Reader's Department: IN TIMES TO COME

Reader's Department: BRASS TACKS

Reader's Department: UPCOMING EVENTS by Anthony Lewis

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**Vol. CXXIX No. 11, November 2009**

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Published since 1930

First issue of *Astounding* January 1930 (c)

Reader's Department: **EDITORIAL: AIMING HIGH—OR LOW?** by Stanley Schmidt

It has long been common in some circles of science fiction fans to refer to people who don't share their taste in literature, or their visions of the future, as "mundanes." So it's perhaps a bit ironic that in the last very few years a movement has arisen within science fiction calling itself "mundane science fiction."

The idea, in short, is that many of the common themes and trappings of science fiction have little basis in established science and so don't really belong in the field. To paraphrase a few of its core tenets, as I understand them: There is no evidence that time travel, alternate universes (and travel between them), or faster-than-light travel is possible. Even slower-than-light interstellar travel or communication is so overwhelmingly difficult that it is unlikely to be achieved by us or anybody else—even if there *is* anybody else, and there's no real evidence for that, either. And even if there were, aliens would likely be so fundamentally different that no real communication would be possible between them and us.

Therefore, the mundane-SF advocates tell us, it is overwhelmingly likely that the future of humanity will be one of humanity alone on Earth or in its relatively immediate vicinity. Therefore and furthermore, that's where science fiction should concentrate its efforts: on imagining what our future is really likely to be, right here on the world of our birth, with nothing to rely on but the resources it provides and no one to rely on but ourselves. And since we're trying to be as realistic as possible, we should do our imagining strictly within the framework of the science we actually know—which implies both capabilities and very strict limits.

No wonder they call it "mundane."

Actually, I have a certain amount of common ground with the mundane-SF people. I have long held that one of the important things for science fiction to do is pretty much what they describe: imagining carefully and in considerable detail what can be done, both good and bad, by application of the scientific principles that we already know. We certainly need writers doing that.

Where we part company is that I maintain that that's only one of the things we need writers doing, while they explicitly discourage doing anything else. Writing about futures in which habitable worlds are plentiful and humans travel among them and interact with their nonhuman but intelligent inhabitants, they tell us, encourages false hopes and a wasteful attitude toward our limited resources.

But they overlook a number of important facts and distinctions. Writers about interstellar travel, first contact, or interstellar federations are not, in my experience, saying that this *is* the way the future is going to be—but those who advocate limiting ourselves to Science As We Know It *are* saying that this is, at least within broad limits, the way it's going to be.

The assumption that we—or they—*know* what the most probable future is seems to me arrogant in the first degree. It assumes there will be no more major surprises in the future, and I'd love to know how they can know that. There have been several huge ones in the last century or so—relativity, quantum mechanics, plate tectonics, and the wild and wonderful world of DNA, to name just a few. The idea that we're finished and there will be no more seems to me far-fetched in the extreme.

Let's see ... what would a conscientious mundane-SF writer in 1900 have considered fair game for his speculations? Urban pollution caused by too many horses in the streets? Maybe even automobiles replacing some of those horses? Radiotelegraphs? Possibly airplanes would have been accepted by some, but not all.

But such a writer would certainly have considered it unacceptably far-fetched to mention the tiny, powerful computer on which I'm writing this, or the internet on which readers will argue about it, or the

communications satellites that enable people to chat with families on the other side of the world. The list could go on for quite a while, but the principle is simple and essential: Our most probable future is one that we *can't* predict, because it will include not only obviously logical outgrowths of what we already know, but lots of disruptive surprises. Relatively little ones, resulting from unexpected convergences of seemingly unrelated sciences and technologies (as the CT scan resulted from the fusion of x-ray imaging, medicine, and high-speed computing); and huge ones, resulting from fundamental shifts in our understanding of the world, like relativity, quantum mechanics, and DNA-based genetics.

Writers who try to be conscientious and responsible by refusing to try to guess what those surprises might be can be assured of only one thing: that the future they try so hard to make realistic will be anything but—because it will not take into account the biggest changes that will shape it.

Writers who do try to guess what some of the surprises might be can't expect to get very many of them right, either. But at least they will get the fact that there will *be* surprises, and they can attempt to explore how people might react to them and how their lives might change as a result. That's important, too. Since we can be pretty sure that future science and technology will take some unexpected turns, exploring how people might handle them can be at least as important as working out the details of developments whose possibility is already obvious.

And, just occasionally, one of those wilder imaginings may turn out to be closer to something we actually get than any of the more careful, conservative extrapolations.

Extrapolation. That's the word I have long used to describe essentially what the mundane-SF folks consider their lofty aspiration: to imagine rigorously what developments might actually grow from already-known science. They consider it a prescription for What Science Fiction Should Be. I consider it a prescription for one of the two main *kinds* of science fiction.

The other, which I consider no less important, I call “Innovation.” That refers to stories that depend not just on extrapolation from known science, but on imagining fundamentally new kinds of science that might conceivably be discovered in the future, and working out what might become possible as a result.

Note carefully that this does *not* mean that “anything goes.” You can't just imagine whatever outlandish thing you like, call it “new science,” and label the story you build on it “science fiction.” In deciding whether an “innovation” story is legitimately science fiction, I use what I call the “negative impossibility” test. You don't have to be able to prove rigorously that your speculation is possible, as in the best of what mundane-SF advocates call mundane SF and I call pure-extrapolation SF. But you do need to imagine it in such a way that it is not provably impossible, or provably inconsistent with parts of established science that are well confirmed by experiment.

There's a precedent for this in real science itself. Physicists sometimes speak of a “correspondence principle,” according to which the predictions of a theory created to explain a new region of experience must give the same results as the old theory in regions where the old theory matched experiment well. The classic example is mechanics. Sir Isaac Newton formulated laws to describe the motions of all the objects he'd seen, all of which moved much slower than light. Albert Einstein created a new set of equations because Newton's version weren't accurate for objects moving close to the speed of light. But, contrary to a popular misconception, this does not mean that Einstein “proved Newton wrong” or invalidated his equations. Rather, he created a model that worked through a wider range of experience—including the “Newtonian” world of slow-moving objects. The predictions of Einstein's equations are equivalent to those of Newton's at very low speeds, and diverge gradually as speeds increase. For slow objects, most of us still use Newtonian equations because they're easier to work with and the results are indistinguishable at those speeds.

Similarly, any new model you invent for a science fiction story—say, to make FTL believable—will still have to include relativity as a special case, and give the same results in the region of experience for which we have experimental verification of relativity. Such a model might well require a radical restructuring of theoretical foundations, but that has happened more than once before and will quite likely happen again.

Besides, one could easily get the impression from listening to the pontifications of some mundane-SF advocates that this whole business is deadly serious and somber: We should write only about the kind of future we're most likely to get because we must make sure everyone has the proper attitude toward learning to cope with it. Well, yeah, we need some of that—but let's not forget that science fiction is also about *fun*. Sometimes a story is worth telling not because it's terribly likely to come true, but just because some outrageous-but-not-provably-impossible idea would have such deliciously wild consequences if it *did* turn out to be true that the temptation to play with them is irresistible.

And there's nothing wrong with that.

In this type of discussion I'm often drawn back to something I once heard Poul Anderson say, when a bunch of us had gathered in Florida for the launch of Apollo 17. The perennial question of what distinguishes science fiction from fantasy came up, and Poul drawled, "You know, sometimes I think the most fantastic fantasy of all is what's usually thought of as the hardest hard science fiction. Because what could possibly be more fantastic than the idea that we already know all the basics?"

Or, in today's context, maybe it isn't really fantastic. It's just mundane.

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*Analog Science Fiction and Fact (Astounding)*, Vol. CXXIX, No. 11, November 2009. ISSN 1059-2113, USPS 488-910, GST#123054108. Published monthly except for combined January/February and July/August double issues by Dell Magazines, a division of Crosstown Publications. One-year subscription \$55.90 in the United States and possessions, in all other countries \$65.90 (GST included in Canada), payable in advance in U.S. funds. First copy of new subscription will be mailed within eight weeks of receipt of order. When reporting change of address allow 6 to 8 weeks and give new address as well as the old address as it appears on the last label. Periodical postage paid at Norwalk, CT and additional mailing offices. Canadian postage paid at Montreal, Quebec, Canada Post International Publications Mail, Product Sales Agreement No. 40012460. (c) 2009 by Dell Magazines, a division of Crosstown Publications, all rights reserved. Dell is a trademark registered in the U.S. Patent Office. Protection secured under the Universal Copyright Convention. Reproduction or use of editorial or pictorial content in any manner without express permission is prohibited. All stories in this magazine are fiction. No actual persons are designated by name or character. Any similarity is coincidental. All submissions must be accompanied by a stamped self-addressed envelope, the publisher assumes no responsibility for unsolicited manuscripts or artwork.

[\[Back to Table of Contents\]](#)

## Chapter 1

### Somewhere Unexpected

Jacques Song opened his eyes and saw a huge fish floating above the canopy of his cold sleep unit and staring at him. He shut them immediately; it must be a bad dream. People often had dreams as cold sleep evolved into normal sleep and wakefulness.

Last night, 21 June 2345, he and the rest of the corps had listened to some inspirational nonsense from Earth Empress Marie, lifted a glass of rum spiked with cold sleep preparation drugs, and dutifully lain down on their hotel beds at Sheffield Station in Earth orbit.

In deep sleep, they'd been transferred to Cold Sleep Units and loaded onto starships bound for 36 Ophiuchi. The process would be reversed twenty-three years later when the invasion force had established itself, hopefully undetected, at a base in the Kuiper belt around 36 Ophiuchi A and B. Their mission was to liberate a colony gone horrifically wrong.

But that colony was not under a sea filled with staring fish.

The colony leaders didn't believe in using robots—labor cleansed the soul. Slavery in all but name had evolved in a decade. Polygamy, child marriage, gladiatorial executions, and inherited subordinate status became the rule. They'd bungled relations with primitive aliens on another of 36 Ophiuchi A's planets, raising concerns about humanity's status in the galaxy.

But those aliens did not, as he remembered, look like fish.

Dissenters had fled to the hills and risked everything to call for help—which would take half a century at best to get there. Before 36 Ophiuchi, the consensus had been that the distance between stars made interstellar warfare impossible. The colony leaders had counted on it.

But faced with a cry for help, Earth considered the impossible. There'd been a mammoth debate informed by massive simulations showing that, absent outside influence, the theocracy might persist indefinitely. The decision had been made, volunteers recruited, and robots instructed to prepare a fleet. Jacques, divorced and looking for distance, had signed up.

Jacques opened his eyes again, and the fish was still there, all too real. Maybe two meters long, it boasted a huge parrotlike beak, but otherwise looked something like a shark. He was wide awake now. He was obviously not on the conveyor ship, *Resolution*, so something *else* had gone horrifically wrong.

He tried to touch the net, but the lack of response didn't surprise him. The CSU seemed inert, but he was breathing, so it must be functioning to some extent. The things were designed to keep you viable in a suspended state for a couple of centuries without external power—they warmed you up to a coma every few months for DNA repair.

"CSU, what's your energy level?" he asked. As soon as he moved, the parrot-beaked shark tried to bite through the canopy, but didn't have much success against the flexidiamond.

A heads-up display flashed in front of him, superposing itself over the curious—or hungry—fish. It



showed he had about two hours left at present consumption levels, which were at emergency minimum. The display flashed off again. The CSU might as well have said, "I've done what I can. It's your problem now."

Jacques raised himself on his elbows. The water—assuming it was water—around him was not all that clear and the light level must be very low. From what he could see, his CSU seemed to be resting on nearly level sand, with a few huge, dark, boulderlike objects here and there. The surface seemed far above him.

He would probably have to try to reach it.

But when? Conventional wisdom would have him wait as long as he could for rescue. The CSU, he realized, had maximized that time. Rescue wasn't coming.

First things first. He needed to inventory his assets. He reached into a cubbyhole to his left for his personal effects; his wrist comp and a couple of backup data disks—what he'd left on his hotel night table for the *Resolution's* robots to take with him. The objects seemed very light—low gravity?

The wrist comp was dead, powerless. He shivered. Just how long had it been? He suppressed the urge to ask immediately—if he were going to get out of this situation alive, he would need to use what was left of the CSU's power very efficiently.

Another cubbyhole held an emergency kit in a sealable bag, which he emptied and inventoried. It struck him as an eclectic jumble of stuff someone assembled to fill a regulatory square, never expected to be used. There was another wrist comp, its memory filled, no doubt, with all sorts of survival information. It was powerless. There was a survival tent, nicely folded down to the size of an envelope. There were a few pieces of primitive, non-electronic gear including a dozen nutrition bars, a compass, a magnifying lens, needle and thread, a ten-centimeter-long multitool, a pair of fabric canteens, a photovoltaic power supply, binoculars, space blankets, etcetera. Finally, occupying most of the volume of the kit, there was a shipsuit.

Even in the low gravity, struggling into the last was not easy in the coffinlike space in the CSU, but once he got his legs in, his body heat began to power the smart fabric up, and it relaxed to make the rest of the job easier. It molded itself around his body like a second skin, except for the hood. The latter had a transparent section that could seal up for vacuum use. Hopefully, it would work as well underwater.

It also had an emergency life-support pack. For a moment, Jacques smiled. It could make oxygen; he could wait several hours more to try his escape, using that to breathe. Then he found it was powerless as well. He sighed; many of the suit's functions could be powered by his own body heat and movements, but not that.

That was all he had. He imagined that, should he survive and return to Earth some centuries hence, some of these objects might be displayed in a museum as quaint relics of bygone pioneers.

Okay, it was time to find out where he was, what it was like outside, and what had happened. He told the CSU to power up. The first thing he got was text telling him that video was down for power conservation.

To the first question, the CSU told him they were at an unsurveyed red dwarf, IRO 031010.36485, on a planet with a breathable atmosphere that the *Resolution* had found 628 light-years from Earth! On the Earth calendar, it was Tuesday, the twenty-third of March in the year 3521.

That was almost a thousand years from when they had departed. He made himself cope with that as an

objective fact; he would deal with the emotional reality later. Humanity was still in the very early stages of biological immortality. Had been, he corrected himself. They'd probably worked things out by now. Some friends might still be alive, active, even looking for him. But the gap in time would be as large as the gap between Marie's ceremonial monarchy and Charlemagne. He could deal with it later, he repeated to himself. For now, he had to survive.

So the *Resolution* had not decelerated at 36 Ophiuchi—the beamrider's nightmare. Starships were pushed to relativistic velocities riding on a beam of microscopic pellets from their departure system, which they ionized and reflected with magnetic fields. To decelerate, they normally relied on a prepositioned pellet stream. Somehow, this hadn't happened.

For the invasion, the first units into the system had carried enough mass to decelerate on their own. These passed by the system and decelerated on the far side, their bulk shielding their exhaust from observation. Once in 36 Ophiuchi's Kuiper belt, they'd made deceleration trails for the rest of the fleet. The whole process had taken an agonizing half century.

The CSU told him the lasers used to guide the nanopellets to the starship had been replaced with a dummy load. Almost all of the pellets passed by the starship without slowing it down. Who or what had done that, and when, was unknown.

There were contingency plans for failure to decelerate. The starship had coasted until it found a habitable planet it could reach and then implemented an emergency deceleration protocol, deploying a superconducting loop several kilometers across to drag against the interstellar medium until it had reached a hundredth of lightspeed or so, and then going into rocket mode, using its auxiliary nuclear power units while sacrificing its water, redundant structure, invasion stores, and lithium hydride shielding, for fuel. It almost made it, but ended up 103 kilometers per second short, and had to try aerocapture.

Starships were tough, but not designed to function in a planetary atmosphere. Its breakup would have absorbed the worst of the reentry forces, perhaps controlled well enough to spill its cargo of CSUs into a shallow body of water. There were three atmospheric shuttles. They weren't designed for that much aerobraking. But if one or two survived on autopilot, Jacques thought, that could make all the difference in survival. The odds weren't good for the CSU occupants either, but with a layer of ice, maybe. That was the best the ship could do.

The CSU went silent and Jacques reflected. Interstellar warfare was “impossible” until the horror of what was happening in the 36 Ophiuchi system made Earth try it anyway. Perhaps they'd been right in the first place.

The parrot-beaked shark, making no concession to human biological immortality, had not gone away. It was, he decided, definitely hungry. So was he—his cells needed to repair the radiation damage since his last CSU cycle, and that took energy. Cosmic rays could be dealt with by shielding, but carbon-14 was part of you. He ate four of the dozen nutrition bars, knowing that he might regret the binge later, but thinking it was a good thing to do while he was momentarily safe and secure. As he ate he eyed the parrot-beaked shark, thinking filet. This eating thing works both ways, fella, he thought with a grin.

He would have to flood the CSU, he realized, to equalize pressure and get the canopy off. That would likely render his last link with technological civilization inoperable. There was irony in that; his expertise was in dealing with artificial intelligences and subsentient systems.

"Can you still record?" he asked it.

[Yes]appeared in the heads-up display.

In a few short sentences, he explained who he was and how he'd gotten there and left notes for any of his fellow passengers in the unlikely event they might find his CSU.

"Make as many copies of that as you have room for."

[Done]

Jacques stuck the emergency kit bag on a geckro patch on his suit. He was ready as he could get; there was no reason to delay longer. His heart pounding, he chanted to make himself relax and use less oxygen. After a couple of minutes, he felt at peace and ready. If his life were to end now, so be it.

"Release the fasteners on both sides of the canopy. Give me pure oxygen—exhaust what you've stored. Then flood the unit." He took more deep breaths as cold water rose rapidly on either side of him. The pressure equalized with his face not ten centimeters between him and the fish's beak. It lunged repeatedly, its blows booming on the canopy.

He sealed his hood without trapping a lot of water in with him, then pushed the canopy off and, grasping it by both edges, stood up. If the fish had sense enough to swim around it, he was done for, but it just kept trying to push through what it couldn't see—a stalemate that would end as soon as he ran out of breath, because the canopy was too heavy to carry to the surface.

He looked down at the empty CSU and smiled to himself. It was easy enough to flip the canopy around between fish attacks and then stand on the edge of the CSU and lean so that the fish was below him. With a now-or-never shove, he pushed the canopy down onto the CSU with parrot-beak still trying to swim through it. With it trapped inside, he swam for the surface.

Judging crudely from the change in volume of air in the CSU, the pressure was something like eight atmospheres at the bottom, the equivalent of eighty meters deep on Earth. But the surface proved much farther away than that. Despite starting with several liters of oxygen in his hood, he was groggy by the time he broke the surface of the water. He pulled off the hood and took a gasping first breath.

He felt almost instantly restored as he bobbed up and down in steep waves; it took remarkably little effort to keep his body high out of the water. At the crest of a wave, he got a view of his surroundings. He'd emerged from a freshwater lake, not a sea, but it was a large one, with distant hills just barely sticking up over the horizon. Hills surrounded the lake without a discernible gap—a caldera, from the steepness of the walls next to him. He saw no vegetation.

Remembering that the parrot-beaked shark might have relatives, he swam for the nearest shore at about a stroke per second. Strangely, he didn't tire and even increased his pace a bit.

The shore proved rocky, and the rocks looked volcanic and sharp, *'a'a* lava, he thought. The waves were impressively high. Still, he felt very strong, much stronger than he should after coming out of cold sleep.

Bobbing along in the waves, parallel to the shore, he eventually found a beach that was more gravel than rock and approached it slowly, feet dangling beneath him. His feet touched briefly, then he was swept back again. He rode the next wave in and got enough purchase with hands and feet to hold on through the backwash. Then he scrambled forward ahead of the next wave.

He stood on the shore breathing easily—not panting despite what should have been heavy exercise. He was fit; all expedition personnel had gotten many hours of hypergravity training, but his lack of distress still surprised him. Gravity here was clearly much lower than on Earth, even less than on Mars, he guessed. The sky was high and gray, there had to be a sun somewhere, but it wasn't immediately

apparent where it was. It was decidedly warm and humid.

Okay, the first thing to do was to plug one of his wrist comps into the photovoltaic power supply and see if anyone else was around. He spread out the flexible array, almost a meter square, and plugged the adapter into his wrist comp, or tried to. It didn't fit! Damning his luck and wondering why, after three centuries or so of electronics manufacture, such things weren't standardized, he reached for the wrist comp from the emergency kit. That would *have* to fit.

It did, but nothing happened. A broken wire? Or had something in the electronics of either device not survived a millennium of neglect? The batteries in the wrist comps were likely suspects. Or, he thought, layers of atoms in contact in various transistors and diodes may have interpenetrated each other through some kind of Brownian motion so they no longer functioned. He'd never had occasion to inquire about the lifetime of such devices and, of course, there was now nothing to ask. If he were going to survive, it would have to be on his wits alone.

He took stock; however great he felt right now, he had only eight nutrition bars left to eat. He had no clothing except for the emergency suit that he wore. There were clearly fishlike things in the caldera, and if they were edible, he might be able to catch enough to survive—though he wasn't sure how, having never fished in his life. For shelter, since the area was obviously volcanic in origin, there should be lava tubes.

Was his the only CSU to make it? He should look for other survivors. Names of classmates slotted for the *Resolution* ran through his mind. They weren't soldiers; their job was to reconstruct and reeducate the colony after the theocrats had been displaced. Most, he had known only since Annapolis, but he'd grown up with Edith Lu, Huong Devieux, and Ted Blackwell in metropolitan Port Moresby sixty years ago—make that something like 1,060 years ago.

He scanned the lake with its strange high waves and impassable lava block shoreline.

Face reality, Jacques, he told himself. He was in no position to find and rescue anyone. He had to find food, and that meant getting out of the caldera. He would come back. There was likely a large variance in CSU survival time; no one else was likely to need help right now.

Everything caught up with him then: his impossible situation, the unfairness of it all, the totalitarian monsters that had been the cause of the expedition and its likely sabotage, the great decision makers of the Interplanetary Association Senate who sent others to take their risks and clean up for their failures of imagination, and the minimum effort logic of those who put only a dozen nutrition bars in a CSU emergency kit.... He screamed. The screams echoed from the barren lava cliffs.

When he recovered himself, he decided to do something to defy the fate that sent him here, to make some mark on the universe that was trying to kill him. He could make a pile of rocks, a cairn. Practically, it would help him find the spot again. It was no work at all in the low gravity to build a stack as tall as he was.

The lava wasn't all *'a'a*. Here and there were rivers of smooth pahoehoe, some of which had fragmented into relatively flat shards. He brushed one off and using another, smaller fragment, sketched the shoreline, and scratched where he thought the sunken CSU lay. Under that he scratched his name and the date. Then, after a moment of thought, he added “= day 0.”

\* \* \* \*

## Chapter 2

### At the Rim of the World

The cliffs turned out to be not as barren as he thought. Here and there, small trees had begun to colonize the caldera wall. He hadn't recognized them because their leaves were a very dark blue green—almost black—and indistinguishable from the lava. The higher he got, the bigger the trees, and the bare rock between them became covered with dark soil.

In a rare level clearing, he tripped and righted himself easily in the low gravity. The culprit was a ground vine with dark, grasslike leaves. I'll call it "tanglegrass," he thought with a frown. At the clearing edge was a thirty-meter tree. He tested its bark with a blade from his multitool; it was very soft and wet, maybe waterlogged—not like a tree at all, but rather more like ice plant.

Was the pulp of the tree edible? It should, of course, be thoroughly tested and analyzed. He laughed at that notion and cut out a finger-sized piece, bit off a little, and spat it out. Acidic, bitter, and with an odor of rotten flesh—he would have to be very, very hungry to try to eat that. He washed the taste out with water from the fabric canteen. That was Earth water, he thought, from a thousand years ago. He ought to treat it with reverence.

No, get hold of yourself, he told himself. Water was water.

It was getting noticeably dark, though not noticeably cooler. Here and there around the roots of the bitterwood tree were pockets of sand and gravel that were reasonably soft and level. He made camp.

The next day he reached the rim of the caldera in early morning. It was anomalously clear when he worked his way around a last boulder to the relatively flat top. The red dwarf sun appeared noticeably larger than Sol in a sky that seemed a somewhat lighter shade of blue. A few more steps took him clear of the brush and rocks.

What he saw made no sense to him—a vast triangular plain stretched out before him, its sides converging to an impossibly distant vertex ahead of him. The plain was divided into great fuzzy arcs of color—gray, white, red, black, green, blue, and green again—apparently centered on himself, with the outermost almost tangent to the triangle's sides.

To his left, haze and clouds obscured the distant view, but to his right, through breaks in high creamy clouds, he thought he could glimpse a repetition of the pattern in front of him. Apparently, the planet had at least two huge conical volcanoes, as perfect in form as Mount Fuji, and so high that they extended beyond the limits of what must be a very extended atmosphere. Could they be in isostatic equilibrium? He shook his head; such calculations would need to be put off for now.

Immediately below him was the rocky mountainside, mostly bare but dotted with trees. Below that was a dark green forest. That yielded to a sea or a very wide river. Beyond its misty, distant shore was another very dark band: probably more forest. That thinned out to a band of lighter green, which merged into a ruddy brown. The last complete arc was white. Beyond that, banding the base of the remaining tip of the triangle were bands of distant clouds. The peak itself was almost geometrically sharp, a dark lunar gray, and apparently cratered.

Scanning the edge of the forest, he spotted a trail, a narrow and very Earth-like path leading down into the forest. What had made it? Other survivors? Natives or local animals? Something edible? Something dangerous?

Well, he had best get going. On the way, something crunched under his foot. It looked for all the world like a piece of curved green and black mottled plastic. If it had been part of a sphere, the whole thing might be half a meter in diameter. Was it part of a broken lava bubble? An eggshell? Of what monster, if so? But there was no time to spend on these questions. Survival called and he would have to concentrate on the trail.

The scale of the trees became evident as he descended. The largest were easily a hundred meters tall and five across, like California redwoods. These trees were not at all like the bitterwood tree he had cut into earlier; their wood was dark and suitably woody. They had a bark of sorts, black, smooth and chitinous in the mature trees, with longitudinal ridges that seemed to run the length of the tree. He decided to call it blackwood, and cut a sapling for a hiking pole and a potential defensive staff.

As he looked carefully, he saw evidence of frequent fire. The darkness of the soil, the great space between the trees—there was a very open feeling to this forest. There was no brush taller than he was, and much of that was composed of immature bitterwood and blackwood. Everything seemed soft—no thorns or scratchy plants.

He came across a running brook and filled his canteen, fine bubbles foaming out of its neck filter. It was only half Earth water now. If he never emptied it, there would always still be some molecules from the home planet in that canteen, in ever decreasing proportion, of course. He considered boiling it, but time was pressing. The filter would catch the microbes and his enhanced immunological system would be pretty tough on viruses that hadn't coevolved with terrestrial life.

Out of the corner of his eye, he caught something scurrying away from the trail, a kind of furry ball with red and black markings that seemed to have too many legs. Why would it be afraid of him? There must be something about his size and shape that was dangerous. He thought about lashing his multitool to a blackwood sapling spear, with its blade deployed. But if he lost that tool!

Given the volcanic nature of the hillside, there should be some obsidian around, but he didn't know what to look for, nor did he have any confidence in his ability to whack raw obsidian into a spear point. Then his eyes fell on a dead blackwood branch. He scrambled off the path to pick it up. The bark had dried into plasticlike hardness. When he scraped out the rest of the rotten pulpwood, he was left with a hard, hollow cylinder. He cut one end of this at a steep angle and jammed the other over the end of his walking stick. Then, with the ludicrous image of himself as a Pleistocene hunter in his head, he threw the improvised spear into a bitterwood tree.

It sank in with a satisfying *thwump*. He made three more slanted cylindrical spear points, put them in his emergency kit bag, and continued his descent.

In his second day down the mountainside, ravenously hungry, with only five nutrition bars left, he decided whatever he was doing was not working. He was seriously thinking of the fish trapped in the CSU—could he find it again, dive down, and kill the fish? It had been big—maybe a hundred kilos of meat on it. He should have taken that opportunity when he was there.

Okay, he wasn't going to just run into something to eat walking down the trail. Why not try setting up a blind and watching for what might come by? He could give that a day.

It was a long boring day, but that evening something did come by. It seemed vaguely like a cross between a kangaroo and a dinosaur, so he mentally dubbed it a kangasaur. It was at least twice his height, and its head bobbed from side to side. Jacques readied his spear, then got a look at the fierce claws on the kangasaur's feet and thought better of it. It stared in his direction, but he stayed perfectly still. It ambled over to a bitterwood tree, reached up about as far as its neck would extend, and worried away at something under a bitterwood leaf. Then it left. What had it found? Could he climb a bitterwood tree? Their lowest branches were about three meters up, and the bark, though not as slick as the shiny blackwood bark, was still very smooth. But gravity was low. An experimental leap up brought his eye level perhaps six meters above the forest floor. He jumped for a branch, clumsily slung himself under it, sloth-like, and shinnied out to look under its leaves. It was barren; he would have to climb higher than he could leap.

Jacques remembered going to an art museum with his class and seeing a picture of a man climbing a tree with rope around the trunk, holding himself to the bark that way. There was a coil of carbon-nanofiber twine in the emergency kit, 100 meters according to the label.

It took some experimentation and a couple of falls, but the next morning Jacques made it up a bitterwood tree and looked under its leaves. He had to go higher than the first level of branches, but finally discovered a cluster of teardrop-shaped fruits. The rind was tough, but no match for the steel of his multitool blade, and he got at the pulp beneath.

He knew the risks, but he had to find something edible. He nibbled at it. It was mostly soft fibers, almost like pasta, and relatively flavorless; nothing sharp, bitter, or otherwise deadly seeming. Ten minutes after the first taste, he took a mouthful. It seemed to go down okay.

He put a couple of fruits in his kit bag, which was beginning to become stuffed, and dropped down to the ground. He would wait a day to see how his body reacted before eating more. He camped by a brook, sealed in his tent despite the warm humidity of the place, and slept fitfully.

The next day, not having gotten sick, he ate the whole thing, minus the hard seeds toward the center of the fruit. So far so good, he thought, and headed downhill.

Part of the apparent flatness of the landscape from the caldera rim, he realized, was because the trees got taller as he descended. As a guess, the tallest blackwoods were almost three hundred meters high and five meters across. He felt like a squirrel in a forest of giant sequoia. Their oval leaves were longer than he was tall, with stiff hollow veins and webbing like sheets of felted canvas. Picking one up, he felt like an ant, able to lift several times his own body mass.

By the end of the day, he was still healthy. With food, he could survive. Under a leaf lean-to, cushioned by soft loam, he lay down. The next thing he knew, morning had arrived.

\* \* \* \*

### **Chapter 3**

#### **The Killer Ape**

Deeper into the forest, rocks had become fewer and fewer; the floor was a rich, soft loam. His cairns were now teepees of fallen blackwood branches. Over the next week, he taught himself to weave a passable basket out of blackwood saplings, discovered a thin fibrous green vine that was surprisingly strong, found a mildly sweet edible berry to break the monotony of bitterwood fruit, found a hollow “flute plant” that grew perfectly straight but no higher than about a meter, and identified six native animals, including the furry spider-like thing he'd seen on his first day. But he was getting increasingly tired—bitterwood fruit and berries alone might not be an adequate diet.

The furry spiderlike things—he decided to call them hirachnoids—foraged on a mushroomlike plant that grew beneath fallen blackwood tree leaves. He didn't try eating those—not a rational decision considering all the other chances he was taking, but eating things that looked like mushrooms made him nervous. He gathered up some of these and put them under his basket, weighted it down with a hunk of lava, then propped it up with a twig to which he attached a string, the idea being to pull the twig out when the furry spiderlike thing was underneath the basket.

This didn't work well—the little animals were able to skitter out before the rim fell. That, he realized, was a consequence of the low gravity—no matter how much weight you put on something it would only fall so fast. If he could only *push* it down.... The answer was a long fallen blackwood branch resting on the top of the trap. The trick was to pull the string attached to the stick first and step on the branch immediately

afterward: one, two. If his timing was ever so slightly off and the pressure from the lever came first, the stick wouldn't come out at all, but if he left too much time between string and foot, the critter would escape.

After a couple of tries, he caught one. Up close, it actually looked very spiderlike, with compound eyes, but six instead of eight legs and seemingly no segments—a big hairy ball maybe half a meter across. Its mouth irised open like an anus to allow a forked appendage to shoot out and grab pieces of the mushroomlike plant. Despite being trapped, it ignored him and worked away at eating the bait.

Jacques hesitated. He had never killed anything before. But he had only two nutrition bars left. He needed to survive, and to survive he would probably need protein. Protein meant meat because he had no way of determining if the vegetation had any. Still it was all guesswork; he didn't know that killing this thing would solve his problem. He didn't know how smart it was, whether it would suffer, or even retaliate in some very effective way. He pondered this for several minutes, then put one of his spear tips on his walking stick and struck the thing hard right between the eyes. It collapsed immediately.

Dissection proved a problem; the hirachnoid's hair was as stiff and bristly as it looked and longer than the blade of his multitool knife. He ended up lashing the multitool to a flute plant shaft with green twine and going at it whaler style. The first cut produced not meat, but a fountain of mucous yellow ichor that stank like rotten eggs. He almost gagged, then recovering himself, made another cut.

Suddenly, the creature's corpse began to pulsate and flop around. Jacques recoiled in disgust. Then out of the cut, a procession of miniature hirachnoids emerged—miniatures of the first except for a lack of hair. Jacques' stomach began to get queasy, especially when the little ones dragged pieces of their mother's—or their host's—innards out of the incision and ate them.

Sickened, Jacques backed away from the trap and sat down to collect himself. Periodically, thereafter, he checked the trap.

By evening, nothing was left of the hirachnoid but the skin and legs. He held a leg up—it was tough and horny, like a crab leg, and felt massive enough to contain some meat. He gathered the other legs and took them back to his camp by the brook. Using some stones, he cracked one open and found some white fibrous meat inside; obviously the leg muscle.

He pulled it out, cut a small piece off with his blade, washed it in the creek and tasted it. It was extraordinarily rich and tasted somewhat like buttered lobster, but was much softer than he remembered lobster being—indeed, it seemed to melt in his mouth.

Jackpot, he thought. Maybe. Would the rest keep until morning? He should wait to make sure nothing untoward happened to him as a result of his bite, but it was too good. He took another bite, then, in an act of incredible self-control, he wrapped the remainder in leaves and sealed it in his emergency kit bag. There was no room for the other legs, so he put them in the basket and hung that by a rope from a branch.

Then he improvised a hammock with green twine and bitterwood leaves and went to sleep.

He woke up with the first light, feeling better than he had in days. The remaining part of the first leg didn't smell right after sitting overnight, so he threw it away and cracked open another. It tasted about as good as the first leg had the previous day, so he ate the whole thing and waited. He didn't get sick and considered himself incredibly lucky.

On the morning of the tenth day since Jacques woke up in the CSU, he had starch, protein, and fruit, and his emergency kit was intact. There were a dozen hirachnoid legs and four bitterwood tree fruits in his



basket. He had painstakingly depilated a hirachnoid pelt and sewn it into another bag. He'd constructed a back frame from flute plant stalks and green twine to carry things in. He laughed at himself; he was becoming a stone age man of substance.

He had now stayed at the same campsite for three days. It had a running brook, in which he'd bathed without incident—if there were local parasites, they didn't recognize him as food. He had been through a local rain shower, kind of a warm, gently descending mist with the lightest of breezes that nevertheless had managed to soak everything. He had taken to going around naked—less itching, less sweating, and less wear and tear on an emergency suit he might need later.

He had fire, though it had taken hours of experiment with a green twine bow and stick to get something going. Then he had a hell of a time containing it—the *Resolution* had found a planet with perhaps an Earthlike percentage of oxygen in its atmosphere, but the pressure here must be something like three or four atmospheres—so the partial pressure of the combustion-supporting gas was that much higher as well. He glanced around him at widely spaced trees, the largest ones being succulent bitterwood, or chitin-barked blackwood. No mystery there. It turned out that tanglegrass ignited easily and dried bitterwood charcoal would glow for days. He was beginning to feel like an old hand.

He estimated that he now only needed to spend only about a quarter of his waking time hunting and gathering and could spend the rest doing something else. What should that be? Did he have enough to do the trek back into the crater? It might mean someone else's life, though he considered that possibility faint. Another thought was of salvaging his CSU. If he could rig up some kind of power source, he might get it partially functioning again. From the rim, he could study more of the puzzling geography of this world and maybe see some stars long enough to orient it in space. He could do such projects later; for now, he had to focus on a rescue effort.

Okay, he thought, back to the rim. He left a scratched rock plaque by his fire pit:

\* \* \* \*

Deliverance Creek Camp

First Human Settlement

Jacques Song

Day 7-10.

\* \* \* \*

He frowned; he was into double digits now.

There was another trail across the creek; he had seen kangasaurs of various types going by on it. Why did they go up to the rim? he wondered. Well, he would have plenty of time later to study such matters. He spent the rest of the day trapping and gathering, then set off the next morning.

Upward with a full kit was still no stress whatsoever in the low gravity and hyperbaric oxygen. Eventually, he thought, he might be able to build an aircraft. Even a small wing area would support a lot of mass here.

He was lost deep in thought when a three-meter kangasaur attacked. He heard it coming and managed to turn and ward off the kick with his staff more by instinct than reason. "Where in the blue sky did you come from!" he yelled in surprise as he swatted another kick with his staff and backed away. His Earth-gravity-bred strength, the quickness of his reactions, and the extension of his reach with the staff seemed to confuse the would-be predator, and for a moment, the two bipeds froze, eyeing each other warily, the beaked head of the kangasaur bobbing back and forth.

Sensing hesitation, Jacques Song, Killer Ape, roared as loudly and fiercely as he could manage and advanced on the confused beast, whipping his staff back and forth. Being hollow, it made a frightening

moan in the dense air. The kangasaur jumped back, turned, and began running away up the path.

Jacques stood there laughing, naked, sweaty and exhilarated. But as he turned to march back up the trail, he heard a much larger crunch. The kangasaur had returned with a pair of much larger ones, probably six meters tall, behind him. Unable to think of anything else to do immediately, Jacques swung his staff again. The smaller one immediately jumped back behind the large ones. After a heart-stopping five or six seconds the larger one jumped, its clawed foot—almost a meter across—looking to come right down on Jacques.

On Earth, he would have been dead meat, but it took much longer for things to happen here. Jacques stepped aside, then jumped himself as high as he could. The huge kangasaur's head followed the leaping human with an open beak. In midair, Jacques whipped his staff across the skull of the monster. There was a cracking splintering sound, and it wasn't from Jacques' staff. The monster squealed in an incongruously high-pitched voice and put its head between its front forelimbs.

"Sorry, I may have overreacted," Jacques said to it, in the humor of relief, as he sprinted up the trail away from the trio. It was the first time he had tried to run quickly since he'd arrived, and he found he had to carefully control his stride to keep from bouncing too high and losing speed to air resistance. The kangasaur didn't pursue him, though, and he stopped after a few hundred meters.

"I may regret this," he told himself, but unable to control his curiosity, he retraced his steps. The small kangasaur family was clustered around the wounded animal, the other two nudging it with their beaks as it continued to hold its head in its forelimbs. A very bright red fluid, apparently blood, had wetted its foreclaws and limbs. Eventually, it stood up and tried to walk, but blundered into a nearby tree. In an entirely human gesture, the smaller one reached for the forelimb of its wounded mother or father—Jacques thought of them as a family—and led it away from the forest and back down the path the way it had come. The other large one stayed behind, looking back up the trail. Its eyes met Jacques'. Jacques whipped his staff around in a circle and it made the odd moaning sound. The kangasaur's head bobbed, looking up at Jacques and then back toward the rest of its family. Finally it turned and followed them down the trail.

Jacques exhaled and continued upward on the trail, much more alert now, walking softly and looking up and down the trail at every turn. The era of carefree strolls in the park was over.

\* \* \* \*

## **Chapter 4**

### **Requiem for a Martian**

The trees began to shrink and the forest to thin as he approached the rim. The sky became soft and hazy with mist. The sun overhead was red and faint to the point where Jacques could look right at it; indeed, through the haze it began to look like what some pre-astronautical artists had thought a red dwarf would look like from a planet. Upward. While his eyes were on the increasingly jagged path through the lava ahead of him, the light suddenly dimmed. Jacques looked up in time to see the last of some great, indistinct silhouette pass across the large red disk. He shivered despite the warmth of air, thinking about wing loading in a dense atmosphere under low gravity with plenty of oxygen. Something was up there. Something big.

He looked at the trees—cover was beginning to get scarce. He built a stone cairn and scratched a crude picture of a batlike thing on a piece of smooth pahoehoe lava. This he put on the cairn just under the top stone. As he brushed his hands off, he noticed a piece of paper caught between two stones on the ground. It was such an ordinary piece of litter that he almost turned away without recognizing its

implication.

He was not alone.

Excited, he lunged for the paper before it blew away. It turned out to be a page from an old-fashioned diary—something one might indeed take into one's CSU. The ink had smeared and faded, but he could read some of the entries:

*...daddy spanked me—not ready for church on time...*

*...went to Blu River concert with Fredrika, Gus, and Tsen...*

*...algebra is too hard!!!! maybe Gus will help me but I won't let daddy know...*

*...went to Solis Lacus Temple Sunday, really, really beautiful. I feel inspired...*

*...Fredrika's 14th birthday party really fun but sad. Her folks sold her to Will Tharsis so goodbye. I wonder who daddy will sell me to? Just one more year—I want to go. I'm afraid.*

Feeling like a voyeur, Jacques didn't read any more. These were scenes from a New Reformationist childhood on Mars—and an understandable excuse to volunteer for a century-long expedition to liberate a people suffering from theocratic tyranny. Was this just a page come loose or had something bad happened? Jacques looked around for clues—but the page might have blown from anywhere by now.

The writer was probably female, he thought. Who? There was someone called Ascendant Chryse, a biotechnician in the third squad; she wasn't necessarily the only Martian farm girl on the expedition, though—just one whose name was memorable. She was tall and reserved, with long straight hair, and had been a bit of a loner. But something had burned in her eyes, and she'd worn her jumper open low enough to show cleavage.

He put the diary page in his breast pocket. In the best of all possible worlds, he would have a chance to return it. Adam and Eve scenarios sprang unbidden in his mind.

He reached the rim before sunset. It was too hazy to watch the sun go down; things simply got dark with their usual suddenness. In the fading light, he managed to find a lava tube with a view to the East across the caldera and set up his bivouac on a hollow filled with soft volcanic sand.

He woke when it was still dark. Had he heard a noise? He listened carefully, but everything was silent now. He pulled the boots from his shipsuit on and felt his way out to relieve himself. Outside, he was greeted by one of the clearest and steadiest skies he had ever seen. The air was dead still and only the faintest stars shimmered ever so slightly.

To the north, rising plumes of steam lit by a faint red glow reminded him that he was on the rim of an active volcano.

The star patterns were unfamiliar and were dominated by a brilliant red star so bright that it cast a shadow and degraded his night vision. He had to block it with his hand to see the Milky Way. But a group of second magnitude stars caught his attention; it looked like Orion's belt. With a start, he realized that it could indeed be Orion's belt, but viewed from hundreds of light-years farther away, and, if the still brilliant red and blue stars above and below it were Betelgeuse and Rigel, somewhat off to the side. 36 Ophiuchi lay near Scorpius; Orion hunted on the opposite side of Earth's sky. So the brilliant red star to its right could be Antares. If so, they had passed a few light-years beyond the heart of the Scorpion. With a bit of searching, he found what he thought were the Pleiades. Somewhere in the direction he was looking would be Sol, maybe a hundred times dimmer than the dimmest star he could see. The compact

binoculars in his emergency kit required power, of course.

He would build a telescope to see Sol, some day. He could grind and polish an obsidian mirror, silver it somehow, and use the lenses from the binoculars as an eyepiece. If he couldn't get home again, he vowed he would at least *see* home again.

A brisk wind hit him from behind and a great dark void filled the sky where brilliant stars had been moments ago. Some primordial instinct seized him and he threw himself down to the lava as something he couldn't see went *whoosh-clunk* above him. The stars reappeared as the black shadow flew off to the east. It was some kind of bird or bat, but the size of a large aircraft—a megabat. With the Milky Way behind it, he could see it bank and begin to return. Terrified, he scrambled on all fours back to his lava tube. There was an audible, hollow *thump-crunch* outside as if a giant had jumped down on the lava field.

Jacques fumbled for his staff and basket and moved farther into the lava tube, glad that he had chosen a small one. Loud scraping sounds commenced at the tube entrance, followed by the thumps of falling rock. Eventually they stopped, but Jacques stayed awake sitting on his haunches and gripping his staff the rest of the night.

When it got light enough to see, he tended the variety of scrapes and scratches he'd gotten from blundering around blind and naked in the sharp lava field. Then noting the monster's excavation efforts hadn't shortened the tube significantly, he lay down on his space blanket and slept.

When he woke, he gathered his things and cautiously poked his head out of the lava tube. The sun was high, peeking through occasional gaps between impossibly tall, dark-bottomed clouds that were rapidly filling the sky.

He emerged and looked around—not a hundred meters to his left, sitting in a depression of lava sand, were three huge eggs; he recognized the mottled shells.

Did he risk the climb down to the lake? He hadn't seen anything on the way up; maybe the megabat only hunted at night. Was there any point? The megabat was another reason not to expect to find any other survivors. Or maybe it wasn't a threat at all and was only protecting its clutch. Supposing that he risked a search, what would be the best way of doing it? Going along the rough lava ashore would be time-consuming and increase exposure to the megabats. But if he were on or in the water, he could dive to escape it—trusting that said dive didn't take him into the jaws of a parrot-beaked shark.

He could make a boat of some kind. A hollow blackwood log should float nicely enough if one could stop up the ends. Bitterwood pulp dried out to something like cork, so that might work. He could braid ropes of green twine. He headed back down the hill and established a working camp at a level where there were logs of about the right size, a running brook, and a lava tube cave just the right size for him and nothing bigger. He called it Forest Camp.

Two weeks later, on Day 25, on the first landing beach, he had assembled four blackwood logs, stopped and sealed, about thirty centimeters across and four meters long—as large as he could carry—along with a coil of three-centimeter-thick green twine rope, numerous flute plant shafts, and a pile of mature blackwood leaves. The next morning, he pondered whether to follow his plan and go for one more log or just go with what he had. One more log would make the raft about 1.5 meters across instead of 1.2. He looked at the high waves and decided to do it.

By this time, the path was well traveled. Carrying a log on the way back, with an overnight stop at Rim Cave, would take a day and a half. But unburdened, he could do it in half a day, so he took off immediately, intending on arriving at Forest Camp by early evening. As he approached the rim, he

witnessed an astounding sight. A group of kangasaurs had gathered at the megabat nest and were apparently trying to break open one of the eggs.

Almost by instinct Jacques rushed toward them, waving his arms, hoping to scare them away and save the eggs from the kangasaurs and the kangasaurs from momma megabat. But the kangasaurs didn't scare and one of them started toward him. Jacques slowed and prepared to do battle with his staff. Then he saw a long scar on the head of one of the kangasaurs that stayed by the eggs. Could it be the same one he hit before? Jacques began to whip his staff around, creating the low moaning sound and approached slowly. The scarred kangasaur left the egg clutch and started heading downhill; the rest followed. The one that had come to challenge him looked back at the retreating group, looked at Jacques, then back at the retreating group and abruptly turned and bounded after them. Jacques was curious about how much damage the kangasaurs had done to the eggs, but decided discretion dictated that he *not* approach the nest.

Instead, he continued quickly along his trail to Forest Camp. A distant movement caught his eye. A huge megabat was coming in for a landing. Though it must have been moving rather quickly, it was so large that even rapid movements took time. In this slow motion, it settled to the ground among the trees as if using some antigravity mechanism.

Jacques scolded himself about curiosity and went to take a look anyway, careful to stay in the cover of the trees. The megabat itself was an ugly chimera of familiar-seeming things: a bear's head with a parrot's beak on the body of a bat. On the ground it squatted on its hindquarters, balancing with a pair of clawed fingers that projected from halfway out on its wings. Its neck didn't seem long in proportion, but still could extend some distance from its body.

What it held nearly made him retch. It had pulled something out of the wreckage of a CSU, a bloated, white thing that nonetheless had recognizable arms and legs. The corpse fell in half as the megabat's beak lifted it, and the monster gulped the half it retained with a quick motion of its head. Then it went back down for the rest. Shuddering, Jacques hid behind a blackwood tree until the megabat lifted off with a single mighty beat of its huge wings and vanished into the gloomy, clouded sky.

He went forward to see what had happened. It turned out that the CSU was not badly damaged—the megabat only dented it in the process of biting off the flexidiamond canopy. The fall, he realized, would not have been so bad. Terminal velocity for something the size of a CSU in this dense atmosphere and low gravity would be a fraction of what it was on Earth—maybe less than ten meters per second, and even that may have been broken by the tree canopy.

The occupant had made a camp around the CSU, apparently hoping to be rescued. A crude table and chair sat beside the CSU, made of flute plant shafts lashed together with green twine.

There was a basket, not unlike his, with personal effects in it. The remains of a handwritten book remained open, several pages having come off. Fearing the worst, he compared the page he had been carrying with the book. It matched; the CSU had been that of Ascendant Chryse.

His nose told him that she had been dead for a while when the megabat found her. He nerved himself to look into the CSU. Her decayed head was mercifully turned away from him amidst the scattered, putrid gore left by the unfastidious megabat. He hoped the bacteria in her body would kill the thing. But probably not—parasites coevolve with their hosts.

The shadow of the caldera had moved over him by this time. He would have to get back to Forest Camp quickly—the megabats, apparently, were already about their appointed rounds. He looked around for her emergency kit items, finding the bag, space blankets, canteen—everything but the solar array and

wrist comp. Was the array working? It had to be around somewhere. He couldn't find it, however.

He was about to leave when he remembered the CSU memory; it might have a more complete record than his own. He found the access panel and the right side and, hopefully, turned the power on. The tiny engineering status screen display lit up immediately—her CSU had probably used much less power than his after landing. For one thing, it wouldn't have needed to make air.

But the external intake status was “off.” That didn't make sense to him. With the power off and the canopy shut and the vents closed, she would have suffocated. Had she simply given up hope and killed herself? That didn't make sense, but the evidence seemed to point that way.

Shadows were deepening. He pulled the systems control module out of the CSU and took it and the diary back with him to Forest Camp.

That night, in his lava tube by the light of glowing charcoal, he got to know Ascendant Chryse and her history. She would not, he thought, have killed herself expecting to go to heaven—as an adult, she had utterly rejected the New Reformist mythology she'd been taught by the people who had abused her childhood. She had become a conforming Anglican, though with private doubts. She hated the New Reformation. The last pages of her diary flamed with her determination.

He wouldn't be able to play back her CSU's record of the *Resolution's* journey until he found another undamaged CSU, but in the last pages of her diary, she vowed to “...get revenge for the sabotage that diverted *Resolution* from 36 Ophiuchi.” There was no despair in this writing, or anything like it.

Needing some closure, he tore out an empty page of Ascendant's diary after her last entry. Some of the cells of her body would be on that, along with her fingerprints. Also, it represented her future, the unwritten pages of a life that might have extended to the end of time itself. Gone now. He took the page and lit it afire from his charcoal lamp. Its brilliance filled his small cave for a few seconds, then flickered out.

He sang Heinlein's *Green Hills of Earth* softly and went to sleep with tears in his eyes and an unanswered question in his mind.

Sabotage required a saboteur. Who? It would have been a suicide mission ... or maybe not. He was alive, after all.

\* \* \* \*

## Chapter 5

### Beyond Survival

He arrived at Rim Camp in early evening. Days had become noticeably warmer and longer since he'd emerged, but the sun still rose at nearly the same place on the horizon each day. At least it did as far as he could tell without stopping to build some kind of a Stonehenge to measure it. The change must be due to orbital eccentricity, he thought. He stuck his thumb out at arm's length to cover less of the sun.

Two days later, after some thought and exploration, Jacques assembled the log raft *Resolution II* on a black sand beach three hundred meters clockwise from where he originally came ashore. The area had a small protected cove, an unusual two-story lava tube cave, and a shoreline of about thirty meters or so of deep black sand. There, he had room to lay the five corked blackwood logs parallel and rope them together with green twine. On top of the logs, he laid out a dozen smaller blackwood branches at right angles and tied them down with a lot of green twine. On top of the middle three of those, he lashed a platform of some thirty flute plant shafts, about three meters long and 1.5 meters wide, each jammed into

its own hole in a blackwood log, fore and aft. On top of this, he secured a block of dried bitterwood to serve as a seat. Three long, reasonably straight blackwood branches served as oars—one was a spare.

He launched *Resolution II* on Day 30. It worked reasonably well in the relatively calm waters of the cove, but tipped so much in the higher waves of the lake that he had great difficulty staying on his seat. He rowed back to the beach and made another trip to the forest for more green twine and provisions.

Finally, on Day 33, having made a green twine seat belt with a whittled buckle, he felt ready for open water. While the waves were high and steep, they moved slowly, and he was able to get into a rhythm of waves and oars that let him progress at maybe two meters a second without too much effort.

He wore his emergency suit—mainly for the clear visor that let him see well underwater. Every hundred yards or so, he would unstrap, dive, and look for a CSU. About a quarter of the way around the lake, he found one.

The CSU was perhaps at half the depth of his and still functional. Its occupant was a man of medium height, a deep tan, and straight black hair. Jacques didn't recognize him. He tied a line to the CSU and opened its panel to start the revival process. Then he went back to the raft to catch a breath and wait. After what he judged to be about twenty minutes, he dove again. The man seemed about as startled to see him as Jacques had been to see the parrot-beaked shark—a thought that made Jacques glance around nervously.

By placing his inflated hood right against the CSU, Jacques was able to tell the man what to do, and soon the two of them were together on the raft.

"What happened!?" was the first thing the man said after pulling his hood off. "My CSU couldn't tell me anything. It was barely functional." He was a wiry, dark man and spoke with what Jacques thought was a slight British or Australian accent.

Jacques shook his head. "The same thing for me. I'm not at all certain, but apparently the *Resolution* could not, or was not allowed to, decelerate at 36 Ophiuchi, and its AI or its crew or both did the best they could to find this place and dump the CSUs here. So far, I've found one who didn't make it, and you."

"Submahn Roy," he said and offered a hand. "From Bengal. Just call me Soob. I was a park ranger and safari leader. I was going to have a hand at occupation logistics."

Jacques gave Soob the basics of his lonely odyssey. "I have Chryse's CSU control module. It may have more data, but I need another CSU to play it. We might try to raise yours."

"I'm not good for much physically, right now. But as soon as I am, we should look for others."

Jacques nodded. Time was running out on the underwater CSUs, and more people would make the job easier. He dove to recover his line and mark Soob's CSU with a green twine-tethered blackwood buoy, then they rowed back to the beach.

Soob recovered as rapidly as Jacques in hyperbaric oxygen, and they were able to set out again the next day to look for others. The first CSU they found was occupied by Lieutenant Collette Obota, an African woman from the Congo. She was a member of the expedition's twenty-person police force—tiny, but any actual fighting would have been done by robots under human direction. A tall, personable, lady with a big grin, Jacques had not met her before, but liked her instantly.

The occupant of the next CSU they found had clearly expired some time ago. The same for the next two.

But the fourth was different. Its occupant looked to be of Asian ancestry and was still in hibernation. Jacques started the revival process from the access panel, and soon the occupant was aboard the raft. He introduced himself as Yu Song-II, a psychiatrist who had been born on Hanguk'i Habitat in the Proxima belt. Almost two hundred years old biologically, he greeted his new circumstances with the joy of discovery.

Not long after they pulled him aboard, it began to rain in huge cold drops that reminded Jacques of water balloons. They had to struggle to row against a gentle but surprisingly insistent wind and monster waves to get back to their beach. Green twine lashings began to fray and snap as the *Resolution II* flexed alarmingly.

A huge wave broke Jacques' basket open and its precious cargo of emergency kits and food spilled aft. Unhesitatingly, Collette dove after them.

For a second, Jacques froze, then shouted. "Soob, Doc Yu, take the oars and try to keep us steady." Then he scrambled after the remaining supplies on all fours as the raft pitched up and down. His hand clamped on a coil of nanotube line before it had a chance to slither overboard. He wrapped this around the broken basket several times in a crude repair. Reluctantly, he cut that part off with the multi-tool, tied the end around several deck boards and tied the other end to a loop on his emergency suit. Then he dove into the water to look for Collette. It had all taken several minutes and she was nowhere to be seen.

"Collette!" he screamed at the top of a wave. Three times he screamed.

"Over here!" he heard at last. He swam toward the sound.

It became difficult to breathe as the drops became more and more dense. It was impossible to avoid inhaling water, and he coughed as he struggled. He lost his direction. There was nothing to do but tread water and call again.

Something brushed against his foot. Instinctively, he kicked. Suddenly he felt a strong tug on his boot and a sharp pain. Ducking underwater, he saw that a three-meter parrot-beaked fish had clamped its jaws around his foot. Unable to pierce the emergency suit, it was still exerting crushing force. In desperation, he bent double and punched it in the eye with all the strength his full-gravity muscles could manage.

No effect.

Trying to calm himself, he got his multitool out, opened the blade, and sank it deep into the fish's skull. Nothing. Lungs burning, he slashed behind its head, once twice.

On the third cut, it released him and swam erratically away. Jacques pushed himself to the surface.

"Over here!" he heard. Not twenty meters to his right, Collette was treading water with two emergency kits in her arms. With arms that felt like lead, he stroked over to her. With Collette gripping him with her legs, she pulled them both back to the raft.

It held together, barely, for the immeasurable time it took to get back to the cove. When they arrived, Jacques could see that the wave line of the lakeshore had already advanced almost a meter. Together, they dragged the raft as far up onto the shore as they could, tied it to a stick they wedged into a small lava tube and carried what was left of their supplies into the lava cave. They had lost all the indigenous food, but only one bag of emergency gear.

Exhausted, they spent the entire next day in the cave, consuming nutrition bars and creating small private areas with shards of fallen pahoehoe lava cleared from the floor. The raindrops hitting the top of their



cave sounded like distant, muffled drums. At one place, water dripped down from the roof of the lava tube. They “corked” a segment of hollow blackwood log left over from the *Resolution II*'s construction, a volume of about half a cubic meter, to place beneath it.

Jacques nursed his swollen foot and recounted his adventures as the storm subsided. He also made another plaque:

New Landing, Day 35

Great storm. Rescued—

Below he laboriously scratched in the full names of his party.

Rainwater, seeping in, filled a large sandy-bottomed depression in the lower part of the cave, and they bathed in shifts. Then they washed their shipsuits and hung them to dry.

Jacques arose before the others to watch the sun rise the next day. While he was happy to have achieved his goal in rescuing other survivors, he had grown used to being alone and not entirely unhappy with it. In the morning light, he found the shore almost lapping at their cave entrance and the remains of the *Resolution II* bobbing in the still-disturbed lake at the end of its tether. He found a secure place above the cave entrance to place his plaque and went back in to wake the others.

There was, he realized a decision to make. Most of the camp outside the lava tube had been washed away. The raft was in no shape to set out again, but every day, every hour, of delay meant that someone might die who might otherwise be saved. Alone, Jacques would have gone back to forest camp for more supplies. Now, with others present who might question his judgment, he hesitated.

Collette stepped smoothly into the silence with a clear, bell-like voice. “Here we are, four naked savages at the mercy of storms and hungry monsters with dreams of climbing back to starflight. Well, what should we do, Jacques?” Collette asked. “You know this place better than we do.”

Jacques looked around at them, uncertain.

“What would you do if we weren't here?” Doc Yu asked.

Jacques told him.

“Ah.” Yu smiled. “And how does our being here change that?”

Jacques shrugged. His situation had suddenly moved from straightforward survival to something involving leadership and perhaps even politics. He was not comfortable with that.

“With all of us working together, we should be able to do it faster,” Soob interjected. “We can hunt more and carry more. I think we should add another log to the raft, and some more cross bracing.”

Jacques looked around him. Heads nodded. A consensus seemed to be forming. “Very well. Let us pack our things and go. We should be able to make Rim Cave by sunset if we leave now.” The sun, he reflected, seemed to be larger, warmer, and up longer than when he first revived. But he had no way of measuring it.

About halfway up the caldera wall, Jacques saw a dark shape against a towering white cloud.

“Everyone, look up, about thirty degrees left of the trail. That's a megabat.”

“It looks as big as an airliner,” Collette said. “Do you think it's the one that ate Ascendant?”

"I've only seen one at a time, but I can't imagine there's only one in the whole ecosystem. I think they prefer feeding at night—probably see well into the infrared."

"The one that ate Ascendant," she replied calmly, "was one that found something to eat in the daytime."

Jacques nodded nervously and increased his pace as they all took turns watching the sky.

They reached Rim Cave at sunset and nervously worked to expand its sleeping area well into twilight. The soft *whummm, whummm* of huge wings was heard in the night, but no long beak attempted the entrance this time.

As dawn broke, Collette and Jacques found themselves together outside the cave mouth.

"An early riser, too, I see," she said.

"And one with a French given name, too. This seems auspicious." Jacques smiled.

"It's my mother's name. My parents met in Kindu, centuries ago now," Collette said. "It dates from the Belgian colonial period."

"My great-grandmother was a French diplomat in Papua New Guinea," Jacques replied. "My great grandfather was a Hong Kong businessman. They settled there, in the high mountains. Someone in each of the last four generations has had a French given name."

At Forest Camp, hunting and gathering was problematic. There were few bitterwood tree fruits to be found, and those seemed well past their prime. Hirachnoids had grown scarce as well and for the first time, Jacques failed to see a kangasaur.

That night in the lava tube, Soob was worried. "It is very difficult to be sure, but we have found in one day somewhat less than is needed to sustain us for three—even supposing that we are not missing crucial trace nutrients. We need another food source. What else have you tried?"

Jacques shook his head. "My priority has been the rescue of other crew members. After finding enough to keep me going, I focused on that and did not take additional chances."

"I see."

"Did the bitterwood pulp wood actually make you sick?" Doc Yu asked.

Jacques laughed. "I didn't try very much."

"The molecules that cause the bitterness may be more fragile than the molecules of nourishment. I suggest we try cooking it. What about tanglegrass?"

"I haven't tried that at all," Jacques answered. Then he remembered what he'd seen when he'd caught his foot in some and pulled it out of loose earth. "It has a thick white root, however."

And so the conversation went. By mid-morning the next day, they had determined that bitterwood pulp was indigestible, regardless of what one did to it. Tanglegrass root was too hard to eat raw, but could be pounded into a paste that didn't make anyone sick; whether it was nourishing would have to be determined later.

But the big surprise, in Jacques mind, was flute plant fronds. Boiled, they proved almost indistinguishable from spinach. Young flute plant shoots also proved edible when boiled soft enough to chew.

They set out for Rim Cave by noon with a corked blackwood log and forty person-days worth of provisions. Soob and Doc Yu carried the log, packed with the supplies, while Collette and Jacques headed over to Ascendant's CSU to see if there was anything else to salvage.

Jacques attacked the area behind the access panel with his multitool. Wires, connectors, optical fibers, braces, components—anything he could pull out quickly went into their emergency kit bags. In the main compartment, the smell had gone and Ascendant's skull lay, face still away, completely clean.

"She had beautiful bones," Collette said. "I wonder what cleaned them?"

"I don't know," he said. "Why?"

She smiled at him. "Protein." Then she laughed at his reaction. "There are only a few ways to do carbon-based life, and what we find here, like about 45 percent of what we find anywhere, must do it our way. If they can eat us, we might be able to eat them."

"We need to be on our way," Jacques said, recovering his equilibrium. "The sun is about halfway down."

As they strode up the fairly well-worn path toward Rim Cave and the tree-bearers, Jacques contemplated the path of their sun. It seemed to be setting in the same place, yet days seemed to be getting longer and hotter. The planet's orbit must be eccentric, he thought. How close to its sun would it get?

Lost in thought, he was utterly and totally surprised when one of the most bizarre apparitions he had ever seen in his life loomed in front of him, held up a hand, and said, "Well, praise the lord! Jack's Song, I presume?"

\* \* \* \*

## Chapter 6

### Community

It was a large ruddy-faced man dressed in a kind of caveman get up—an animal skin of some kind wrapped around his waist and over a shoulder. He had a large bag made of the same skin slung over his shoulder and a large flute plant staff with the fronds still attached.

"That's me," Jacques said. "But how did you know? What do you call yourself?"

"Gabe Eddie," he stuck out a hand, which Jacques shook. "Just call me Gabe. I was a psych warfare troop on the *Resolution*. I'm from New Jerusalem. I've been following your trails for days now—all those cairns and markers, with your name on several."

"Of course," Jacques said.

"We need to catch up with the rest of our party," Collette said. "We have a camp on the rim in a lava tube, which we should be in before the megabats come out."

"Jacques, you don't mind me joining your party, do you? My dragon hole's a little farther south on the rim than yours."

"Agreed, but we should start walking," Jacques said, starting to pace up the trail. "My colleague is Lieutenant Collette Obota, of the expeditionary police."

A transient frown passed Eddie's face. "That's long ago and far away now."

"Nonetheless, that is our governing authority. Anyway, we all live forever now. Empress Marie may still rule—and our laws as well."

Gabe's expression resolved itself into a smile and a nod as he tagged along. "Well, maybe. But your gal's prettier than the Empress is, though a bit underdressed."

Collette laughed. "But very comfortable. How do you put up with that ... skin?"

"Smoked, scraped, soaked, scraped, and soaked. Rendered some fat to oil and soften it."

"Really?" Collette sounded skeptical. "Gabe, do you know more about how we got here?"

"More than what?" There was a hint of wariness in this answer of a question with a question.

"None of our CSUs seem to have a full record of what happened at 36 Ophiuchi, except that the homing lasers failed. *Resolution* didn't stop there and ended up here."

"Mem'ry triage," Gabe said quickly. "Takes power to correct and refresh memory—when the CSUs get low, they skip whatever ain't immediately needed. I'd guess we all been here a while. Wakin' someone up alone at the bottom of the sea is kind of the last resort."

The power needed to refresh memory was trivial, but Jacques didn't want to start out on Eddie's wrong side. He simply said, "That's interesting. Do you have any ideas, Collette?"

"Those who crashed on land may have used more power for cooling than those of us deep in the lake needed for oxygen," she said. "That's why there's still hope to rescue some more."

"You kill a dinoroo, yet Jacques?" Gabe asked

"Dinoroo? There is an animal I call a kangasaur. That's a bipedal hopper about six meters tall as an adult, pretty much hairless?"

"That's a dinoroo!"

"I almost killed one by hitting it in the head when it came at me. They've left me alone since—I wonder if they aren't able to communicate the danger to each other?"

"Wouldn't know. I got me a whole family of 'em with a spear thrower, though—great meat and useful skins. Almost like the Lord put 'em there for us. Haven't seen many around lately, though."

"Me neither," Jacques answered. "I suspect something seasonal." He saw movement on the path ahead of them. "There's Soob and Doc!" During the conversation, they'd caught up with the tree-bearers. Collette gave her emergency bag to Jacques and rushed forward to help.

With three people carrying the blackwood log, they were able to arrive at Rim Cave well before sunset. Excited by the new arrival, they talked well into the night, comparing notes. Gabe told of hunting at night, from blinds, and had observed a list of critters Jacques hadn't seen, including what he called a "roachrunner," a hairy beetlelike thing that went after any meat left out for more than an hour.

"You wouldn't believe how they fly," he said. "No sound at all. They just float up. I swatted one once; it kind of popped."

For his part, Gabe was surprised that the legs of "spinyballs," as he called the hirachnoids, were edible. Jacques offered him one of the last remaining ones, but Gabe turned it down. "Got my own meat," he said.

The next morning Jacques and Collette got up to watch the sunrise. It was even bigger and redder near the horizon.

"I don't believe this character," Collette said. "New Jerusalem?"

Jacques shook his head. "New Jerusalem is a big Baptist space colony at the Earth-Sun L4 point. We had a lot of old line Christians among the volunteers. From our point of view, it may seem like a family fight, but nobody was more ready to go after this New Reformation fringe group than the Old Reformation."

Collette nodded. "I get the picture. Well, he's going to need to realize this isn't New Jerusalem, and it isn't going to be."

"We're all in this together now," Jacques said.

"Watch," Collette said. "Just watch."

The walk from the rim down to the beach only took an hour in the relatively cool morning. The water had receded since the storm and the *Resolution II* was laid out on the sand, its five logs barely held together—mostly by the remaining lashings of its deck braces. The cargo basket was pretty much gone, but they'd brought the makings of another. With five people working, the expanded raft was shipshape again before sunset.

At daybreak the four men lifted the raft and carried it to the water. "I'm not much of a swimmer, so you three go on," Gabe said. "I'll hold down the fort here."

At that point, Collette carried a supply basket down to the raft and handed it up to Doc. She and Jacques pushed the back end of the raft off the sand, jumped on, and waved goodbye to Gabe. Gabe stood on the shore alone, dressed in his Robinson Crusoe costume, open-mouthed, then seemed to recover himself and returned their waves.

It was very hot on the lake and surprisingly still. As they rowed, they had time to talk.

"It is too bad we do not have any working electronics," Doc said.

Jacques nodded. "Given a thousand years with no maintenance, it's not that surprising. Even my photovoltaic unit didn't work."

"You thought it might?" Collette said. "Maybe we should try mine."

Focused on the rescue effort, they had been too busy during daylight hours to perform any such experiments. Collette got her emergency kit and they spread the array on the slightly rolling deck and plugged it into the kit's wristcomp. Nothing happened. They tried Jacques'. It stayed dark. Then they tried Soob's. The comp screen glowed. Jacques felt a surge of relief. Maybe they wouldn't have to reinvent everything.

"Time?" Soob said. But the screen stayed blank. The device refused to recognize any commands.

"We have power," Jacques said at last. "And five wrist comps. When we get back, maybe I can make a working one using pieces of all five."

"People!" Doc shouted. "Below us, a CSU!"

Jacques scrambled over to Doc's side and looked down—it was deep, maybe as deep as his had been.

That was hopeful.

Collette donned her emergency suit. By consensus, she and Jacques were the best swimmers. Soob tossed overboard green twine line weighted by a net full of rock to serve as an anchor and communication line. After first sticking their heads in the water to look for parrot-beaked sharks, they dove.

They came up with Edith Lu. She had spent a day trying to get her damaged CSU to release its canopy—which Jacques managed in seconds from the controls under its access panel. Once on deck, she threw her arms around Jacques and sobbed.

By sunset, they had completed their circumnavigation of the lake and counted two new companions and four nonsurvivors. Besides Edith Lu, they found social engineer Maria Lopes. Despite being in shallow water, Lopes' CSU seemed to be in the best shape, and they took careful note of its location for potential future salvage.

The *Resolution II* rowed out the next two days, crisscrossing the lake, but no more CSUs were found. Submahn, however, operating on the hunch that behavioral evolution may have had some parallels, made a trap and snared a two-meter parrot-beaked shark. He also caught a previously unseen, flat, eel-like critter and what looked to be a lacustrine version of a hirachnoid. The shark proved delectable.

When they returned, they had three more mouths to help eat it.

Leo Suretta, a weapons engineer, had left his CSU-based campsite in the forest and, like Gabe, had followed Jacques' cairns to New Landing. A small, dark man with straight black hair, he had little to say. Evgenie Malenkov, a tall, blond biologist from Coriolis, Luna, an expert in artificial ecologies, had wandered in from a CSU landfall the other side of the mountain with Arroya Montez, a diminutive cyberneticist of striking beauty, who stayed very close to Evgenie and spoke very little.

Maria Lopes was another matter entirely. A talkative forester from a Portuguese family, she almost immediately started a theological debate with Evgenie, who Jacques took to be Reformed Orthodox, or something of the sort. Lopes was Roman Catholic.

Edith Lu nodded her head to the theological discussion. "Ascendant would have loved that."

"You knew her?" Jacques asked.

"We were physical skills training partners. She was convinced the Anglican communion had found its way to a world view that was both Christian and consistent with 'the book of nature,' as she called it. She liked to quote Bacon."

"Are you part of any belief system?" Jacques asked. He'd been raised Buddhist, himself, but had given it up, unwilling to swallow the notion of rebirth, and unwilling to ignore it.

Edith shook her head, "As far as I can tell, what you see is what you get. My people have some wonderful old rituals that are fun to reenact, as long as you take them allegorically, and not too seriously at that. I suppose I'm Confucian, in a way. I like traditions and feel comfort in them, but I don't ascribe magical powers to them."

At dusk, they retreated to the cave, created more rooms, and then slept as people got tired. Sometime in the night, Edith found her way to Jacques' "room" and nestled in beside him.

"Are you sure this is wise?" he asked.

"You're the only one I know," she said. "Just hold me. Please don't send me away."

Jacques didn't. They'd had one night together while at the academy, a very sweet but unexciting experience for him. While he was fond of Edith in a brotherly way, he hadn't seen her as a partner; they were both too reticent. In a good pairing, he thought, people's natures would be complementary, filling in each other's weaknesses and abating each other's enthusiasms. He dreamed of a strong partner, to compensate for his own hesitation and diffidence.

On Day 37, the CSUs of Helen Gorgos and Dominic Oporto were found in deep water not far north of New Landing. Helen, a physicist, struck Jacques as a gentle, thoughtful lady while Dominic was short, bright, and bubbly.

After he'd recovered from his ascent from his CSU and been apprised of the situation, Dominic announced that he was not giving up the mission. "I will return to 36 Ophiuchi!" he declared. "I do not care if a thousand years have passed. If things have not changed there, I will try to change them. That is what I left everything to do, so it is my life. It is my goal."

Jacques smiled at that. "Mine as well. If I have to rebuild civilization from the stone age up to do so, I will do it!"

\* \* \* \*

Finally, on Day 39, they declared the rescue effort over. Of 200 CSUs on the *Resolution*, they had found a total of fifteen in the lake, six with live occupants. If there were others, elsewhere on this planet, they were beyond reach for now.

Gabe, who had some experience as a lay minister, led a memorial service at the lakeshore. "We give up them up to God," he concluded, "and pray for his guidance as we take up the task of our own survival."

That night, they sat around a fire on the beach and talked about what they wanted to do. They might explore nomadically as a group or they might establish a settlement, then send out expeditions. Doc and Gabe, respectively, were the proponents of these positions.

"We have much to learn about this world," Doc argued. "And what we learn will affect what we do. We may find a much better place to start a city. It is very hot here, and this is an active volcano."

"But we gotta get our feet on the ground," Gabe countered, "start acting like human beings instead of a bunch of naked savages—not that I mind the scenery, but the Lord made other plans for us long ago. Anyway, we need some place for explorers to come back to, if they run into trouble. If we all go exploring, it's a single point failure. One disaster and boom, we're all gone!"

"Smaller exploration parties would be easier," Soob said. "The surplus from the labors of the larger group can be concentrated to supply the exploration group and they can operate more efficiently, spending less time on provisioning."

"Yes, at some point," Doc said. "But it should be sited at a better place. There are four huge mountains around us. There will be some place on their slopes where the air and the temperature are more Earth-like."

"Maybe even above the altitude where the dragons fly," Collette added

Even she, Jacques thought, had started using Gabe's names for the life forms on this planet. He had, almost pointedly, refused to adopt Jacques' names, and it being a matter of no particular importance to anyone, others had begun to adopt Gabe's nomenclature to avoid confusion.

The trouble was, on the issue at hand, Jacques agreed with Gabe. Small exploration parties made more sense. The dilemma was that to support that position would be to accede leadership to Gabe, which, for some reason, bothered him greatly. But he didn't want any kind of formal leadership position for himself. He might lead by example—not by argument or politics.

The discussion was winding down without his input, in favor of Gabe's. But many were waiting for him to say something. He was, after all, the first settler and the one who had organized their rescues. That should still count for something. What could he say?

"I am," he said, finally, "going to look for a better place for a colony on this world, and, eventually, a way to rejoin the rest of humanity. But I think it would be best to spend a few weeks in this area to recover more technology and learn more about where we are. Will it be a permanent settlement? That is a question for the future. If the volcano is active, it is not very active. The cave here at New Landing is large enough to house us for the foreseeable future. We can fish. We can try growing flute plant or even bitterwood. We can forage over the rim."

Doc looked at him thoughtfully. "I would choose days instead of weeks. Each day grows hotter, and to reach cooler high elevation we must first descend into even warmer low elevations and cross an ocean. Each day we wait will make that more difficult. But I must concede we are not ready to go today."

There were murmurs of assent around.

"Well then, it's settled," Gabe said. "Now let's start organizing who does what. Arroya, why don't you get busy with the other women and come up with some clothes for us. Evgenie and Doc, we need some more fish. I'll take Soob over the rim and get some more game for us. Jacques, why don't you go up to the rim and try to figure out where we are. Okay, everyone?"

Most agreed immediately. Jacques felt something important had happened to which he should object, but couldn't come up with a clear reason or argument against anything Gabe had proposed. Even spending time on clothes—if they went up a mountain to where it should be cool enough in the hot season, it might be too cool when the weather turned. So he stayed silent.

But Collette did not. "I will go to the rim with Jacques."

Gabe frowned momentarily, then said. "Let's go, everyone. God be with you."

Suretta and Arroya stood up, then stopped as everyone else sat still.

Jacques simply stood up and nodded. The others then rose and dispersed as well.

\* \* \* \*

## **Chapter 7**

### **Finding a Place in the Universe**

Jacques thought he would be glad for Collette's company, but what he got on the ascent to Rim Cave was a tongue-lashing.

"You are letting him walk all over you," she concluded after rehashing the morning's events.

She was in the lead, and her flute plant staff sent shards of lava flying to punctuate every point she made. There was actually a kind of cadence to it; she was a natural orator, he decided. A pause in her monologue perhaps meant he should say something to defend himself.



"Really, Gabe was just making common sense observations about what needs to be done. I would have said very similar things."

"No, you would not have! You would not have relegated all the women to making clothes. You would not have ignored everything I said because I'm a woman. You would not slip in references to mythological deities every other time you open your mouth."

Jacques had to admit she was right. "Okay, he betrays his origins. That's probably the way it is on New Jerusalem. We'll straighten that out when we get back. I think Doc and Soob can keep him in check. Collette, he gave me just what I wanted; a chance to get away from politics and worrying about who does what and how everyone's going to eat. I have a couple of days now to stop and think about where we are, what we've got and how we can get back."

She stopped, turned, and walked into his arms. He held her for what seemed minutes.

Finally she said, softly, with her lips at his shoulder. "Jacques, I just do not want any part of what Mr. Gabe is dishing out. I am thinking I may just go away and start my own civilization. I would like to bring you along. Also, I have a mass murder and an individual murder to solve."

Jacques was still focused on recovering their technology base and getting out of here. "Perhaps that's a bit premature."

"Is it?"

"Collette, how can I tell? I'm an engineer. Give me an engineering problem and I fix it. I don't like fighting with people." He squeezed her a little tighter. "If there's a split, though, I think I'd rather be with you."

She kissed him, then broke away. "We have to hurry up to Rim Cave before we become dragon meat."

"Megabat meat, Collette. Megabat."

"Hey, that's the spirit," she answered with a big grin, and seemed to fly away from him up the trail in big joyful leaps.

In the cave, he and Collette spent much of the night with their multitools, a nonfunctional wrist comp, and Ascendant's CSU control module. When he was done, he had the wrist comp's power jack twist-wired into the CSU control module. That was as far as he could go without sunlight. Morning would tell whether he got it right.

There was one more chore. He took a look outside. It was hazy, but he was pretty certain that he saw distorted Orion and Antares setting in the west. It wasn't a real measurement; he didn't even know if the time of night was comparable. But what he saw suggested that their little world had completed something like half an orbit in the intervening forty rotations or so.

He went back into the cave and lay down on the space blanket by Collette.

"Uh, hi." She yawned.

"Hi. Collette, I think I've got our orbit worked out, roughly. The period should be about eighty of our days here, which is about ninety Earth days—that kind of fits with red dwarf luminosity and our atmosphere. The sun is getting larger, maybe half again the size it was when I got here, so the orbit is fairly eccentric and we're probably getting closer—approaching periastron."

"Tell me all about it in the morning, okay?" She turned away and went to sleep.

\* \* \* \*

He was up for sunrise. He stood behind the cairn marking Rim Cave and noted where the sun rose behind the small hill to the east of him. He put another cairn there. By now, he was pretty sure this line wouldn't change, but even with this primitive setup, he should be able to confirm that lack of change to a fraction of a degree.

Collette came out with some warm tanglegrass root mash for his breakfast. Thanks to Gabe's predations on the kangasaur population, they had bone spoons to eat it with. He was scraping the bowl when Collette called his name and pointed to the sky.

"Jacques, what's *that*? A supernova?"

A star had appeared in the daylight sky, well above what Jacques had decided was the projected plane of their planet's orbit. It was far too bright to be a planet, he thought. Collette was probably right.

"If so, it's not near enough to affect us, I think."

"That's the first since 2148, and we're probably the first ones to see it."

Jacques laughed. "Too bad that we cannot file a report. Well, let us see if I've succeeded in anything. This is going to take some time. While I'm at it, do you think you could draw a map from what you see from the high point on the ridge south of us?"

"On what?" Collette laughed. "Wait, I have an idea." She grabbed a shard of rock and scratched the deep ebony skin of her arm. The line stood out clearly, much lighter than the skin.

"Ouch," Jacques said. "That must hurt."

"Not much. Okay, see you later." She grinned and gave him a peck on the cheek, her left breast brushing his arm as she did so—but neither of them did anything to acknowledge this accidental intimacy.

"Be sure to be back well before nightfall; remember the megabats," Jacques said.

She nodded seriously and was off. As she left, Jacques, to his wonderment, found himself following her with his eyes. She was not what he had grown up with thinking was beautiful, particularly in her wide hips, curly hair and projecting face. Still, she moved with an easy, powerful grace. But it was her mind, he thought—its quickness and spirit—that attracted him and made her body seem beautiful.

He sighed. He would have to deal with this complication in his life later.

He spread out the array and carefully plugged it into the various wrist comps. Two of them lit up. With the multitool, he very carefully cut off the back of one that didn't work at all and one that lit. He worked painstakingly on this all day, and when he was done, he had a working wristcomp, although it could not operate without the solar array.

With the sun setting, he hurried to the highest point of the rim and queried it for any other signals. It found three. One was another wristcomp, about the right direction and distance for New Landing, another was a CSU in the forest below, and the third was apparently midway between the northernmost mountain and the easternmost mountain.

The wrist comp identified the third as the *Fortitude*, an atmospheric shuttle carried aboard the *Resolution*.

One survived! The wrist comp would never reach it at this range, but if he could get nearer...

It should be looking for them. The joy of seconds ago turned into a cold cramp in his stomach. Even if damaged in reentry, it was self-repairing and nuclear powered. Its AI should know where the CSUs went down and should be seeking them out, unless told not to.

Someone may be playing games with us, Jacques thought.

The wrist comp abruptly shut down as a shadow fell on Jacques and the array. His head spun away from the display to show a huge megabat gliding down toward him, beak open. He quickly looked around for his staff—in his excitement over getting a wristcomp working, he'd forgotten it. Nor had he thought to set up near a lava tube. The nearest trees were too far to reach before the megabat arrived.

He would make the thing work for its meal, anyway, he resolved, and started scrambling toward the trees, keeping his eyes open for sticks, loose chunks of lava, anything.

The megabat deviated from its course to follow him. About a hundred meters away now, its wings filled the sky.

Coming over a ridge, Jacques leaned far over, gathered his legs beneath him, and leaped toward the forest edge with as much strength as he could muster. Landing from his ersatz flight could be painful, he thought, but his speed had increased greatly. He couldn't spare a look back at the megabat, and resigned himself to the big crunch that would end it all. As he lost altitude, he brought his legs under him, and seeing a smooth spot, kicked off of that, staying airborne. His body, he realized, was acting as an airfoil in the thick atmosphere.

He risked a look back. The megabat had landed on its hind legs—the wing webs joined the legs far enough up the leg to let it do so—and was swinging its head back and forth between where Jacques was now and where he had been. Up close, the monster's sharp-edged beak was bigger than he was.

"Jacques!"

It was Collette. He turned his head to see her waving from a hundred meters or so down slope, on the edge of the trees, hurrying toward him.

"Jacques! Electric fields! You, me, the solar array!"

Damn! The monster must locate living prey by their electric potential, like a shark. If it thought his power supply was something to eat, the entire small community could be condemned to decades of struggle. Putting his feet in front of him, he managed a not-too-painful halt on a hillock of smooth lava.

Collette charged toward the monster, waving her arms in the air. It turned its head away from the array, toward her.

They could probably out-jump the thing, he realized; their reactions and one-g muscles might be more than a match for it. He took a deep breath and strode toward it yelling "Here, here!"

It swept its head from Collette and lunged for him, incredibly quickly. Jacques' eyes found a large, somewhat dish-shaped fragment of lava and picked it up. With more instinct than deliberation or aim, he whipped the piece of lava toward the megabat's head, using the reaction from his throw to push him down to the ground much faster than the low gravity would take him. The piece of lava missed, but whether the flying rock had distracted the monster, or Jacques had simply ducked too fast for it to follow, the beak snapped shut on empty air just centimeters above him.

There was only one place to avoid the next bite. Jacques jumped up, grabbed the neck of the megabat, and pulled himself up behind its head, his hands gaining relatively easy purchase in its hairy pelt. The

creature swung its head slowly side to side in confusion.

While trying to figure out what to do next, he felt a tap on his back.

"Fancy meeting you here!"

"Collette!" Jacques shouted. She'd jumped onto the creature as well.

"Hang on, I think we're going for a ride!" She grabbed handfuls of hair with both hands.

Behind them, vast wings rose and the creature gathered itself and uncoiled for a stately stretch into the air. The downstroke of the wings was hardly audible, but the whoosh of their backstroke was deafening.

They gained altitude like an airliner and were soon soaring hundreds of meters above the lake and the landscape.

"It's a square!" Collette shouted.

Jacques looked around. Above the local cloud cover now, he could see the layout of the land as a whole for the first time. The four huge distant mountains, indeed, formed the corners of a huge square that looked almost geometrically perfect from their viewpoint. He shook his head; what this implied seemed impossible.

"It *looks* like a square," he shouted back to Collette.

In turning back to her, he'd shifted his grip and his hand found a firm ridge of flesh, almost hidden in the hairy pelt of the back of the megabat's head. As his hand grabbed it, the megabat screeched and turned its head to the right, banking right in the process.

Jacques shifted his grip to a less sensitive place and their course straightened out.

"I think I found its ears!" he said.

A sharp bank to the left in response to a tug indicated that they must be very sensitive organs.

While it was still light up where they were, a deep shadow had quickly covered the world below them, leaving the rim of the caldera for last.

"Let's see if you can make it go down!" Collette shouted.

Jacques nodded, instinctively pushing the rim of the megabat's ear down. Its head also went down, and they descended. By pushing, tugging, and pulling he was able to get it to land in the fringe of the forest just below the rim of the caldera.

Collette laughed. "They're so big they don't have to be smart!"

With unspoken assent, both Jacques and Collette jumped for the branches of a passing blackwood tree. Just as well: on the ground, the megabat ducked its head to where its huge claws could reach its ears. Scratched, the megabat swung its head up, then, seeing them, moved quickly away, as a person might avoid a bumblebee. With a screech, it fled into the sky.

Jacques and Collette dropped from the trees, made their way up to the Rim, collected Jacques' apparatus, and made their way into the shelter of Rim Cave.

"Wow!" Collette said, "Just wow!"

Whether from the adrenaline coursing through their veins, or the mutual realization that they'd come very close to losing each other, and that suddenly mattered, they were quickly in each other's arms. When they let go, Collette had a silly grin on her face, and Jacques realized his life had changed forever. However, from natural reticence, or prudence, he said nothing.

"It's a perfect square," Collette said. "As close as I could tell, this side of the world is a perfect square with a huge mountain on each corner, and it looks flat, too, except for this hump in the middle."

"The flatness may be an illusion. Those mountains look like they stick way up out of the atmosphere."

"Uh huh, but the gravitational field should still be radial, shouldn't it? So if the side of the world is flat, and gravity is radial, and atmosphere conforms to gravity, the edges would stick out." She made a ball of her fist and put her other hand flat on top of it.

Jacques tried to visualize it. If Collette's model was right, walking out to the edge of the square would feel like going increasingly uphill, even if the side was geometrically flat. He shook his head. "This is unbelievable. The compression under the corner mountains must be astronomical! I don't see how anything in nature could do that."

Collette looked him in the eye. "We're part of nature. We could do this, someday."

"Okay, it looks like an artifact."

"Where there's architecture, there may be architects!" Collette's eyes were bright with excitement.

"How old do you think this place is?"

"Don't know. With all the vulcanism, the oldest parts of the surface are maybe on the order of 100,000 years? I don't see any craters, except maybe on the mountain tops."

"The life forms have adapted to this gravity. Maybe evolved some. I'm thinking a time scale of at least a million years. Whoever is watching over this has a lot of staying power."

Collette frowned. "A century is still a long time to me. I wonder what it's like to know so much time. Maybe we'll get to ask them. Maybe we'll even get a ride home!"

Jacques laughed, "They're being pretty scarce."

That night, they made love for the first time, and afterward, Jacques clung to Collette as if to the most precious thing in the universe to him. Then they went out and, cautiously staying close to the opening of Rim Cave, watched the stars.

"What are you looking at?" Collette asked.

"The bright yellow-white star over the North rim, about halfway up over the part of the rim lit by the north lava flow."

"Okay. It seems ordinary enough."

Jacques squeezed her hand. "Probably is. What's significant is that it hasn't moved from that position since forty days ago. I think it's our north pole star."

\* \* \* \*

## Chapter 8

## Testimony of a Ghost

As soon as the sun cleared the rim of the caldera, Jacques plugged the solar array into Ascendant's CSU. The maintenance screen lit up instantly.

"CSU, what happened aboard the *Resolution*?"

The tiny speaker below the maintenance screen produced a tinny, minimally inflected voice. "I have no records of events before atmospheric entry. During atmospheric entry, there was structural failure of Sphere 4 and this CSU was ejected at 48 km altitude."

"The same thing as with all the other CSUs," Collette observed.

"I thought as much. Ascendant was a diarist. I'm hoping she did what I did. Do you have anything from after Ascendant's revival?" Jacques asked.

"I have a command trace and redundant copies of recorded messages."

Pay dirt! "Play the recording."

Ascendant Chryse had been awake for the approach to the 36 Ophiuchi system. She was well aware that a starship was at its most vulnerable during the months it took to decelerate from almost 90 percent of the speed of light, and as a passionate opponent of the New Reformation, if they were attacked, she had wanted to know about it and die fighting back.

Great precautions had been taken; for instance, laying out the deceleration trails on the far side of 36 Ophiuchi from Sol, so that the reflection plume would be directed away from the star and shielded by the starships' bodies. Particles had been engineered to self-ionize at low temperatures. Additional rings had been added to better collimate and cool the exhaust plume.

According to Ascendant, surprise had been preserved; there was no indication whatsoever that their opponents had any idea that an invasion force was establishing itself in the 36 Ophiuchi system. But when it came time for the *Resolution* to decelerate, it had not done so.

Ascendant's voice was a mellow, throaty warble that the CSU's minimally functional speakers clearly did not do justice. "Why aren't we decelerating?" I asked. It told me someone or something had removed key components of the homing beacon system. The particles that were supposed to be slowing us down were just blowing by us. I got out of the CSU to look."

"That took guts," Collette said.

Jacques nodded.

"Everyone else was suspended in CSU fluid," Ascendant's voice continued. "I couldn't find the beacon parts—the ship couldn't either, and there wasn't time to make new ones. But I did find someone else up and about. I kept hearing things. But whoever it was has blinded the ship to himself somehow. I told the ship to wake the captain, and it said his CSU was off line. I went to his room and turned it back on—just in time.

"We woke a couple of the other crew, and they implemented the 'Ghost Ship' contingency plan, for if deceleration goes wrong. They've plotted a course that will pass near several stars near our line of flight—they'll look for habitable planets or moons as they get closer, but at best we'll be traveling for centuries. The ship put out the emergency magsail to slow down a little and change course a little. When it gets to the destination star, it passes through the star's solar wind and ultimately its atmosphere to lose

most of its velocity, using the ship's magnetosphere as a reentry shield. If it survives all that and still needs to dump velocity, it will crash into the target planet's atmosphere, break apart, and dump the CSUs. Those are pretty tough. If anyone is listening to this, I guess it must have worked. They think maybe 10 percent of us will make it.

"The captain risked a great deal by sending one low-power encrypted message back to the base in the 36 Ophiuchi Oort cloud explaining what happened and pleading for a rescue if possible. But we aren't expecting rescue—any such attempt would reveal the base and endanger seventy-plus other inbound starships. Against that, we're expendable, may the bastard that did this rot in hell! We all said our good-byes and went to sleep."

"Including the saboteur," Collette said in a hushed when the record finished. "Ascendant made it through all that only to get murdered again! What sort of monster could do this?"

Jacques shrugged. "A fanatic willing to make the sacrifice? Or maybe one who thinks that some supernatural force would intervene."

In the silence that followed he heard something skitter down the slope above him. He turned his head in time to dodge a small stone heading for them, probably loosened by the warming day. A happenstance, certainly. But he looked around anyway. We are programmed to suspect some agency in everything that happens, he thought. Even when you know it's a random event, you look. Intervening gods, or devils, are easier to imagine than pointless chance.

Collette shook her head. "The saboteur probably wiped all the CSU records before going into cold sleep himself. He might have come across her camp while she was asleep or away, read her diary, then destroyed the incriminating pages and silenced her, not suspecting she'd left another record."

She looked at him, worry on her face. She clearly had devils of the nonsupernatural kind on her mind. "Gabe. Does he know you have her CSU memory?"

Jacques went through the events of the past few days in his head. "I've not told anyone but Soob about Ascendant's CSU control module."

"We'll need to hide it," Collette said, "and bring Soob into our confidence."

"What about the shuttle?" Jacques asked.

"Assuming Gabe is the saboteur, it would be under his control, wouldn't it?"

Jacques thought carefully about that. "If the AI were intact, and convinced that Gabe, or whoever the saboteur is, had been responsible for human death, it might respond to another human authority. But someone who really knew what they were doing might have been able to degrade the AI just enough so that it wouldn't respond to higher function programming, but would still be flyable."

"So we're screwed?" Collette threw a small pebble at a nearby rock, clearly angry and not willing to submit to that fate.

"Maybe not. If the AI is intact, with Ascendant's record, I might gain control by argument. If not, it might not be able to stop me from getting physical access to the systems I would need to bring its higher functioning back on line. But there's a problem. The shuttle would certainly be programmed to report any attempt at access immediately. We'd have to be much closer to it—on site, preferably."

"Jacques, there's something else I think we should keep up our sleeve."

"Yes?"

"Our megabat ride—I'm not sure I want to do it again, but it's a transportation option maybe someone else shouldn't know we have."

Jacques nodded. "CSU, what's your power state?"

The display read 23 percent.

"That's up!" Collette exclaimed.

Jacques smiled. "But yes! We have some energy storage. CSU, what is the design width of your casing?"

It displayed 10.25 centimeters.

Jacques grinned. "We can now measure space and time accurately. We are about to leave the stone age!"

They plugged in the wrist comp and got temperature and humidity—about 35 C and 20 percent. Atmospheric pressure was a whopping 3,123 millibars, and they were at least four kilometers above the lake.

By evening, they had determined with a pendulum that local gravity was 14.38 percent of Earth's. By the next morning, they had the local day pegged at 28.25 hours—significantly longer than Jacques had guessed. By the time they went to bed, they had a working hypothesis that their world was approximately moon-sized, though somehow managing more extreme elevation differences. The orbital period was 91.48 Earth days, give or take a little—almost exactly 79 local days. It got substantially less insolation than Earth; it was hot where they were because of the deep, high-pressure atmosphere—it would probably be well below freezing at the one bar level.

\* \* \* \*

## **Chapter 9**

### **Social Issues**

They returned to the lakeshore about noon the next morning to find their small colony almost fully clothed. All the men except Doc Yu were wearing parrot-beaked fish-skin kilts. Edith and Maria were wearing muumuu-like tents. Helen Gorgos, the female exception, was talking to Doc, away from the others.

As soon as they came into camp, Edith ran up to Collette and handed her a dress.

Collette sighed and smiled at her. "Edith, I'm really comfortable the way I am."

Edith looked crestfallen and glanced back at Gabe and Leo, who were looking in their direction, then back at Collette. "I made it just for you," she said, plaintively. "Look, I even put your name on it." She held it out wide, with a hand on each shoulder.

There, just under the neckline, Jacques saw "Collette" embroidered in cursive letters on the parrot-beaked fish skin with green twine.

"Will you just try it on for me? Please?"

Collette laughed, took the garment, and pulled it on over her head. She gave Edith a hug. "That must have taken a lot of work. I'm sure this will come in handy when we get in a colder place."



Edith beamed.

Gabe came up to them and thrust a piece of cloth at Jacques. "Well, looks like at least some of us are gettin' civilized."

Jacques took the cloth with a smile, but simply held it. Then he yelled, "Come on over, everyone, I've got news."

"Hey..." Gabe said.

"Jacques," Leo said. "We appreciate what you've done, rescuing people and getting things started, but we've done some organizing while you've been away and—"

"Welcome back!" Doc said, holding out his hand.

"I was talking," Leo said, stepping between Doc and Jacques.

Jacques and Doc stepped around him to greet Evgenie and Helen.

Gabe put a hand on Jacques's shoulder. "What you being so impolite for? We got things to get clear here, about who's running things and how, and you need to listen up!"

"Stuff it, Gabe," Helen said, standing with her feet spread and her arms folded.

Dominic Oporto trotted up behind Gabe. "Something wrong?"

Jacques noted that they'd found themselves in two groups. Gabe, Leo, and Dominic with Edith and Maria cowering nervously behind them, facing Jacques, Doc, Evgenie, Helen, and Collette. Arroya and Soob were nowhere to be seen.

"Aw, nuts," Gabe said. "Look, we had a kind of election and I got myself elected mayor. It's no big deal and if you want to have another election, I guess that's all right."

"Are you sure?" Dominic asked.

"God will take care of it," Gabe said.

"Okay, okay," Leo said. "Look, we had a discussion about where we're going, what we're going to do, and why. Maybe we should have waited for you two, but there it is."

"More of a bunch of assertions than a discussion," Doc said. "With some of us a little too busy to participate fully."

"If you let me tell you what we've found out," Jacques said, "I think it will give us a better idea of what to do next. Now please give me a little room. I'm going to draw in the sand."

With some grumbling from Leo, they backed off and Jacques drew a square with his staff.

"All the land we can see is in the form of what looks to be a pretty geometric square. Now the gravity field is radially symmetric, so the atmosphere and ocean surface are spherical. So the corners of the square stick up out of the atmosphere and the oceans bulge out of the center a bit." He drew a circle inside the square. "The breathable air would be limited to a radius of something like this a few hundred kilometers from the center, where we are."

He drew a tiny circle in the center. "We are on a roughly circular island, maybe a hundred and twenty or

thirty kilometers across, with a crater lake in the middle."

He drew another pair of nested circles, leaving what looked like an archery target inside the square. "It's surrounded by forest and grassland; more forest to the east, more grassland to the west, down to the ocean shore.

"The ocean is maybe three hundred and fifty kilometers wide. There's forest on the other side, thinning out more and more as it moves out and the air gets thinner. There's snow or frost just inside the breathable atmosphere ring, then it gets pretty bare beyond that. The land looks pretty flat to the naked eye, but I got some binoculars powered up, and it's actually pretty rough—almost terraced as you go farther out."

"I don't see how this can be an accident," Collette added. "I think it's a designed place."

"The whole universe is a designed place," Gabe said.

There was a moment of tense silence. "Well, this looks like it's a little more designed than usual, Gabe," Doc said, to muffled laughter, "by someone or something with a bit of an artistic sense, or maybe a sense of humor. Jacques, you don't suppose the whole world could be a cube, do you?"

"That's ridiculous," Dominic said. "This is all just a trick of perspective. Out in space, it probably doesn't even look square. We're just in a huge crater, like Hellas on Mars, and the rim just happens to look like this from the center."

"Well, maybe," Helen said. "In any event, we're on a volcanic pimple at the bottom of a bowl, gravitationally speaking, summer is starting, and it's already forty in the shade. We're better able to stand heat than our ancestors, but still we should be thinking of moving elsewhere."

"You seem to be comfortable enough with heat," Gabe said, getting chuckles from Dominic and Leo and a bit of titter from Edith. "Seriously, we've put a lot of work into this here new town, and *if* we credit what Jacques's saying, in a few days we'll be past periwhatever and it will start getting cooler."

Helen shook her head. "No, it won't. Thermal lag, Gabe. Especially with an atmosphere this thick and massive. This is the start of local summer. Maria, I think you have something to say?"

Gabe frowned at Helen, but Maria hesitantly stepped forward. When she was rescued, she was chatty and exuberant. What, Jacques wondered, had happened in three days?

"There are only two kinds of tall trees in the forest," Maria said. "Both are well adapted to fire. It's been dry for the last ten days or so. The brush plants, edenhemp, tanglegrass, ablecane, and others have gone to seed and are drying out. The dinoroos have vanished and we haven't seen a spinyball for days. I ... I think things are getting ready for a fire. It's probably part of the natural life cycle here."

"Well, we can wait it out," Gabe said. "We got all we need right here with the lake."

"Not exactly," Doc said. "I can't do a proper analysis, but we're probably getting a lot of what we need from the plants we've been eating. Ascorbic acid definitely—nobody's getting scurvy, and we've been here about long enough."

"Aw, that's just a pointy-headed theory of yours," Gabe said. "You don't have an AI to ask."

"If the fire starts while we go through the forest," Dominic said urgently, "then we're in for a real disaster! I think we're safer here. Like Gabe says." He smiled at Gabe.

Gabe smiled back.

"This is an active volcano," Helen said. "And we're near at the point of maximum tidal stress."

Jacques looked at the north side of the caldera. What he remembered as wisps of steam had become a fairly constant cloud.

Gabe groaned, "Aw, bullfeathers! We could wait a million years for an eruption!"

"Or an hour," Doc said.

"Has anyone seen Soob?" Jacques asked.

"He's still hunting," Gabe said. "I had to come back and get things organized."

And it just so happened he wasn't there to oppose you, Jacques thought. "Where were you?" he asked.

Gabe waved a hand toward the north. "Down by where my CSU crashed. Hunting's better."

"It's getting dark," Leo said. "Let's say a prayer for him tonight and discuss what we're going to do. We can send a search party at first light tomorrow." He stared right at Jacques.

Do I challenge him? Jacques asked himself. Not over something that he's right about. "Okay, let's talk."

"Tell him, Gabe," Leo said.

"Yes, tell him," Dominic said.

"We need to think about what kind of life we're going to make here," Gabe said. "Now, I'm no New Reformationist myself; I'd been a real Christian for seventy years before I joined this expedition. But if you take away all that nonsense about the face on Mars, they have some ideas about how to organize a colonial agricultural society that really work."

"Like keeping women in their place?" Collette asked.

"There's a natural division of labor; it's in our genetic makeup. Child-rearing, making clothes, domestic stuff and all that. Most women want it that way."

"Well, I don't," Collette said.

"Okay, well, so maybe we make a few exceptions to start with. Now there needs to be some firm secular authority. We can't be forever debating on what to do. And there needs to be some spiritual authority, too, someone to remind us that we're human beings made in God's image."

Doc cleared his throat and said very softly and mildly, "I'm not going to practice or pay lip service to your religion."

Gabe waved his hands, "And I wouldn't want to make you do so. But now just think downstream a little. We get ourselves all sorts of kids, and kids can be unruly if they aren't afraid they're going to get caught. Even adults; God knows what we'd do if we didn't know someone was watching us and judging us!"

"The golden rule gives me a sufficient standard," Helen said. "The laws of the physical universe show us the consequences of our actions to others, and to ourselves."

"But we don't all have Ph.D.s in physics. What's going to keep everyone else in line? We need, I say we

need, some kind of religion, something to scare people to do the right thing that can't think it through themselves all the time. I mean, what's it going to be like when we have a thousand, ten thousand people here? What's going to keep them all in line?"

Jacques' patience was wearing thin. "We are not going to stay here and found a colony. We are going to recover our technology, build a starship, and go home."

"But how are we going to do that?" Dominic asked. "It's not possible. We've got one wristcomp and solar array that's just barely working. There are only a dozen of us. We have to spend most of our time just finding enough to eat and keep from being dragonoid meat. Be realistic. Maybe in a few years, some of us will have some spare time to work on the problem. Meantime, we need to accept reality. I think Gabe can give us some real common sense leadership, and we're going to need that to get through this."

This was the same man who, just days ago, had so emotionally stated his commitment to finishing their mission! Jacques wanted to tell him about the shuttle, but realized that would reveal his knowledge to the saboteur.

"I think someone who doesn't have a religious agenda would be more appropriate," Doc Yu said. "Helen, for instance."

Gabe shot him a look of pure contempt. "An atheist nudist! You expect *me* to follow *that!*"

Helen laughed. "No, I don't suppose you would. Perhaps we can compromise. Gabe has the energy and desire to organize things. So he can be our CEO. But we can be the board and vote on policy matters, and I would think Jacques should be our chairman. Can we make that work?"

"It seems a lot more complicated than we have time for," Dominic said.

"Do you want to split the community already?" Doc said.

"Do you?" Dominic retorted.

Leo touched Gabe's arm. Gabe nodded and opened his mouth, but before he could say anything, a new voice echoed off the rocks.

"Hello, everyone, someone give me a hand!" It was Soob, from somewhere in the dark.

Jacques ran into the shadows toward the voice and found the missing hunter dragging the better part of a kangasaur carcass on a travois of blackwood branches.

"It seemed confused, running toward the fire," he shrugged. "It was going to die anyway. So I speared it and dragged it across the river before the flames got to me."

"What fire?" Maria asked.

"Don't you see it? It's huge! Look at the sky glow over the caldera rim. The whole north slope is going up!"

\* \* \* \*

## **Chapter 10**

### **Out of the Frying Pan**

Jacques stared at the flames and tried to calculate how long it would take them to spread around the rim of the caldera. If his guess about the ecology was right, the large trees themselves had evolved to tolerate

the fire; it would be mainly the smaller brush that was burning. Flames would be less likely to jump gullies and creeks than similar fire back on Earth.

"Oh my God!" Gabe said and stared at the glowing sky. "Well, that settles it. We have to stay here where we're safe. It's a sign, I believe."

"I don't recommend that," Doc said. "We'd be trapped without an adequate food supply."

"At the risk of repeating myself, we should get out of this caldera," Helen said.

"That, apparently is what the rest of the animal life in these parts has done," Soob added.

"We aren't animals and if Gabe says we stay, we stay," Leo said. "He's our leader."

There was a moment of silence, broken by Edith Lu. "I don't think that has been decided," she said, very hesitantly. Leo shot a look at her.

It was then that the slow drift of air brought the first smell of fire. Jacques looked around. "Deliverance Creek hasn't gone dry yet. We should be able to follow that down to the coast; there are a number of kangasaur trails paralleling it."

"You shut up!" Leo said, raising his staff. The smaller man's eyes bored into him.

"What?" Jacques said, dumbfounded at the threat of violence.

"Now just hold on a minute here, both of you!" Gabe said. "We can't go anywhere tonight. Let me sleep on it. Maybe it'll look different in the morning, after you two cool off."

"Jacques doesn't need to cool off," Doc said quietly. "He didn't do anything. Leo staged that to give you an opportunity to look like a leader."

Everyone looked at Leo, who just stood there with his hands tight around his staff. Jacques spoke into the awkward pause. "We have plenty of light to see the trail," he said, waving a hand at the sky glow. "Let's gather things up and get going. We can spend the night at Rim Cave."

"Too risky," Gabe said. "Dragons up there."

Dominic Oporto shook his head. "I'm with Gabe. I'm not going out there to get fried just on the chance the volcano might burp. We can eat fish until the fire's over."

There was another long silence, with people staring at each other. Leo brought his staff down slowly and Jacques took a deep breath. His own hands, he noted, had clenched into fists with such force that his fingernails had dug into his palms. Low gravity beside the point, weeks of unremitting physical labor had hardened his body. Staff or not, he probably would have little trouble in a physical confrontation with Leo. Perhaps what was in the other man's eyes was as much fear as anger.

"You need more than fish," Doc said.

"Perhaps splitting up is not such a bad idea," Helen said. "If there is risk in both directions, our overall odds of survival are better if we try both. Assuming even odds, that would give an overall probability of success of 75 percent. The successful group can rescue the other, if need be."

"The question is who's in charge," Leo said. "I say it's Gabe, and if you walk out on him, you're gone and don't look for any rescue."

"I really believe we're better off staying together here," Oporto said. "I just know it."

Gabe nodded and waved an arm. "Okay. My decision is to stay."

Jacques looked around. Collette and Soob had already gone back into the cave to gather things. Helen turned and walked in that direction as well. That left him, Gabe, Leo, Dominic, Maria, Arroya, Doc, and Edith. Maria looked down, not meeting his eyes. Edith looked to be on the verge of tears, but stayed where she was. Gabe and Leo, Jacques thought, had chosen their own fate, but he felt responsible in some way for the rest.

"Arroya?"

She was looking at Collette, almost in fear. She shook her head sharply.

Evgenie attempted to dissuade her, but she wouldn't move. "I need to stay with her," he said.

"Edith?" he asked.

She glanced at Collette, then looked down at the ground. She'd had her heart set on him, and he, in her mind, had deserted her for Collette. Jacques felt awful, but was unable to give Edith what she wanted.

Doc walked over to Jacques, put a hand on his back, and nodded to the cave. Jacques followed him. The sooner gone the better, he decided.

When they emerged, set for their journey, the remaining group made no quarrel with the division of the few common resources and pretty much ignored them. Except Gabe, who walked with them to the trailhead.

"Are you sure you won't reconsider?" he said, motioning to the glowing red sky. "Looks pretty hot out there."

Jacques hesitated. Was Gabe a saboteur and a murderer? Somehow Jacques didn't think so; the man seemed too sure of himself and his beliefs to stoop to such tactics. Should he warn Gabe that among those remaining was probably the author of their entire situation?

Yet Gabe might still be that person himself. Or Leo, hiding behind Gabe. Or someone hiding from the group. Or anyone, Jacques thought. With a surreptitious power source, even the people they'd pulled from the CSUs could have gone out and in again, he thought. His next thought was that he was getting paranoid.

He shook his head and without another word turned and headed for the ridge. He did not look back, even when he heard Edith sob.

\* \* \* \*

The scene when they reached the rim, about local midnight, was surrealistic; the inferno from the North side of the caldera had extended fangs of fire into the area between the rim and the sea—a vast glowing upper jaw. Underlit red and gold clouds laced with black and gray roiled into the sky above. The air smelled of soot and a dull crackling roar, still distant, banished silence.

"We shouldn't stop to sleep," Helen said, clearly appalled at the scene to the north. "The coast could be a day or two away, even at a downhill lope."

"I think Jacques has something else in mind," Collette said.

Jacques shook his head. "Not unless we're very lucky. There's a river valley to our south that we can follow down. It hasn't gone dry; I think it's fed by the lake in the caldera through an underground passage. There are pools along the way. If the fire catches us, we duck. The slope flattens out toward the coast. I'm hoping for better foraging there."

"And what if we get lucky?" Soob asked.

Should he tell them? What if one of them decided to go back to Gabe?

You can't avoid all risk, he decided. "We get a megabat to give us a lift." Jacques recounted the flight he and Collette had taken. "We're a lot quicker than they are; they're basically carrion eaters, not hunters. I'm hoping the misfortune of some kangasaur along the way will prove our fortune. It takes some nerve but once you get on, you can steer them by pulling on their ears."

"You're serious?" Doc said.

"He certainly is!" Collette said.

"Okay, okay." He shook his head. "We should take at least a couple of hours rest here; we'll get the time back by being more alert and making better decisions on the trail below."

There was general assent to that and people headed for the cave. Inside, Jacques went to where he had hidden his electronics. Did he want to lug Ascendant's CSU control module along with everything else? He decided not to; he knew what was on it. But he did pull its memory chip. The shuttle computer might be able to get more out of it than he could. With that done, he turned in, about an hour later than everyone else.

\* \* \* \*

Morning was like waking up in an oven. The smell of smoke was everywhere now, and the sky was a red blanket, lit from beneath by the fires in the north and only somewhat lighter in the direction of the sun. Jacques assembled the small group for the dash to the sea. It was 48 C at 3600 plus millibars. Fortunately, there was plenty of water, even if it was warm. Everyone was quiet and apprehensive; the next two days would likely test them physically and mentally as nothing in their life had ever done.

But before they left, Collette wanted to have a word with everyone.

"As some of you know, or have figured out, Ascendant Chryse was murdered."

"What?!" Helen exclaimed.

Doc simply nodded, and Jacques had already told Soob.

"She was camping in her CSU. Someone came by at night and cut the power from outside, locking her in and suffocating her. Whoever it was left fingerprints on the control module and the sides of the CSU." Collette held up a small thick rectangular card, about half the size of the palm of her hand. "My micro crime lab. It does fingerprints, voice recognition, DNA matching, and a number of other things."

Jacques stared at her. He knew she was a policewoman, but had just assumed that circumstances had left that far behind. But if he looked back, there were clues. The long time she'd spent on the hunt before they'd taken the ride on the megabat. The careful attention she'd paid to everything. He gulped, suddenly realizing his own prints were all over Ascendant's campsite.

"It's not an AI, Jacques. I wouldn't have held back on something useful. Anyway, the same person may have been responsible for the sabotage of our mission and our present predicament. I'm 90 percent

certain it was nobody in this group."

"We were all under water!" Soob said.

"One can swim up and down from a submerged CSU, as long as it has enough power. And our perpetrator would have been able to plan in advance. What I'd like everyone to do now is to come up and touch the mini-lab. We all need to trust each other, and be sure. Then I'll explain everything. Jacques?"

"But my prints are all over her CSU!"

"Two days after she expired, and during the day."

"That can tell the difference?" Soob asked, in wonderment.

"It can date fresh prints within about 12 percent. I already have Jacques' prints," she smiled at him. "Soob?"

He shrugged, walked up, and touched the device where Collette indicated. Helen and Doc followed. There were no matches.

"Now I hope we get to hear what this is all about," Helen said.

Collette nodded to Jacques.

"Okay. There's an intact starship shuttle on this planet," he said and pointed west. "That way. We think we can take control of it, if we can reach it physically."

"Then we'd best get going," Doc said.

\* \* \* \*

They jogged, rested at a walking pace, and jogged again. The high oxygen content and the downhill slope helped; however, their lack of calories made them tire easily. As the day wore on they spent less time jogging and more time walking. The kangasaur path that roughly paralleled Deliverance Creek grew wider as they descended.

"It's almost like a river itself," Soob remarked during a water break at the creek's edge. "Other paths join it."

"A migration path, maybe," Jacques noted. He wanted to sleep. More than anything else, he wanted to sleep. The sun had probably set, but with the fire glow lighting the sky, it was hard to tell.

"Dry down here," Helen said, snapping a desiccated flute plant stem. "Hot." She ducked out of her bag, pulled her boots off, and picked her way into the creek. It still ran vigorously, but it was easy for Jacques to see where its normal boundaries were.

"I'd join you, but I'm too tired," Collette said.

"Listen," Doc said. "That crackling noise. The fire must be getting near."

Three hundred meters upstream, a stand of flute plant burst into flames, without any spark that anyone could see. Quickly, its neighbors caught fire.

"Let's get in the creek," Soob said.



But Helen, who was already in, did the opposite. "It will be filled with burning logs in minutes. I think we have to run for it."

For the moment, fear banished fatigue, and soon they were jogging down the trail again.

But in a few minutes, the adrenaline rush ran out. Fantasies of heroic leadership dying, it was Jacques, himself, who hit the wall first. Perhaps because he was a bit larger, or because he'd been subsisting on a native diet longer, or perhaps because he'd had less sleep. Or all of that.

"I can't go on," he said as he collapsed. "Muscles won't move."

Doc came back for him and pressed a small patch on his arm. "Only a few of these," he said. "I've saved them for emergencies. It should give you another couple hours, then you're out."

Jacques felt a sort of coolness flow through his body. He shivered, then found he could stand. Doc looked at him and nodded. Two hours would not be enough, and they both knew it.

An hour and half later, Jacques started to slow down again. The world reeled around him. "Collette," he tried to call out, but it was only a whisper.

Soob saw him stumble and came back to aid him and called for Doc to help.

"Eureka!" Helen yelled from somewhere in front of them. "It's a lake!"

"Come on, guy," Doc said. "Just another hundred yards or so."

Later, Jacques would swear that Doc said that at least five times before he fell into the water.

Wall of flame rose around him as he was towed to a hillock of pahoehoe lava in the lake. It was free of vegetation—probably underwater most of the year. The smooth rock felt cool on his back as he lost consciousness.

\* \* \* \*

## **Chapter 11**

### **Flight**

Jacques woke to devastation. In place of trees, skeletons of white ash stood like ghostly Ents beyond the shores of their refuge. The forest floor was as white as if covered by snow. The sky above was gray now, though red-tinged toward the west horizon. The air smelled and even tasted burnt.

"Good morning," Soob said, from somewhere behind him. "Doc caught something!"

It looked vaguely like a catfish with three sets of lobed fins and a horizontal tail.

"I hope you like sashimi," Collette added.

There was, Jacques realized, nothing combustible left within many kilometers to cook with.

The meal was woefully inadequate, but too much better than nothing to complain. They ate it silently, packed up, forded the lake, and headed west. With no point in hurrying any longer, they tried to move as efficiently as possible.

"Another day," Helen said, then asked, calmly, "Are we going to last another day?"

The ground crunched beneath their boots and staffs as clouds of ash flew up to coat their bodies. They passed a scorched Kangasaur. Someone I knew? Jacques asked himself, but he didn't have the energy to examine it closer.

"Think about lasting another five minutes. Then do that again," Doc whispered.

Jacques' vision focused on the ground ahead of him. Not five minutes, but one more step.

No! He shook himself. He could not give up; he was supposed to be their leader. He had to think ahead, see ahead. Angry with himself, he straightened up and looked around and up. Then he saw the shadow coming down at them.

"Megabat," he croaked. "Overhead."

"Another one, to our right!" Soob pointed. "Two. Three."

All over the sky, huge black crescents emerged from the haze, gliding downward.

"Appears they've just been invited to a barbie," Soob said.

There was nowhere to hide or take cover, absolutely nowhere. The megabat Jacques saw got lower and lower, headed directly for them. Too exhausted to run, they huddled together, with Collette, who seemed strongest, in front. The great beak on its thick neck opened wide and Collette waved her staff at it—a disparity in force so incredible that it would have been humorous but for the desperation of their situation.

Then, with a downbeat of its wings that sent ash flying up all around them, the monster sailed over them for the dead kangasaur upstream.

"It's about ten times our combined mass and no resistance," Helen observed.

Jacques found his voice. "Collette, if we can get on that thing..."

Doc and Helen looked at him as if he were crazy, but Soob, the hunter, smiled.

"It's busy with the kangasaur," he said. "It would hardly notice us if we jump up on it."

"I can barely lift my arms, let alone jump," Helen said.

Doc reached into his pack for a couple of boost patches. "I don't think any of us are in shape to do much jumping. But if two of us take these, we'll be able to help the others on."

"We can rope ourselves together," Helen suggested. "Collette, you've done this before. Jacques shouldn't have another dose, Doc has to monitor us, and Soob, you're stronger than I am. It should be Soob and Collette, I think."

Everyone murmured an assent. Collette was already into her kit. "We should put our suits on, too. Hard to believe now, but it can get cool up there."

Moving as quickly as they could, they washed off in the river. Lack of towels was no problem—in the desiccated air, they were dry by the time they climbed back up to the trail. Once in the suits, except for the long beards on the men, they looked civilized again. Along with that, having their fill of water to drink and the anticipation of the upcoming adventure raised spirits. Doc administered the drug to Collette and Soob. Then they all approached the feeding monster from behind. It had been diligent; the kangasaur was half gone.

The megabat shivered slightly as Collette clambered up its stubby tail and onto its hindquarters, but didn't pause from its grisly meal. One by one the rest of the party followed, stepping into Soob's hands to be boosted—essentially to be thrown—onto the megabat back. Then there was nothing to do but wait.

Helen and Soob were already asleep in the soft fur between the megabat's shoulders, safely secured between Doc and Helen, when it decided it was satiated and took flight. Jacques grabbed the fur and stuck his head up. Collette was on the beast's neck, ready to try to guide it toward the ocean.

But that proved unnecessary. Riding on a powerful updraft from the fire, the megabat gained a tremendous altitude, then headed for the far shoreline on its own. Amazingly, except for the smoke and haze over the island, the entire sky seemed devoid of clouds. The land below was a perfect square, the ocean a huge circle inside of it, and the island a target in its center. Megabats—Jacques estimated perhaps as many as a hundred—circled over it, not unlike buzzards over a corpse in a desert, though the scale was a hundred times larger. On the shoreline, still green and moist, he saw kangasurs in the surf, fishing like bears with great swipes of their forearms. Then the shore passed beneath him, and soon they were over a vast ocean.

Collette released her hold on the monster's ear, worked her way back, settled beside him, and roped herself to him. They kissed briefly and she fell asleep. Too far out to think about swimming back, they were going wherever this megabat was going.

\* \* \* \*

Two hours out over the ocean, when Collette and Soob revived enough to listen, Helen held forth. She had rigged a circle of lines on the megabat's back by braiding patches of megabat hair into short ropes that could be knotted to their lines. With this, everyone felt more secure, though the megabat had hardly tilted at all during the flight.

"So I think Doc's cube world idea is correct," she concluded.

"On this side, anyway," Soob said, "the biosphere is a fluid bulge on a square face."

"Indeed," Helen responded. "The ocean and the atmosphere respond to gravity and intersect the cube in circles. See how the snow line curves up toward the mountain peaks? If there were only four mountains, the thing would be unbalanced, I think. It works better as a sphere with eight huge mountains the shape of triangular pyramids, arranged symmetrically."

"Why don't the mountains collapse?" Soob asked. "My memory is a little hazy, but I thought planets this size would inevitably assume a more or less spherical form."

Helen shook her head. "They should. I can only guess that the mountains are made of something very strong and lightweight. Made is the operative word. I think this is a manufactured world."

"But why would anyone do this?" Collette asked.

"The mountains and the ridges connecting their peaks extend beyond the atmosphere," Soob observed.

Helen nodded. "All but the last traces. Each face of the cube would be isolated from the other faces, for things not able to travel through vacuum. It could harbor six separate biomes, but each with the same insolation and resources."

"A zoo?" Jacques speculated. "With life forms from different worlds?"

"You wouldn't need a perfect cube for that," Soob said. "I suspect some esthetic motivation as well—form and function. It's architecture on a scale we've only begun to think about. I'd like to meet

whoever came up with this."

Everyone fell silent at that point, gazing at the incredible sight below them. Jacques felt an unjustified, giddy relief. Saboteurs, murderers, and fire lay behind them. In the alien forests and cliffs ahead of them, somewhere, was a link to the civilization they had lost. If they could find it. If they could feed themselves. If they could avoid being eaten.

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*TO BE CONCLUDED.*

[\[Back to Table of Contents\]](#)

Science Fact: **ROCK! BYE-BYE, BABY** by Edward M. Lerner

What can we do about the remote but potentially catastrophic danger of Earth-asteroid collisions? Some people are beginning to take the question seriously....

In the early morning of December 14, 1807, something streaked across the sky above Weston, Connecticut and exploded. At least six rocky fragments reached Earth, the largest (now on display at the Yale Peabody Museum) weighing twenty-eight pounds. Yale University professors Benjamin Silliman and James L. Kingsley collected fragments and published a detailed report in the *Connecticut Herald*.

Upon first learning of the incident, President Jefferson said, "I would more easily believe that two Yankee professors would lie than that stones would fall from heaven." [1]

Times change.

That objects fall to Earth from the sky is now common knowledge.

This is (as I write) the hundredth anniversary year of the Tunguska Event, in which an aerial explosion (the site did not show an impact crater) from an asteroid or comet flattened and burned forest across a broad expanse of Siberia. Atmospheric disturbances extended to Western Europe, with Londoners able to read newspapers by the night sky's sudden eerie luminescence. [2] And an asteroid or comet strike is a leading explanation for the sudden disappearance of the dinosaurs—the so-called Cretaceous-Tertiary extinction event.

*Atlantic Magazine* recently ran an article, "The Sky Is Falling." [3] That article was headlined with the provocative teaser: "The odds that a potentially devastating space rock will hit Earth this century may be as high as one in 10. So why isn't NASA trying harder to prevent catastrophe?"

Is Earth wearing a bull's eye? We'll look at that, relying on more primary sources, and at realistic approaches toward handling space-rock hazards. We'll also consider obstacles to preparing—and motivations beyond fear for developing—a planetary-defense capability.

First, let's get some definitions out of the way.

\* \* \* \*

### **Meteoroids and Asteroids and Comets (Oh, My)**

What *might* smack into Earth?

Many more things than planets (however defined—I won't go there) whiz about the solar system. We call these sub-planetary objects:

\* meteoroids, if boulder-sized or smaller (and meteorites if they survive reentry and reach the Earth's surface), or

\* asteroids, or,

\* comets, if they exhibit a coma (gaseous envelope).

Meteoroids, by definition, are too small to endanger many people or any significant area. Only size distinguishes asteroids from meteoroids.

Asteroids orbit mostly between Mars and Jupiter, in the too inclusively named Asteroid Belt, at a distance from the Sun of between about two and four astronomical units [4]. Of course, if *all* asteroids

orbited in that belt, this would be a short article. And maybe dinosaurs would still rule the Earth.

The threat to Earth comes from Near Earth Objects (NEO). How near? The current standard is approaching within 1.3 AU of the Sun. Stated another way, a NEO is anything that comes within 28 million miles of Earth's orbit.

Astronomers distinguish several populations of near-Earth asteroids. Generally speaking:

- \* The Aten asteroids orbit within Earth's orbit.
- \* The Amor asteroids approach from the outside, but do not cross, Earth's orbit.
- \* The Apollo asteroids have orbits that cross Earth's own orbit.

NEO can be comets rather than asteroids. Short-period comets originate in the Kuiper Belt, a disk-shaped region that begins beyond Neptune, about thirty AU from the Sun, and extends (depending on whose guess you favor) to fifty or fifty-five AU from the Sun. Long-period comets, it is hypothesized, originate in a spherical region even larger and more remote (and whose existence remains speculative): the Oort Cloud.

Asteroids and comets generally differ in composition. The ice line marks the distance from a star at which water can condense as ice. For our sun, the ice line is at about 2.7 AU—within the Asteroid Belt. Water evaporates from objects that orbit within the ice line, and is driven outward by the solar wind, possibly to condense in the outer solar system. Other volatile materials (like ammonia and methane) behave in similar ways and have their own ice lines.

Objects originating in the inner solar system generally consist of rock or metal. Objects originating in the outer solar system add ices of various kinds. We call the latter comets. If a comet has an eccentric<sup>[5]</sup> orbit that crosses the ice line(s), sunlight starts turning the volatile materials to gas. Gases escaping the object's usually minuscule gravitational attraction, and any dust carried away by the gases, are pushed and shaped by the solar wind to form the comet's tail.

Most space-rock discussions focus on asteroids. Comets certainly can be dangerous, but their long, slow orbits are much harder to characterize. Known and suspected asteroids with Earth-approaching orbits far outnumber known and suspected comets with Earth-approaching orbits.

Not all objects represent the same threat. Size is a factor, obviously, but it's not the only factor. Speed of encounter (the net velocity difference between Earth and space rock) matters, naturally. Composition also matters. Metallic objects will better survive an atmospheric passage than stone. Solid objects survive better than loosely-packed rubble piles. And the angle of impact matters. Objects entering the atmosphere at a shallow angle undergo more friction from entry than rocks entering at a steep angle.

Solar-system objects do not have fixed orbits. True, many objects have *stable* orbits. They must, because the solar system has an age on the order of 4.5 billion years. The familiar planets have avoided a plunge into the Sun or being hurled into the interstellar darkness. Still, forces are constantly at work on orbiting objects, including the gravitational perturbations from other orbiting bodies, tidal drag<sup>[6]</sup>, the propulsive effects of gas eruptions, and light pressure.

When orbits change, things can collide...

\* \* \* \*

## **Expert Opinions**

The Asteroid Deflection Research Symposium (ADRS), held October 23-24, 2008, in Arlington, VA,

drew invited attendees from concerned U.S. government agencies:

- \* the National Aeronautics and Space Administration,
- \* the National Research Council,
- \* the National Science Foundation,
- \* the Air Force,
- \* the Defense Threat Reduction Agency (part of the Department of Defense)
- \* the Department of Energy, and
- \* the Department of Homeland Security.

A small number of attendees came from academia (especially from the aerospace department of Iowa State University, organizer of the event), the aerospace industry, and science-oriented media outlets. A few were science-fiction authors like me.[7]

ADRS was hardly the first symposium on the topic of planetary defense, but it was *my* first. It appears to have been a good place to start. The organizers kept the conference small to facilitate candid discussion—and succeeded. Most attendees stressed that their presentations and participation reflected personal opinions and not the official viewpoints of their organizations. For that reason, I have not attributed information to individual participants.

ADRS provided the original impetus and much of the source material for this article.

\* \* \* \*

### **How Serious Is the Threat?**

The conference opened with an overview of the problem. Congress has tasked NASA to survey the threat from NEOs. NASA's Near Earth Objects Program maintains a running count of the findings at [neo.jpl.nasa.gov/stats/](http://neo.jpl.nasa.gov/stats/). New NEOs are found more or less daily; discovery trends suggest the cumulative number of such objects will reach 6000 in 2009. The count of large objects, a kilometer or more across, will likely reach 800 during 2009.[8]

A kilometer—besides being a nice, round number—is about the size at which a rock's impact would have global repercussions. (One kilometer isn't yet dinosaur-killer sized: that impactor, whether an asteroid or a comet head—a question still in dispute—is estimated at about ten kilometers.) Initial effects would include fireball, air and ground shock waves, and (with a water impact) tsunamis. Dust and debris would add acid rain, diminished sunlight, and secondary impacts.

How precise are the statistics? That's open to debate.

- \* The search has used telescopes neither designed for asteroid hunting nor dedicated to the task.[9]
- \* An object must be observed several times to derive its orbit. A “new” discovery may prove to be a repeat sighting of an object whose orbit had not yet been characterized or has shifted. The less massive an object, all other things being equal, the more likely it is that the object's orbit will change with time.
- \* Objects this small aren't round, being too small for gravity to have collapsed them into a generally spherical shape. Glimpses of a rock from different sides differ, complicating the recognition, sizing, and orbital-determination problems.

\* Size estimates often derive from a pinpoint of reflected light. A dark rock is harder to spot than a light rock. Size estimates derive from estimates of both average asteroid albedo—we don't have up-close data about very many asteroids—and distance. The sizing model will mistakenly conclude that a dark rock is smaller than it truly is.

\* \* \* \*

Here's the good news: a decreasing rate of discovery for large NEO. This suggests that we've found most of them.

The not-so-good news: It doesn't take a kilometer-sized rock to do a lot of damage. Impact of a rock as “small” as 140 meters would cause a regional disaster. In 2005, Congress tasked NASA to find 90% of such medium-sized objects by 2020. Congress did not provide funding for this mandate; NASA's current forecast shows it missing the deadline by a few years.

The most worrisome NEO are dubbed Potentially Hazardous Objects (PHO). These are large objects—about 500 feet or greater—whose orbits approach too close to Earth. “Too close” is defined as a 0.05 AU: about 4.65 million miles. In comparison, the mean Earth-moon distance is about 240 thousand miles.

NASA's NEO Program has identified about 1,000 PHO.[10]

Sky surveys probably won't give much warning of potentially dangerous comets (mostly Kuiper Belt Objects with highly eccentric orbits). Until a comet begins to show a significant coma or tail—i.e., as it gets closer to the Sun—it is very difficult to spot and track. Even short-period comets have orbits of decades (the famous Halley's Comet has an orbital period of seventy-six years), so modern surveys have likely characterized very few of them.

The bigger the rock, the rarer, of course. Table 1, adapted from NASA's 2006 Near-Earth Object Survey and Deflection Study[11] and several ADRS presentations, gives one view (based on a variety of estimates, uncertainties, and assumptions) of the probabilities. The bigger the rock (all other things equal), the more dangerous. Estimates vary, but impact by an object as small as 50 meters might deliver five to nine megatons of energy.

And that alarming forecast in *Atlantic*? Sky surveys do not back it up. Nor does the historical record. Nor, in fact, does the article itself. Its only substantiation is an expert's statement citing—without context, definition, or explanation—“a one-in-10 chance per century of a dangerous space-object strike.” For *some* level of danger, that is certainly true.

\* \* \* \*

### **A Case in Point**

When first discovered in 2004, the asteroid now named Apophis 99942 was given a 2.7% probability of hitting Earth in 2029. In its longest dimension, Apophis is believed to measure about 220 meters—which, as Table 1 suggests, would make its impact unpleasant. Refined orbital estimates for 2029 now predict Apophis won't come any closer than 18,300 miles—from the Earth's *center*. That is, Apophis might pass inside the orbits of the geosynchronous communication satellites. (Because of the angle of approach, the satellites aren't at risk.)

\* \* \* \*

**Table 1.** Risks of, and from, asteroid/comet encounters.

\* \* \* \*

As for Apophis' return visit in 2036, there remains an estimated 1-in-45,000 chance of a collision with



Earth.

Why state collision risks as probabilities? First, orbit determinations are statistically derived from NEO sightings whose estimates of position and velocity unavoidably include a measure of uncertainty. Second, orbits can and do change over time, influenced by rarely known details like mass, spin, absorption and reemission of sunlight, and the gravitational influence of other asteroids. Even the influences of major planets are inexact since planetary orbits themselves are known only through estimates. The uncertainty in Apophis' nearest approach in 2036 is millions of miles. The most likely separation that year is a comfortable 0.32 AU.[14]

\* \* \* \*

### A Small Success

NASA's rock-tracking prowess recently had its fifteen minutes of fame. On October 6, 2008, the NASA-funded Catalina Sky Survey identified a small (few meters across) NEO dubbed 2008 TC 3 and predicted its atmospheric entry over Sudan the next day. The object did, in fact, burn up in the atmosphere over Sudan exactly as predicted, releasing an estimated one kiloton of energy.[15]

\* \* \* \*

### When Push Comes to Shove

If an asteroid or comet is headed our way, there is really only one thing to do: Shove it into a slightly different orbit. The difficulty, of course, is that an object large enough to be dangerous carries a *lot* of momentum.

Let's consider the mass first. As one idealized asteroid, we'll assume a sphere[16] fifty meters in diameter, with the density of a typical stony meteoroid: about 3.5 grams/cc. This sphere masses about 229 million kilograms (or about 500 million pounds). As a second example, consider a 150-meter-diameter sphere—barely meeting the size standard for a PHO. This time we'll assume a composition like an iron meteoroid: 8 gm/cc. *This* sphere masses about 14.1 billion kilograms (or a bit over 31 billion pounds).

\* \* \* \*

**Table 1.** Representative collisions.

\* \* \* \*

Next, we'll consider velocity. Meteoroids typically reach Earth with velocities in the range of 10—70 kilometers/second (or about 6—43 miles/second). Earth's atmosphere slows most meteoroids down to terminal velocity, but would hardly affect anything as massive as our example asteroids.

Consider a mass  $M$  traveling at velocity  $V$ . (For simplicity we'll assume the object isn't spinning. Spin would contribute angular momentum and rotational kinetic energy.) Elementary mechanics gives us:

\* \* \* \*

$$\text{Momentum} = MV$$

$$\text{Kinetic energy} = 1/2 MV^2$$

\* \* \* \*

The squared term in the kinetic-energy formula means the total energy goes up rapidly as velocity increases. Twice the velocity means four times the kinetic energy. When the asteroid comes to a halt—stopped in its tracks by the far more massive Earth—that kinetic energy turns to heat and shock waves.

Table 2 shows the momentum and kinetic energy involved if our sample asteroids strike with representative velocities. For comparison, there's a row for a fully loaded tractor-trailer traveling 65 miles/hour. The values for momentum and kinetic energy are shown in scientific notation—millions and billions hardly suffice. The kinetic energy of impact is also shown in equivalent megatons of explosives.

For reference, the largest atomic weapon ever tested had a yield of 50 megatons.

\* \* \* \*

## When the Sky Really Is Falling

To deflect an imminently dangerous (per Table 2, read: massive and fast approaching) asteroid requires a large push. Conclusions at ADRS differed on many topics, but on one there was near unanimity: Nuclear explosives are the technically superior—and in many cases, the only currently practical—defense against an imminent PHO strike. Intuitively, that's reasonable. Shifting the orbit of megatons of rock or metal will take megatons of energy.

In principle, nuclear deflection is straightforward. A nuclear detonation near (or within) an asteroid releases a flood of gamma rays (very energetic photons) and neutrons. The radiation vaporizes part of the asteroid; the spewing gases create thrust. The radiation itself also delivers a push.

Alas, we know so *little* about asteroids, and that ignorance creates uncertainties about the effects of an explosion. The radiation absorption depends on the elemental composition of the asteroid. The asteroid's composition also influences what fraction of neutrons is blocked—absorbed by material already boiled off by the faster-moving photons. A blast might break an asteroid into pieces still headed our way, many still large enough to be dangerous. Or the fragments might coalesce over time, drawn together by their mutual gravitational attraction.

Delivering a nuclear device adds complication. The asteroid is a fast-moving target. Putting a spacecraft at precisely the correct spot and detonating the device at exactly the right instant as the spacecraft speeds past stretches the limits of navigational practicality.

The ideal detonation position is far from obvious. While ADRS presentations considered optimum detonation positions for idealized asteroids (and results varied), real asteroids won't be ideal. Optimization should take into account the target's shape and composition. An ill-timed detonation near an asymmetric object will waste energy by uselessly altering the object's spin.

Split-second timing for a flyby detonation is not the only approach. Another option is a rendezvous mission, whether to take up a position near the object, make a landing, or (with a multi-part payload) both. On the plus side, a rendezvous allows close-up study before making the targeting decision (or decisions, because the spacecraft might bring multiple devices). On the negative side, decelerating to orbit or land on the PHO expends more fuel and time. Carrying more fuel means bringing a smaller payload—hence, all other things equal, less ability to deflect the PHO. If the target is a comet, the coma is both a barrier to observation and a source of debris potentially hazardous to the spacecraft. Loitering near a comet might reduce the odds for mission success.

If a PHO on a threatening trajectory allows us more lead-time (i.e., if we discover the PHO and characterize its orbit early enough), the mission constraints are eased. A small orbital change made well ahead of time may suffice. In this case, the payload might simply be a high-energy impact device. Like bullet-hitting-a-bullet missile defense—and ABM programs deal with a closing rate of “only” about 8 km/sec—direct impact is a tough problem. A near miss with a nuke has some effect; a near miss by a kinetic impactor does nothing. Like a nuke, any major explosion or impact risks fragmenting the object.

\* \* \* \*

## **Nudge, Nudge**

What if a PHO allows us lots of lead-time? Then more subtle methods may suffice to change the object's orbit. Even sunlight, given enough time, might do the trick—just paint the object white.[17]

Slightly faster-acting would be a structure that alters the sunlight pressure on the NEO. A huge solar sail, perhaps configured as a parabolic reflector (to concentrate the sunlight), is one approach. A solar sail kept between the object and the Sun becomes a solar shade; it reduces the incident light. Such structures must be huge to have much effect, even over long time spans. Huge here means hundreds of meters in diameter. The structure will be tricky to deploy and, however thin the material, massive. And while the science of solar sails is well established, solar-sail propulsion remains—after several attempts—an undemonstrated technology.

One could install a propulsion device on an asteroid. It's unlikely we could deliver enough fuel to appreciably change an asteroid's orbit, but perhaps fuel could be produced in situ. Or perhaps solar cells can power an electromagnetic rail gun, using parts of the asteroid itself as reaction mass. Or a solar-powered laser on a standoff spacecraft could boil off asteroid material.

The gravity tractor is a particularly elegant concept. Place a small payload, the tractor, near the PHO. Gravity draws tractor and asteroid toward each other. Now, slooowly—so as not to overcome the weak attraction—move the tractor. The asteroid follows. The gravity tractor operates over a long period of time, so low-thrust, solar-powered propulsion is needed.

The tractor's propulsion could come from a solar sail or ion thrusters powered by an array of solar cells.[18] Using solar-sail propulsion, there is only one position for the gravity tractor: where light-pressure thrust on the sail balances the gravitational drag between asteroid and tractor. That positional restriction makes this sort of gravity tractor a single point of failure. If anything should go wrong, we lose our defense against the object that was being towed. A single ion-thruster-propelled gravity tractor is also a single point of failure. A constellation of solar-cell-equipped, ion-propelled gravity tractors, however, would have redundancy if single units failed.

So a dramatic intervention or (time permitting) something subtle? On the one hand, non-contact methods work very slowly. The mechanism must work flawlessly—or be deployed with sufficient redundancy to cope with failures—for many years. On the other hand, non-contact methods avoid the risk and uncertainties of fragmenting the PHO. Given how little we know about specific asteroids and comets, that is a major plus.

With so much relevant technology yet to be proven, and so few asteroids and comets yet explored, it's premature to commit to one or two defensive measures. We cannot yet know in detail how space objects would respond to nuclear detonations or kinetic impacts, or whether in situ resources can be used to change space objects' orbits gradually.

\* \* \* \*

## **Progress**

Enough dwelling on what we don't know. We've learned a great deal about asteroids and comets in the past few years ago, thanks to:

- \* NEAR-Shoemaker: rendezvous and landing mission to asteroid Eros.
- \* Deep Impact: rendezvous and collision with Comet Tempel 1.
- \* Stardust: sample return mission to Comet Wild 2.

And we'll learn even more about asteroids and comets in the next few years:

\* Dawn: mission to asteroid Vesta and (now promoted to dwarf planet) Ceres, arriving at the former in 2011 and the latter in 2015.

\* Rosetta: orbiter/lander mission to Comet 67P/Churyumov-Gerasimenko, arriving in 2014, after two asteroid flybys (European Space Agency).

\* \* \* \*

### **Getting There Is Half the Fun**

All the mitigation options make a common assumption: that we can deliver a significant payload to the PHO. For an object closing on Earth at 70 km/sec, that's no easy task. Almost certainly, chemical rockets alone won't suffice for missions to such fast-moving rocks. For reference, the Saturn V rockets used in the Apollo program cut off at 11.2 km/sec.

Over time, spacecraft with ion thrusters can build up enormous velocities. In principle, so can solar sails. The catch is, time permitting.

Gravitational slingshots are another way to gain velocity. The Rosetta mission, for example, will have swung around Earth three times before it reaches its destination comet. Exploiting Earth's (or another body's) gravitational energy in this way costs maneuvering time, and requires that some planet be in the right place at the right time.

\* \* \* \*

### **The Real World Intrudes**

It's worth remembering: For lead times of years (or perhaps even a few decades), standoff nuclear devices may offer our only chance of deflecting kilometer-scale objects.

The Outer Space Treaty[19], in force since 1967, prohibits the stationing of nuclear weapons in space or on any celestial object. The treaty has no loophole to permit use against a PHO. (One ADRS attendee argued unpersuasively that deflecting a space object was “propulsion,” not a weapon, and thus does not come within the purview of the treaty.)

Even more restrictive for planetary defense, the treaty expressly forbids “the testing of any type of weapon” in space. I'm no space lawyer, but kinetic impactors—guided projectiles with closing speeds of kilometers/second—seem like weapons to me. If they are to become a part of our planetary defenses, I would *hope* we test them before needing one to work.

Could the treaty be amended? Clarified? Surely countries would rather update (or ignore) the treaty than face a major asteroid or comet strike. Whether the Outer Space Treaty should be amended in anticipation—say, to allow a demonstration test against a harmless asteroid—seems more contentious.

As with most international treaties, signatories can withdraw upon one year's notice.

Judging from ADRS discussion of planetary-defense policy—and here we debated as citizens, not technical experts—only the questions are clear. Would countries agree to subcontract Earth's defense to a particular space-capable nation(s)? What is to stop a country from acting unilaterally? While an international planetary-defense organization might be preferred by some nations, other countries would be loath to see an international organization controlling missiles and nukes. Will the public trust an international entity to maintain control over its nukes, or not to preempt its nukes for other purposes? If a NEO intervention is only partially successful—the asteroid, or a fragment thereof, smacks Country B

instead of Country A—who is responsible? What if a defensive launch fails and spreads radioactive materials? Groups have taken NASA to court (so far, without success) to stop launches of spacecraft using radioisotope power generation. Might someone sue an international planetary-defense group, perhaps in the World Court, to prohibit launches of nuclear devices?

Some simulations suggest that several small nuclear detonations would deflect an object better than one big blast. The organization(s) entrusted with Earth's defense might therefore want to develop or stockpile miniature nuclear devices: “suitcase nukes.” The associated proliferation risk is not insignificant, and one terrorist attack using a stolen suitcase nuke would produce a casualty count comparable to a fairly hefty asteroid.

Maybe we won't seriously prepare for an asteroid strike. The basic data are in Table 1: While fatalities could be cataclysmic, the expected fatalities in a century—fatalities weighted by the likelihood of an impact—are quite small. Other challenges, like diseases and climate change and the current recession, have more severe expected short-term consequences and are apt to consume mindshare and scarce threat-mitigation resources. Like not buying insurance against a “once-in-a-century” flood risk, skimping on planetary defense may look prudent—until it doesn't.

If we *knew* a big rock would hit Earth, our attention would likely increase. We could chose to wait until we spot such a rock and hope the world will then respond wisely—but to wait guarantees we'll have to respond to the emergency from a state of ignorance and unpreparedness.

\* \* \* \*

## **What Now?**

Let's think proactively. What preparations might we take for planetary defense? At a high level, there are three tasks to undertake:

- \* Study—and tag with a radio beacon, for more accurate tracking—a few asteroids chosen for their threat potential. (If they are of scientific interest, so much the better.) Without detailed knowledge of the mass, shape, and composition of an object, any deflection plan will necessarily be subject to major errors.
- \* Test—on non-threatening asteroids—candidate deflection technologies.
- \* Decide who has what planetary-defense authority, and amend the Outer Space Treaty to allow for planetary defense.

We almost certainly have decades before a NEO endangers us, but most mitigation strategies will also need a long time to deploy and operate. It's risky to ignore the NEO hazard until a collision is near-certain.

If you consider planetary defense worthy of investment, what can you do? Option 1: Lobby NASA and Congress. It may help to point out that PHO-related missions will also advance the main areas of NASA focus: technology demonstration and science. Option 2: Convince a billionaire. Wealthy citizens are massively underwriting such worthy research projects as the Large Synoptic Survey Telescope Project (which has many uses, including asteroid surveys) and the Allen Telescope Array (for SETI purposes).

For years, NASA has had a fairly stable budget (well below that of its Apollo heyday), and existing programs have their constituencies. Synergizing with current NASA initiatives may be more a realistic goal than competing for funds. Crewed spaceflight programs are among NASA's biggest efforts, and can contribute.

A near-Earth-asteroid mission is in some ways—notably the fuel payload needed for target rendezvous and return to Earth—easier than a moon mission. Announcing a NEO destination for the Constellation program (NASA's latest human-spaceflight initiative)[20] rather than a lunar return mission might spare the U.S. from an embarrassing space-race loss to China. A mission to Phobos or Deimos, both likely asteroids captured by Mars, would be easier than a mission to Mars itself. From a base on either Martian moon astronauts could prove most of the technology necessary for a Mars base. They could also teleoperate robot explorers[21] without contaminating the pre-biotic conditions—or perhaps, even, alien life—on Mars itself.

And trying to be positive, in 2008 Congress tasked NASA to recommend “the optimal approach to developing a deflection capability.” Now if Congress would only increase the \$4 million NASA spends annually on asteroid surveys and deflection studies ... [22]

\* \* \* \*

### **Catch a Falling Star**

Asteroids are potential resources, too.

A few near-Earth objects of suitable composition, nudged into safe and convenient orbits, could revolutionize the economics of spaceflight and space colonization. Water, of course, from comets. Oxygen from the water. Metals refined in space using plentiful solar power. Silicon processed in space to build mass quantities of solar cells.

Cheaper spaceflight and in-space resources could also revolutionize our terrestrial energy infrastructure. Earth's atmosphere blocks most sunlight but is almost transparent to microwaves. Solar-power satellites beaming microwaves to antenna farms on the ground will be much more efficient than surface-based solar-power generation.

To study, reach, and change the orbit of a NEO will take a significant investment. Perhaps the fortunes to be made will make a more compelling case for that investment than fear of an unlikely—but devastating if it happens—collision. Of course, NEO exploitation, like NEO deflection, raises issues of trust. Whom do you trust to aim an asteroid *toward* Earth?

Fear and greed are great motivators. Here's hoping at least one of them motivates humanity enough to avoid the dinosaurs' fate. n Copyright © 2009 Edward M. Lerner

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### **To Read Further:**

\* NASA FAQ page on asteroid and comet impact hazards, [impact.arc.nasa.gov/introfaq.cfm](http://impact.arc.nasa.gov/introfaq.cfm)

\* NASA's Near Earth Object Program, [neo.jpl.nasa.gov/](http://neo.jpl.nasa.gov/)

\* Minor Planet Center (the clearinghouse of record for asteroids and comets, including their designations and orbits), [www.cfa.harvard.edu/iau/mpc.html](http://www.cfa.harvard.edu/iau/mpc.html)

\* B612 Foundation (dedicated to “significantly alter the orbit of an asteroid, in a controlled manner, by 2015”), [www.b612foundation.org/](http://www.b612foundation.org/)

\* 1st IAA Planetary Defense Conference: Protecting Earth from Asteroids, [www.aero.org/conferences/planetarydefense/index.html](http://www.aero.org/conferences/planetarydefense/index.html)

\* Lifeboat Foundation (dedicated to “encouraging scientific advancements while helping humanity survive existential risks”) Asteroid Shield white paper, [lifeboat.com/ex/asteroid.shield?white](http://lifeboat.com/ex/asteroid.shield?white)

\* \* \* \*

### About the Author:

A physicist and computer scientist, Edward M. Lerner toiled in the vineyards of high tech for thirty years. Then, suitably intoxicated, he began writing SF full time. His most recent novels are *Fools' Experiments*, *Small Miracles* (October), and (with Larry Niven) *Destroyer of Worlds* (November). Ed's short fiction and fact articles appear most frequently in *Analog*. His website is [www.sfwaweb.org/members/lerner/](http://www.sfwaweb.org/members/lerner/)

\* \* \* \*

### Footnotes:

1: This isn't a criticism of Jefferson, who was perhaps the most scientifically inclined of all American presidents. He not only chartered the Lewis and Clark expedition, he personally instructed Lewis on the information to be gathered and trained Lewis in surveying techniques. Long after (1962), while entertaining forty-nine Nobel Prize winners at the White House, President Kennedy said, "I think this is the most extraordinary collection of talent and of human knowledge that has ever been gathered together at the White House—with the possible exception of when Thomas Jefferson dined alone."

2: "The Tunguska Mystery," Luca Gasperini, Enrico Bonatti, and Giuseppe Longo, *Scientific American*, June 2008. The event may have been more than an air burst. In the article, the authors assert that pieces of that exploding object survived to reach the ground, and that Lake Cheko was carved by such a fragment.

3. [www.theatlantic.com/doc/200806/asteroids](http://www.theatlantic.com/doc/200806/asteroids)

4: One astronomical unit (AU) = the mean distance between the Earth and the Sun, about 93 million miles or 150 million kilometers.

5: An orbit's eccentricity expresses its deviation from circularity.

6: Energy dissipated in ocean tides slows the Earth's rotation. To conserve the Earth-moon system's total angular momentum, the moon's orbital radius grows at about 4 cm/year. Similar effects slowly alter the orbits of other planet/moon systems.

7: We SF types attended as members of SIGMA, a pro bono group of authors (and the occasional editor)—many with names familiar to *Analog* readers—that offers the government our outside-the-box perspectives on a spectrum of issues. For more about SIGMA, see the group's website at [www.sigmaforum.org/home.php](http://www.sigmaforum.org/home.php).

8: This is as good a spot as any to stress that practically every number in this article is an estimate. I'll mention some major sources of uncertainty as I go, but a disclaimer before every number would get tedious. Different references (and the same reference at different times) may give different estimates. Legitimate scientific uncertainties do not detract from the overall message: lots of big rocks in the neighborhood that could do Earth (and us) harm.

9: Current surveys involve narrow field-of-view astronomical instruments and mostly visible-light frequencies. The soon-to-come Panoramic Survey Telescope And Rapid Response System (Pan-STARRS) survey will take a different approach. The instrument nearing completion will have a 30 field of vision (wide for a large telescope), allowing full-sky surveys (of the sky visible from the Hawaii observatory) four times a month. The instrument will also observe in the infrared band. Dark, faint objects that are difficult to spot by reflected visible-wavelength sunlight are expected to reveal themselves through the contrast between their sun-heated surface and the cold background of space.

10: [neo.jpl.nasa.gov/neo/groups.html](http://neo.jpl.nasa.gov/neo/groups.html)

11: [www.spaceref.com/news/viewpr.html?pid=22583](http://www.spaceref.com/news/viewpr.html?pid=22583)

12: In a topic rife with assumptions, the prospective fatalities/impact is among the most subjective. The Tunguska event of 1908 had no known human casualties—because it happened in a remote part of Siberia. The area devastated by the event is larger than metropolitan Washington or New York. Location matters.

13: The “Fatalities (in 100 Years)” entries reflect a Poisson distribution of collision probabilities around the mean estimated arrival rate given in the “Typical Rate (Years Between Events)” column.

14: [neo.jpl.nasa.gov/apophis/](http://neo.jpl.nasa.gov/apophis/)

15: [www.planetary.org/blog/article/00001684/](http://www.planetary.org/blog/article/00001684/).

16: Spheres make for easy calculations. The term often used to describe actual asteroids is “potato-shaped.”

17: The Yarkovsky effect describes the force on a rotating body from differential emission of thermal photons. The sunlit side of an asteroid is hotter than the dark side, making the emission of heat—thermal photons—asymmetric. See [en.wikipedia.org/wiki/Yarkovskyeffect](http://en.wikipedia.org/wiki/Yarkovskyeffect).

18: Ion thrusters use electrical fields to expel a high-speed stream of charged particles, typically xenon ions. Ion thrusters produce low acceleration but can maintain thrust for much longer than chemical rockets. See [en.wikipedia.org/wiki/Ionthruster](http://en.wikipedia.org/wiki/Ionthruster)

19: Formally known as Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies. See

20: [www.nasa.gov/missionpages/constellation/main/index.html](http://www.nasa.gov/missionpages/constellation/main/index.html)

21: Phobos orbits within 10 thousand kilometers of the center of Mars. Light-speed communication delay between Phobos and a robot on the Martian surface would be negligible. The current Mars rovers are terrific, but there is a reason—Earth/Mars comm delays—why their explorations are measured in months per mile. With real-time control, robots could explore much farther and faster.

22: The 1998 disaster movie *Armageddon*, about an asteroid threatening Earth, had a reported budget of \$140 million. *Deep Impact*, same year, same subject, had a reported budget of \$75 million. Our priorities seem wrong.

[\[Back to Table of Contents\]](#)



Novelette: **AMABIT SAPIENS** by Craig DeLancey

Taking a long view is commendable, but easier in planning than in foreseeing or obtaining actual results....

A key turned in the heavy lock. The sound echoed in the concrete and steel of the hall. I lifted my head, listening, tense like some fragile, frightened animal. Which is exactly what I was.

A great steel door creaked open. A gust of warm air touched my chest. It felt, for a moment, almost pleasant. Footsteps clacked across the threshold. The door swung closed, the latch snapped into place with a clang that ricocheted tightly in my bare cell, and the freeze of the heat-thieving concrete bit into me again.

"Ms. Sumaran." This was a new voice. I could see only a dim silhouette of the man through the coarse nylon weave of the black bag over my head. He seemed my height, or smaller, with broad shoulders. American, with a voice of middle age. Or maybe younger.

"Let me down," I croaked. My chest and shoulders shifted as I spoke, and agonizing pain shot through my arms. I thought I had grown adjusted to the dull agony, but discovered now rather that my stillness had merely rendered me numb. A crushing, consuming ache overwhelmed each muscle with the slightest movement.

One, two days before—I could not judge how long—I had worked past sunset in the field office at the oil well test head. As I walked to my car in the sweltering Argentine night, someone came behind me and pulled a bag over my head. I screamed, tires screeched, and car doors clattered open, and I was packaged away in a van within seconds. The prick of a needle in the arm put me to sleep. I awoke here, shivering and naked but for my underwear and bra, surrounded by a cacophony of voices as two men dragged me through long halls.

They chained my hands behind me at my waist, then ratcheted them up to a hook on an icy steel pole. My bare feet just touched the coarse, cold cement floor. I don't care how other people fight over definitions: anyone who has been hung up like that knows it is torture. That's why they did it, after all. Your tendons and muscles first burn fiercely, and you become convinced they are being torn apart from the shoulders. Then that pain seems almost insignificant as all of your muscles start to twist into burning knots. Finally, after endless hours, this pain dulls—though it never ends—but the slightest movement, even a flinch, sends it roaring back with even greater force.

They weren't criminals then. Kidnappers seeking ransom would not begin with torture. And rapists would not have waited.

"What do you want? Let me down."

"No, Ms. Sumaran, not yet. Before we let you down, you're going to answer all of my questions."

"This hurts. It hurts!" He gave no response. I added, "I haven't done anything. I have nothing to hide. I'll answer any questions. Just let me down."

"You're lying." Metal scraped along concrete as he pulled a chair out of the corner and to the center of the room. It creaked as he sat in it, too close, carrying a hint of cloying cologne. "You have done something. You did something to the oil well. You are working with other people."

A shuffling of paper. He opened a folder, turned pages. "These other people include Allen Reed."

I lifted my head. Had they snatched Allen? Were they torturing him too, now?

"I see that interests you, Ms. Sumaran. We know far more than you think we know. For that reason, I will know when you are lying. And I will punish you. So if you want things to get better, not worse, you will have to tell me the truth. Do you understand?"

"Yes."

"Good. Let's start with your relationship with Allen Reed."

"Our fathers knew each other," I whispered. "We both became geologists. That's all."

"And you went to the same private school. The Marrion School."

"Our fathers both supported it."

"And then you went to the same graduate school. I know these are not coincidences."

"Harvard is the best school for geology," I whispered. I took a long pause to get my breath, slowly, evenly, with the minimum of motion. "No coincidence."

"So how did you both end up geologists? Who told you to become a geologist?"

"I wanted to be a geologist."

"I want to be a mathematician," I told my father. He had come on my fourteenth birthday to the Marrion School, to bring me presents. He offered me a box and an envelope: from my "uncle" David a gold bracelet, and from my parents, two spring-break plane tickets to Barcelona for my mom and me.

I put on the gold bracelet and showed it to my father. It was a very heavy chain of irregular, organic kernels of gold. It sparkled but otherwise seemed like something you might discover lying on a forest floor.

"You like it?" my father asked.

"I love it. Thank uncle David for me!"

"He'll be very pleased."

We settled in one of the libraries, pulling two seats close to the crackling fireplace. We were alone among the long oak shelves stuffed with worn books.

I had come to Marrion, a private boarding school, when I turned eight. I cried when I went and Mom and Dad cried, but they said this was the best school in the world for people with my special talents. I didn't know what my special talents were, but all the teachers at Marrion School acted as if I had one and they knew what it was, so I didn't much worry about it.

My father now leaned back.

"Math, honey?"

"Yep."

"I'm impressed. And proud. I still don't know what I want to do."

I laughed at him. I bet it was true.

"What about biology?" he asked. "You said biology last time I visited you."

"Biology, too, but I like math more. Everything is math—I mean, you need math to describe anything, to do a science of it. Right? Well, I can do math and biology, right? Or be of use to biologists."

He furrowed his brow in thought.

Allen came into the room then. Allen also studied and boarded at Marrion, same year as me. Allen's father had named him after my father, as everyone knew. Our dads were really tight friends. Sometimes I teased Allen because his dad was gay, but mostly we were close even if we didn't hang much. Allen was thin and kept his hair long enough to hide his eyes and seemed always a little embarrassed about something.

"Hey Uncle Allen," he said. He pushed the door closed carefully, moving slowly, methodically. "Hey, Lyta." My name is Hippolyta, but I insisted upon Lyta.

"I asked Allen to join us," my father said softly. Then he called to Allen, "What do you want to be when you grow up?"

"A paleontologist."

"Consistency! You said that last time I asked."

Allen nodded. He dragged one of the heavy armchairs over.

"How are things in New York?" Allen asked. He sat squarely down and crossed his hands formally on his lap as if unsure of where else to put them.

We talked about family and friends a while. Then my father said, "I want to ask the two of you for a favor."

"Sure," Allen said. I nodded. But I felt afraid. My father seemed worried, suddenly. He frowned, and his eyes took on a sad look. It was confusing.

"Last time I visited, you remember how you both told me you wanted to do something about ... some of the problems in the world?"

"Of course," I said. I blushed a little. We must have sounded like such kids. Who didn't want to make the world a better place? All people planned their life around that—that went without saying. Right?

"We—Allen's parents and Lyta's mother and I—we believe we know of a way that both of you can help. But you'll need to do two things. You'll need to study geology. We have found a tutor, a very good geologist willing to come here several times a week to tutor you two. And you would need to tell everyone that you are studying geology because you want to study geology. That it was your idea to have the tutor."

We were silent a long time. The fire popped. I looked at Allen, but he stared at the flames. Always serious.

"Why, Dad?" I whispered finally. "That's weird."

He looked really pained. It shocked me to see that he even looked about to cry. "It will take a long time to explain. And I will explain, I promise. What I can tell you now is that if you are good at it, you would have a chance to do something extraordinary, something to really ... force changes that would make the world a better place. But it would be best if first you just try this for a while. If you don't like it, if you are not good at it, we can stop the sessions. How would that be?"

The fire popped again. Allen nodded. "Of course. But for me it is not ... much to ask. Paleontology, geology. Mostly the same. Many of the great paleontologists were geologists." He looked at me. The inference was obvious: of me more was being asked.

"This is weird," I repeated. But I trusted my father. He had never lied to me. He had never spoken a word that he had not weighed. "But I'll try it. Geology sounds fun."

\* \* \* \*

"Geology is boring. It's just hard, boring facts," the American said. "Like rocks. Yet, explain this to me. What do Iraq, Saudi Arabia, Indonesia, the North Pole and North Sea, the Gulf of Mexico, Nigeria, Canada's tar fields, Texas have in common?"

He poked me with a cold metal rod. I didn't expect that, I didn't know he had such a rod, and I gasped involuntarily in surprise, causing pain to shoot through my limbs as I jerked away.

"What do these places have in common?" he repeated.

"Accelerated biodegradation. Every geologist knows that."

"Yes. And this is a suspiciously interesting fact. Why, why is there accelerated biodegradation?"

"The new strains of hydrogenes, of hydrogen-generating bacteria, have spread there. They are eating the oil quickly."

"That is not my question." He prodded me again. I gritted my teeth in anger. I suddenly wanted to scream at him, to tell him I would kill him or that my Uncle David would break his neck or that my father would turn the world upside down until he found me and then we would expose them all.

"That is not my question," he repeated. "My question is, why? Why all of them, nearly simultaneously?"

"No one knows."

This time he hit me. Hard, in the thigh. The whipping motion of the rod sent sharp, bitter pain through my legs.

"No one knows!" I shouted. "The oil fields must be connected!"

"Perhaps, perhaps." He jabbed the chill end of the rod against my ribs. "But the oil-eating bugs could never travel that fast. Around the world nearly simultaneously? No. You will tell me. How?"

"Christ, I'm a geologist and even I don't know."

He hit me across the thigh again.

"Oh," I cried pathetically, starting to weep.

The chair scraped. He rose and his steps circled behind me. The hairs on the back of my neck pricked. He pulled the hood off with a snap. I started in surprise, then blinked at the lights. Tears welled as the freezing, dry air hit my eyes. I saw my cell, finally. It was clean, perfectly cubic, with a green steel door. Glaring diode lights were arranged in a ring near the concrete ceiling and aimed at me. The air on my face was shockingly cold. It reeked of urine. My urine.

Before me stood not only a chair but also a small table on which a laptop sat, turned so that I could see the screen. A grainy, low-pixel movie of me played on it: I crouched in the field station, connecting a small ten-liter aluminum barrel to a high-pressure water line feeding the test drill.

I visualized the room, to picture where the camera had sat. On a shelf of equipment, I decided. I could have looked right at the camera there on the shelf and not have noticed it, or if I had noticed it I would have assumed it was some surplus hardware and surely not on, surely not transmitting.

"We have footage of you doing it." He whispered. "Look at that. Look."

\* \* \* \*

"Look at that," my father said. "Look."

It was my fifteenth birthday, and my father took me to a small bistro in Manhattan that served Tuscan food. I ordered tortellini and after the waiter left, menus in hand, my father pointed out the windows.

"There. Do you see that guy?"

Across the street a heavy man in a wrinkled pinstriped suit stood a little to the left of the entrance of a shining glass financial building, smoking a cigarette.

"Yes."

"Why do you think he smokes? Why doesn't he quit?"

I shrugged. "He doesn't really believe that it'll kill him."

"Oh, come now. That building houses derivative traders. That man's probably a quant jock there. A mathematician. No, he understands statistics."

"But he doesn't keep it in mind. He doesn't worry about it."

"Good." My father rapped the marble-topped table with his knuckles, punctuating his approval. "Now we're getting closer to the truth of the matter. But why? Why doesn't he worry about it?"

"It's inconvenient to do so?"

My father shook his head. "Okay. Try this. A thought experiment. Imagine I walked over there and handed him a revolver, and convinced him that Russian roulette was as pleasurable as smoking. Would he play?"

I looked back at the man. He eyed the traffic and scuffed his feet self-consciously as he dragged hard on his cigarette.

"No," I said. "Of course not."

"He would fear the roulette?"

"Yes."

"What's the difference? The odds are the same. Or we could make them the same."

"The time."

*The time.* To that man, the future is an abstraction. He can't bring himself to care about it because deep down, in his gut, in the limbic core of his brain, it's not real to him. What happens in the future is too far away to matter. Economists even have a name for this phenomenon: exponential discounting."

I looked back at my father. He was staring at me intensely. He leaned forward slightly, and his voice

dropped.

"That's the difference between us and them." He waved his hand at all the passing traffic, at all of Manhattan, to make it clear that 'them' referred to everyone out there. "To us the future is a real place. A real world. We care about it."

I took these words to refer to our family—to mean, you and I are especially thoughtful folks. I cultivated a bit of ignorance in this. For a while.

"You think we're better people?" I asked, with teenage pique.

"Oh, no. Not better. Not kinder, not smarter, not more selfless, not more empathetic. Nothing like that. Nothing so noble. Just this: we care about the future—what they would call the distant future. And they don't care about it. They can't." He leaned back. "And so, what we see as a clear and immediate danger, like playing Russian roulette, they see as a gossamer shadow of a threat, like smoke."

Across the street, the man threw his butt on the ground, stepped on it, and went back through the glass doors. My father snorted, "Of course he's a polluter, too. The future is also a place where his garbage will disappear."

\* \* \* \*

"What is that garbage you're putting in there?"

The video played of me attaching the cables, again and again. With my arms hoisted behind me, I could not turn to look at my tormenter. My own shoulders were in the way. I turned my head the little I could.

"What?"

The stick slammed across my lower back. Crystal sheets of sharp pain broke through me.

"Oh, god, don't do that," I wept. "Please. Please."

He came up close behind me. I smelled his heavy cologne and felt his body heat and the warmth of his breath on my shoulder as he said, "You instructed your crew to pump cool water into the test well for two days. Then this."

"I was testing for potential infection. Everyone is testing now. Before this, we were pumping down boiling water." I swallowed. "The water we use to drive the tarry oil out—that would kill any bacteria in the area.... You have to inject cold water. That—" I pushed my face toward the screen, trying to point with my chin. "That's a formula meant to feed hydrogen-generating bacteria. To increase the local population, so we can test it."

There was a long pause in which I waited for the stick to hit me. Nothing happened. I heard a faint, distant buzzing. I realized, suddenly, that the man was listening to another voice. Over an earpiece or headset.

Finally, he said, "No one else uses such a procedure."

"It's my own," I said in a rush. "My own. No one has been able to test for the bacteria before. As you said, it seemed to come out of nowhere. I had a theory that maybe the usual test procedures killed the bacteria in the area of the drill. So when we tested we missed the infection—the samples came up sterile because we sterilized them. Maybe the bacteria wasn't new—we had just failed to test correctly before."

Another long pause. I watched the looping video of me: I attach the line. I check it. Attach the line.

Check it. Attach the line. Check it....

Two hands came forward quickly, into my view. Tan skin, rough-edged nails, short fingers. And, in a flash: the small finger on the right hand ended at the second joint. The tip of it was missing. But I saw this only for a moment, fast enough that I could not be certain, as the hands pulled the black bag over my head.

"You're lying again," he said.

And then he shouted out, "Bring the board!"

\* \* \* \*

"Should I bring my board?"

My uncle hesitated. "If you like."

I pulled my surfboard out of the sand and started down the beach. Tall waves broke on the Baja coast, and a sharp, warm wind pelted us with fine golden sand. My uncle took off his shoes, stuffed his socks in them, and tossed them back toward the beach house. Then he jogged to catch up.

Uncle David was tall and had hard arms and moved like a cat. When he used to visit me at the Marrion home, I had loved it that other students looked at him sideways, slightly frightened. But I wasn't scared of him: he was Uncle David.

But that was then. Now I was a college student, out on my own, trying to enjoy a break. I had split the weeklong rental of the beach house with Steve, a nice boy from the math department. Steve stood where the surf just touched his feet. He watched us walk away, holding his own surfboard but frowning thoughtfully.

"He doesn't understand," I said petulantly, making it clear to my uncle that I blamed him for the discord. "You know, other college kids don't have their uncles arrive for a private meeting during their spring break."

"You are not other college kids."

I hissed disapproval through my teeth.

"When I was your age," he said, pointing down the beach, "there was a lot more sand. The seawater rise has stolen much of the beach. Looks like Florida now."

"It'll get worse," I told him.

He nodded. We trudged through the hot sand a while longer before he said, "You will graduate cum laude, I understand. That's an accomplishment for Stanford, and for a double major."

"Everybody gets an A at Stanford."

"Not in math and geology."

"Even in math and geology."

He smiled. "You're self-deprecating like your father. He could never take a compliment."

"I'm more like my mother."

"You have Janet's painfully acute sense of fair play. That I grant." He looked over his shoulder with a smirk. "And she would approve of a sensitive-looking kid like that Steve there.... But someday you'll agree with me that you're more like your father."

He looked around. We were alone. "Let's sit."

I planted my board and we sat side by side, staring at the waves breaking on the sand. The salt sea air smell was still new and fresh to me. I twisted my heavy gold bracelet around my wrist, waiting.

"You still have that." He smiled.

I nodded. "Why are you here, Uncle?"

"I wish I could say it was only to see you."

"But your virtue is honesty."

He laughed.

"I'm heading to the Valley for some business."

"Business for my father?"

"I don't do any other kind. But I came here because I wanted to see you alone, without others knowing. I can be seen at Stanford."

"Why?"

"Let's say, I want you to tell me about the oil ecosystem."

"What?"

He brushed sand off his pants. "Humor me a moment."

I stared into his eyes, trying to understand why he would ask me something so odd, trying to judge if he was joking in some way.

I had come to realize, after I left the strangely sheltered world of the Marrion School and was studying at Stanford, that this uncle of mine was an enigma. I had Googled him many times and found that he had long ago been a famous activist and even once a poet. But in the last twenty years, he had evaporated: there was not a reference to him that didn't reach back in time. There were dead stay-at-home moms with a more dynamic web presence. I had no idea what he did, no idea why he flew about in suits looking ominous, no idea why I called him uncle.

"Humor me," he repeated. "Tell me about these methosomething bacteria and the hydrowhatevers."

I grabbed a handful of sand and threw it on my feet. "There is a whole ecosystem of microorganisms deep underground. In the oil deposits. Many different kinds of bacteria, which live on oil or on other organisms that live on oil."

"And they ruin it?"

I shrugged. "That's how an oil company would put it. The bacteria tend to make the oil more dense and viscous, less suitable for extracting and refining."



"And there are two kinds of bacteria."

"Many kinds. But two important groups. The methanogenics eat oil and excrete methane. The most successful of these are hydrogenotrophics. They eat oil but they also use hydrogen to make methane. This hydrogen comes from bacteria that eat the oil and excrete hydrogen—hydrogenes or hydrogen-generating bacteria."

Uncle David reached into his coat pocket and pulled out a long aluminum cylinder. It shined in the sunlight, announcing clearly a very high-tech manufacturing. Only the thinnest line near one end revealed the presence of a kind of cap.

"Suppose," my uncle said, "that this cylinder contained several strains of bacteriophages, of viruses that attack specific bacteria—extremely virulent—that would kill the methanogenic bacteria, including the hydrogenotrophic methanogenes. Suppose someone injected it into an oil well. What would happen?"

I shook my head. "I'm not sure. If it really worked, and if it could survive down there, then you would significantly reduce the methane generation. Slow the biodegradation of the oil. But the oil companies are trying that. No one has succeeded."

"*They* have not succeeded." He pulled another cylinder out of his jacket. "Suppose instead that this cylinder contained a new strain of hydrogen-generating bacteria. Very aggressive, very successful at eating all different qualities of oil. What would happen if you inserted this into the same well after?"

The cylinder flashed, blinding, as he turned it over. I reached out and took both cylinders, one in each fist. They were warm from resting by his heart. They felt almost like something alive. And they were light: empty. Only here for illustrative purposes. Or here because he came to see me before, not after, he made his more important stops on the West coast.

"If you injected this after you killed the methanogens? Wiped out the competition?"

He nodded.

"And if this stuff were resistant to the bacteriophages you put in earlier?"

"Assuming it were completely resistant to those bacteriophages."

"They'd eat the oil. Quickly. Turn it to sludge."

"And?"

"And excrete hydrogen. A lot of hydrogen."

"Which could be tapped."

"Yes. But this has been discussed, and the oil companies and the governments of the world have made it clear they consider the approach impractical, and they would never allow such a thing. It's too dangerous."

"More dangerous than burning the oil?"

I shook my head. "No. Probably not."

"The problem," my uncle said, "is that they don't see how to make as much money off it. They are invested in their gasoline infrastructure. Their profits—I mean, their short-term profits—are larger if they don't have to build a new hydrogen infrastructure."

I nodded. "Sure. That's probably the real reason they've resisted experimenting with such approaches. It just doesn't make good sense for next quarter's profits. Never will."

"What, then, if someone else put both of these strains into the wells?"

"The oil economy would crash and we'd have to make a blitz switch to a hydrogen economy. It would cause terrible immediate economic turmoil."

"And what will waiting do? What will inaction cause?"

I had to grant the point. "Worse turmoil—the same eventual collapse of the oil economy but with greatly worse global warming. But farther in the future. Twenty, thirty years out."

He nodded. "So, if we don't discount future costs radically, then this," he pointed at the cylinders, "would be the best course of action."

"No, a peaceful, gradual switch to alternatives would be the best course of action."

He sighed impatiently. "Don't waste our time. That is not going to happen."

"You talk as if this was something other than academic." I'd done an internship with an oil conglomerate, at my father's request. I knew how these things worked. "But it can't happen. How would this someone ever get close? And maybe you could get it in one well, but you'd never get it into all the major reserves."

"Agreed. One person could not. You'd need someone inside of each major oil project in the world. And these people would have to put the bacteria and viruses into many different wells simultaneously."

I looked at him, unwilling to follow the steps to their conclusion. "Enough riddles. What are you saying?"

"I'm asking you to go to Harvard for the geology Ph.D. I'm asking you to get a field research position in South America with a major oil company."

The wind gusted and I squinted against the sand that blew against my face. And then it dawned on me.

"Even the Spanish," I whispered. "Even the Spanish classes—the paid trips to Argentina, my time as an exchange student, even that was planned."

He pressed his lips together. After a long moment, he said, "I ... I hope you still believe those were valuable things for you to have done. The summers in Argentina. You wouldn't change that, would you?"

The truth was those summers had been the most painful part of my youth. I had never seen real poverty before, never hidden from crime, never eaten a meal with a family while in the distance police sirens screamed the constant death cry of a shantytown. The sun had been shrouded for months as thousands of squatting arsonists burned the last of the rainforest away, its cremation smoke rising up to clot the sky; and below those black clouds, fumes choked the long boulevards as a flood of cars and motorcycles belched oily blue smog. The hopelessness of it had overwhelmed me. There was no order, no planning, no vision for the future. And I alone seemed to recognize that we were trapped in a nakedly desperate, all-consuming now—in which everything was burned, devoured as quickly and as violently as possible—and after which we were obviously going to choke and starve.

"This isn't normal," I whispered. "Everything planned like this. It's not normal."

"I admit that we are planners, your father and I. But so are you." He reached over and took the cylinders from me and slipped them into his coat, their brilliance disappearing within his dark pocket.

I stood. "This is crazy. Look at other people, they'd never put up with this, they'd get on with their lives and say the hell with this. I see how other people live. We're like a—a cult or something. You, my dad and mom, your friends—asking people to keep secrets, to plan, to change their whole lives. Half our kids going to that secretive little school together, the other half spirited away to other private schools. That's not normal. I know that now, I've seen how other people live. How can you ask this of me? How, after I've seen how other people live?"

"Because you see how other people live."

That was part of the air of danger, part of the fierceness of Uncle David. His threat was not just that, at an age near fifty, he still looked like a lithe killer and cast a cold eye on everyone who passed him. It was also that his words could surprise like a blow. They were often painful, sharp, too correct, too true.

I ran my hands through my hair.

"But why?"

"You know why. To save the world."

"That's not enough. Forcing a hydrogen economy."

"No, it'd take a lot more than that. Hundreds of people, doing hundreds of different things, for hundreds of years."

"If there were such a conspiracy, you wouldn't tell me."

"If I didn't tell you, you wouldn't help. You'll keep the secret because you'll see that you should."

"This is crazy," I repeated. "How can you ask this of me? Other people would tell me I'm crazy if they knew the things I did just because you ask."

"Lyta, you're not like other people."

"Why do you always say that?"

He stood. "Because it's true."

"All my life you've said that. My dad too. That's why I went to the Marrion School, they told me. But I'm not special. I'm not smarter than other kids. Not faster. Not more creative. There's nothing special about me. You think I'm being humble about Stanford, but I'm not. Everyone gets an A, but you can tell who the smart ones are, and I'm not one of them. Why say I'm different?"

I stood too. He took my hands in his. My fingers disappeared in the folds of his rough palms.

"Hippolyta." It was one of the rare times he called me by my full name. "Do you really want to know? Right now?"

I didn't answer. I told myself the question was rhetorical. I knew it wasn't.

I pulled away, grabbed my surfboard, and stormed off down the beach, to the thin comfort of following Steve from the math department as the waves swept him out into the surf.

\* \* \* \*

The door swept open again. Two other men came in, then a third. I could hear something big but light banging awkwardly first on the doorframe, then against the door and the floor. They spoke in hushed voices.

"Over there."

"Like this?"

"Right. But grab that."

"Where should I put this?" someone asked in a voice that revealed obvious strain. I heard water sloshing in some kind of barrel.

"There."

Footsteps circled behind me. Someone jerked my arms up and I screamed. The pain was impossible. I was certain my shoulders both dislocated. But then my hands fell to my waist. They had lifted my chain off the spike.

"What's happening?" I asked, as the white blaze of pain subsided. Self-loathing coursed through me when I heard the fearful pleading of my tone. No one answered.

Each of my arms was seized. Keys jangled, and my chains were unlocked and fell away. They put their hands under my armpits and hauled me across the room, too quickly for me to try to walk, so that the soft tops of my feet dragged along the cold concrete. They turned me over, pushed me down onto something hard—a wood board. Velcro hissed. My arms were pressed down and wide straps were Velcroed closed over my wrists, then my ankles.

"What are you doing?"

My feet tilted up in the air. They had strapped me to a board, I realized.

"What are you—"

Water poured onto my face. For a second I thought the spray was meant to shock me. But it continued. Water filled my open mouth. I bit down, but the black bag over my head caught in my teeth. Water ran into my nose and filled my sinuses, burning. I choked, gasped, but could not find a way to breath. A horrible, wracking gag clawed at the tops of my lungs and bruised my throat. I was drowning, I was being destroyed by the water. I would have to breathe, I had to breathe, I had to breathe, I had to—

The water stopped. I coughed bitterly. Then my harsh, explosive inhale scraped at my throat and lungs.

"You will tell me now everything." The man again.

"What—" I choked. "What do you—" The water fell into the sentence, into my open mouth, into my gasping for breath.

It was impossible. I was going to die now. Not even die. I was dead already: there was nothing left of me but the burning, the pain in my throat and lungs and stomach and nose. I was lost—all of me that was human was lost—and only a spinal, mindless, uncontrollable terror remained, a will without future that gasped for air, grasped to escape drowning.

The water stopped again.

I coughed and vomited water. It fell back into my nose, tasting of hot bile, and I had to vomit it again.

"Everything," I managed to croak, to cling to the life my body demanded that I seize. "I'll do anything you tell me to."

\* \* \* \*

"I did everything Uncle David told me to do. I followed the protocols perfectly."

I sat on the edge of the bed in my father's hotel room, a generic suite in a mid-list hotel in Buenos Aires. It reeked of smoke; people still smoked in hotels here. He stood by the window, shoulder pushing aside dingy yellow drapes, and looked out at the night lights of the city.

"I took the starter cultures," I continued. "And tried to breed a viable vector population, but neither would take."

He nodded. "We knew you would do everything perfectly. That's why you were scheduled to perform the last injection. The seeds must have been contaminated."

"But why did you start the other injections? And weeks early! Now there's panic at the office. Everyone knows something is happening. The whole world knows. Hydrogen blooming through desert sands!"

"There were difficulties at the other sites. We had to act or it would have been too late." He turned away from the window. "I'm sorry, Lyta. We'll pull you out now. Tonight."

"No way in hell," I told him. I stood up. "No way in hell."

He looked exhausted. He was jet-lagged, but also clearly overwhelmed with worry. His red eyes made me suspect that he had been weeping before I arrived. He locked his bloodshot gaze on me now.

"It's not safe. Even David agrees. We need to—"

"Fourteen years."

"I..." But he could not finish his sentence. His hands fell at his sides, hopelessly. His gaze turned to recognition, his expression to sorrow.

"Fourteen years," I repeated. "Since you asked me to start this mad project. College, graduate school, summers here, a worthless job with men I hate, years climbing the ladder to become lead research scientist. No lovers, no friends. I was here, working, the night my mother died. Fourteen years. For this."

"I know, Lyta," he whispered, barely audible. "I know. I'm sorry." He hesitated. "Your mother never doubted—I mean, she always knew how much you loved her."

"Why did I do it?" I asked him.

I knew what he would say. Tonight I wanted him to say it.

"Because you're special."

"Why am I special?"

He sighed and sat on the edge of the bed. Our situations were reversed now. I went to the window and waited, holding my purse as if about to leave, while he kneaded his hands together between his knees, twisting them into fists.

"Why am I special?" I asked again.

"I ... your uncle and I ... we ... we were—we *are*..." He looked up at me. "GMOs."

I thought about that a minute. "You mean gene-manipulated? Like those kids whose parents paid to make them blue-eyed and blond?"

He grunted. "I never thought of it as something so ... mundane. I should have realized that it would be less of a shock—maybe no shock—to you. But yes. Like those kids."

"But you're—that was years ago. They didn't have reliable technology before your birth, did they?"

"It was done secretly. By William Marrion."

"Oh my god. The founder of the orphanage. The man who raised you all."

He nodded.

"All of you are...? All the kids of the orphanage?"

He nodded again.

"And what...?"

He smiled at me sadly. "Yes, 'what'? That's the question. We're not all blue-eyed. We're not all blond. What was done? Just this: we were made to care more. About the future."

"To care more? That's absurd."

"No. No, it's not. It's basic neuropsychology. Jack has explained it to me many times. You can teach a dog to see the consequences of its actions a few minutes out, perhaps an hour out. Chew the chair and if the master sees you, you'll be punished. But you can't teach a dog to care about a day away. You can't teach a dog to plan for next week. Why? Because the advanced portion of a dog's frontal lobe is a thin wafer compared to ours."

He pressed a rigid index finger against his forehead. "This is where the mammal brain represents the future, and also where it enables us to care about the future. And this ability is a matter of degree, not of kind. And we were ... designed to care far more about the future."

I shook my head in wonder. "Who else?"

"All the orphans of the former Marrion Home, the people you know as your aunts and uncles. And their children."

"Uncle Reed and Aunt Trend and Aunt Joy and Aunt Marr and...?"

"Yes. All of them. Eighty-eight in the first generation."

"And mom?"

"Including your mother."

"And me?"

"The genetic traits are dominant."

I turned and looked out the window again. "So everyone out there...?"

"To them, tomorrow is real. Next year is a vague image. And five years away is as unreal, as unmoving as a fairy tale."

He watched me for a moment, as I gazed at the city buildings and wondered about the futures behind each lit window.

"You know it's true," he said. "I have stood where you stand now, while Marrion told me this by recording. It seemed incredible, but I knew it was true, and I realized then that I'd always known it was true. That becomes clear now, doesn't it?"

"Yes," I admitted. My hands were shaking. I felt distant, as if I were watching myself from another time and place. These revelations weighed too much, stood too tall, for me to grasp them. My voice seemed to come of its own will.

"And so," I asked softly, "you think you're supermen? And you can just try to run the world, take things over, in order to make it as you see fit?"

"Oh, no, Lyta. No. We are just the only people who care enough about the future to try to save it. That's all. We're the only people who care."

We were silent a long time. Then I said, "It may make things much worse, you know. All the cities might go dark, the planes grounded, the cars heaped up in junkyards. Chaos could follow."

"Chaos is guaranteed, now or later. The question is which will be worse. It's a matter of comparing calculated risks."

"Calculated risks," I hissed bitterly. He shrugged. I stared at him a long time before I said, "I'm going to finish it."

My father shook his head. "Please, hon. They'll watch the well heads now. They'll watch you. A *gringa*."

"No. They'll turn to me to help protect them. They have no one else. They'll ask me to test the wells. It'll be even better cover than before." I held out my hand. "I'm going to finish it. I can inject during the tests. Give them to me."

He looked at my outstretched palm.

"Dad, you would not have come without them. I know this. Give them to me."

He did not move for such a long time that I started to feel sure he would say no—that he would take my arm then and direct me out the door, to a car, to the airport, almost carry me like he did when I was a little girl. But then he reached very slowly into his breast pocket, and pulled out two shining cylinders. He laid them on my hand, one at a time. They clinked softly against my bracelet. I closed my fingers around the warm metal.

"I wish I was like them," he whispered. "Like all the others. I wish I didn't care about the future. I wish I didn't care about the world. I wish I only cared about you."

I put the cylinders in my purse. "So do I."

\* \* \* \*

"I don't care!" This was a new voice. Out in the hall. Not loud but penetrating. Also American, and older, perhaps sixties. "You've broken all the rules here."

The key turned in the lock. I listened to the footsteps of two men enter the room.

After the confessions I was given a wet towel and a dry towel, and allowed to clean myself alone in the room, a silly pretense of privacy since I knew they watched me. An orange jumpsuit lay limp by the door and I dressed in that. I had to roll the sleeves and legs of it, but was glad for the thin addition of warmth it

yielded.

A lot of time passed. Three meals were slipped through a panel at the bottom of the door, and then later taken away.

Finally, two men in masks came with two additional chairs and another table. They chained me to the metal chair with my back to the door, hooded me again, and left me to wait. Until now.

Two chairs scraped, they sat, and the chairs scraped again as they scooted up to the table.

"Ms. Hippolyta Sumaran," the one I knew, the torturer, the younger man, started. Though I did not believe he would strike me again, I felt the shiver of fear to have them behind me, addressing me, while I sat there helpless. "With me is an important colleague. You will tell him what you told me."

"Yes," I said. My voice was a whisper.

"How did the oil plague get into the Argentine reserves?"

"I put it there." I was ruined. Not because of fear of the waterboarding. The waterboard did not even seem so fearful now. But because I knew, clearly and without doubt, that I would break again if they put me on it. That knowledge, not the torture itself, crushed me into docility.

"How?"

"Through the test well. Where we do experiments."

"And how did it get into the other reserves? In other countries?"

"Other people. Like me."

"A conspiracy?" the other voice, the older man asked.

"Yes."

"Including Allen Reed," the younger interjected.

"Yes."

Papers shuffled. The older man said, "you went to school with Allen Reed."

"Yes. At the Marrion School."

"The elite private school?"

"Yes."

"And when were you recruited into this conspiracy?"

"At the Marrion School."

"At the school? Together?" A tone of incredulity seeped into the older man's voice.

"Yes."

"You both were told to become geologists?"



"Yes."

More shuffling of papers. "How old were you?"

"Fourteen."

This much I had confessed, but no more. I had not told him what we were.

There was a long pause. Finally the older one sighed heavily.

"Do you realize, Ms. Sumaran—do you realize how absurd that is?"

"Sir..." the younger man started.

"Shut up," the older one demanded. "Shut up." Then, in a softer tone, to me he said again, "do you realize how absurd that is?"

Yes. Of course it was absurd. No fourteen-year-old girl could commit to a goal more than a dozen years in the future, not a goal that required her to push aside her dreams and to bend all her life to such a purpose. She might say yes, but she couldn't keep a secret for years, she couldn't follow through with the education, the long toil of climbing the corporate ranks. And if she could, if there were such a girl, there could not be a dozen other such boys and girls, also raised to this purpose. Such a conspiracy was impossible. Human beings simply did not have that kind of foresight and focus. They did not have that kind of commitment to the future. Especially not upper-class American kids, with a world of instant indulgences and possibilities laid before them, tempting them every second of every day with immediate pleasures.

As if an open door stood before me, I saw clearly my way out of this cell: I had only to confess part of the truth and to yield to some of my fears.

"Don't put me back on the waterboard," I whispered. I started crying as I pleaded. "I did my best to say what he wanted me to say.... I could tell he wanted me to say something. Just tell me what you want me to say."

"You bitch," the younger man hissed.

"Out," the older man commanded. "Now."

"Sir, can't you see she's playing games with—"

"Stop. Shut up. Go to your office and wait for me."

A chair scraped backwards. Footsteps retreated. The door opened and closed.

The older man sighed.

"Your father has influential friends," he said. "He has made a lot of noise. He has convinced many people—including some people to whom I must answer—that a mistake has been made. I am now inclined to agree with him."

"Please let me go," I whispered.

"Of course, Ms. Sumaran. Of course." There was a long pause. His chair slid back. "May I just say something?"

I did not answer.

"Yes? Well. You will never find us, Ms. Sumaran. We don't exist. It would be best if you went home and forgot all about this. Raising trouble, making complaints, looking for revenge—dare I say, looking for justice—well, that will only make it harder to forget this mistake. It will be better for you if you just forget and move on."

"I would like to move on," I replied meekly.

"I'm glad to hear that. We will bring your clothes. You may dress and then we will put the hood back on you. We will take you to your embassy and drop you there."

"Now?"

"Soon, yes."

He shuffled papers. A pen scraped briskly across paper, signing. Then there was a pause, followed by the sound of a piece of paper—or perhaps a large photograph—being lifted and then snapped into standing.

"What is this that it says over the doors, over the doors of the Marrion School? *Ambit sap*—"

*"Amabit sapiens cupient caeteri."*

"Meaning?"

"The wise love, others merely covet."

"Ah. A nice sentiment. I would like to think that some of the wise do love."

"It is love," I told him, "that makes them wise."

\* \* \* \*

They pulled a hood over my head, banded my hands together behind my back, and then put me into the back of a car. We drove around for a while, making lots of turns, and then they stopped, pulled me out, and shoved me stumbling forward.

"Go straight ahead," someone grunted. Doors thumped closed, and the car's engine gunned and retreated.

I walked a short distance, until I bumped into a wall. I heard footsteps approach, hard soles slapping on pavement. The hood was pulled off.

*"Señora,"* a Marine asked, looking around, one hand on his belted pistol. *"Señora, estas bien? Estas herida?"*

"I'm an American citizen," I said. "Take me inside."

After hours of questions and phone calls and stale cups of coffee, and after the ambassador allowed me to wash up in his private bathroom in his top floor office, they let me go. I walked, wobbly and shaking, to the elevator and rode it down. The steel doors opened silently on a small lobby. A man sat against one wall, reading a newspaper. Beyond him, two sets of glass doors, with a little armored Marine station between them, let out onto stone steps and then a walkway to an iron gate by the road. A black car waited by the curb, sunlight gleaming off the long hood. Its windows were opaque. Uncle David paced, like a furious lion, back and forth beside it.

When I had taken two steps toward the door, I glanced at the man reading the paper. His face was hidden behind the opened pages, his hands holding them out between us. Then I saw it: the pinky of his right hand lacked one joint.

I froze, staring. I began to tremble. I wanted to flee, but fear paralyzed me. The paper came down. A bland, small man looked at me with bloodshot eyes. He had short brown hair and a thick neck. I smelled it then: his familiar cologne.

We stared. Finally, he said softly, "I'll be watching you."

I opened my mouth but nothing came out. I wanted to say, "You're going to be disappointed." I meant to go back home to New York, start school again, finish my studies in math. Nothing there worth watching.

I moved toward him, half a step. It took me a long moment to find my voice. But finally I said, "I forgive you." My words were barely audible. My hands shook. I said it again, louder. "I forgive you."

"I don't need—"

I cut him off. "Maybe you're just a bad man. But maybe instead you thought something had to be done to help the world. Something that might not work, something that might be bad, something that might even make things worse—that would, in the near term, surely make things much worse. But you couldn't think of anything else to do, and you hoped it might, just might, force an answer." I nodded. "I understand that. I understand desperation. I understand the terrible things we sometimes do on the thin hope of a calculated risk."

I moved on before he could respond, pushed through the heavy doors, and walked out into the blinding sunlight of a new and uncertain day.

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*(EDITOR'S NOTE: Marrion's kids appeared earlier in "Amor Vincit Omnia [April 2008].)*

[\[Back to Table of Contents\]](#)

Short Story: **FOREIGN EXCHANGE** by Jerry Oltion

\* \* \* \*

*Illustration by John Allemand*

\* \* \* \*

Plan ahead can only take you so far....

\* \* \* \*

The return vehicle touched down in a swirl of red dust. The engine continued to burn until the sensors in all three footpads reported contact, then it throttled down and let the entire weight of the craft settle onto the Martian surface.

A few minutes later the protective shroud split open from nose to waist, four solar panels tilted out like flower petals, and a pump began pulling air through a chemical fractionating unit. Inside, catalysts stripped the oxygen from atmospheric CO<sub>2</sub>, and further pumps liquefied it and stored it in fuel tanks alongside the already-filled liquid hydrogen tanks. It was a long, slow process, restricted by the low wattage available in Martian sunlight, but it was steady. Molecule by molecule the tanks would fill, and by the time the manned landing party arrived they would have a fully fueled return vehicle waiting for them.

Mission controllers on Earth directed the nose camera to swivel around for a full panorama, mapping the rocky floodplain at the mouth of the Valles Marineris so the astronauts could study their base camp site before they arrived. There were no facilities for soil samples or life-detection tests; that would be the explorers' job.

Off in the distance—a distance everyone hoped was far enough to keep the astronauts' ride home safe from danger—they could see the fresh scar of the recent outflow event that had made them choose this landing site. Water had flowed out of the canyon wall and carved a gully just last year. "Follow the water" had been the dictum of Martian exploration since the 1990s, and this was about as close as you could get to a sure thing.

The return vehicle kept making fuel. NASA, perpetually strapped for money and downlink time, switched off the camera and reduced the polling interval of the vehicle's status to once every two weeks. They left it alone to do its job while the second spacecraft was assembled and tested in Earth orbit, and after six months, when the return vehicle reported that its tanks were full, humanity's first manned expedition to Mars set out on its historic journey.

There were only two astronauts. The ship couldn't carry enough supplies for more. Some people doubted that even two people could survive the trip, but Melissa Nelson and Will Randall were willing to risk it. They had faith in the engineering and faith in themselves and faith in each other. There were hundreds of unknown factors that could complicate the mission, but facing the unknown was what exploration was all about.

The trouble with the unknown is that you can plan ahead all you want, but you can't plan for everything. Melissa and Will were only halfway to Mars when the return vehicle launched itself from the surface and headed for Earth.

They cursed like sailors from a previous century when they heard the news, even though they were on an open mic. This was their ride home that had apparently, through some software glitch or stray command signal, grown impatient and come back too soon. They couldn't just turn around in space and come home themselves, either; they were committed to going all the way to Mars. They could use its gravity to swing around toward Earth again, like Apollo 13 had done around the Moon when its oxygen tanks had blown;

but if they landed, they couldn't come back.

Heads rolled throughout NASA. A Senate investigating committee convened to assign blame to anyone the new administrator had missed. Every company who provided so much as a bolt for the return vehicle was investigated, fined, and just for good measure, audited.

The astronauts flew onward. The lander flew the other way. Minimum-fuel transfer orbits aren't straight lines; the two spacecraft were millions of miles apart at their closest approach, and moving at thousands of miles per hour relative to one another.

The news reports went on to other topics. It would be months before the astronauts returned, and nobody but the scientists were interested in the malfunctioning lander. They ran it through its paces all the same, guiding it home and separating the crew capsule for a splashdown in the Pacific. Might as well test as many of its functions as possible.

So they were unprepared for the sight that greeted them when they hauled the capsule on board the pickup ship and popped open the hatch. They hadn't taken any decontamination precautions; after all, the outside of the lander had been burned clean by reentry, and the inside had never been opened to Martian air. There wasn't anybody official on hand to give a speech or any of that. Just a dozen curious sailors and a computer tech named Carl Chapman, who carried a notebook computer and a patch cord that he intended to hook into the onboard control system and find out just what had happened.

But someone in a spacesuit blocked his way.

"What the hell?" asked Carl.

If the Martian said anything, its voice was muffled by its spacesuit helmet.

The smell that came out of the capsule nearly knocked Carl over. He backed up a couple of steps, sneezed, and looked over his shoulder at the sailors who stood in a ragged semicircle around the hatch. "Get the captain up here," he said, and one of the sailors broke away and ran across the deck toward the bridge.

The Martian put one foot out onto the deck. Its other two feet stayed just inside the airlock. All three hands held onto the frame. Its face wasn't clearly visible through the red-tinted bubble helmet, but Carl could see a wide mouth with lots of pointed teeth set below two bulging eyes.

"Uh ... welcome to Earth," he said belatedly.

The Martian stared at him with its improbably large eyes.

"Something tells me you don't speak English."

The creature's spacesuit looked like it had seen a lot of action. It was patched in half a dozen places, a couple of them with silver duct tape that had no doubt come from the lander's tool locker. Carl couldn't imagine anyone trusting his life to such a patchwork job.

He looked around again for support, but the sailors were just as bewildered as he was. He turned back to the Martian. "What were you thinking?" he asked. But that was obvious when he thought about it. An empty spaceship lands, refuels itself, and just sits there waiting for someone to fly it home; it probably looked like an invitation. The Martian apparently had his own pressure suit—probably because he lived underground in a sealed environment and needed it when he went out onto the surface. So he had evidently grown curious enough to climb inside, close the hatch, and push the "go" button, trusting whoever had sent it to take care of him in transit.

"Oh man," said Carl. "You're in deep trouble."

The Martian grinned toothily.

Fortunately the captain showed up just then, and he was a little more used to making snap decisions than Carl was. "Hello, welcome to Earth, and get back in the capsule," he said. "We don't have any idea what kind of microorganisms you might be carrying."

The Martian showed no sign of comprehension, but when the captain ordered the sailors to rush toward it, the creature ducked back inside and slammed the hatch.

"Get a cable around that to hold it shut," the captain ordered. "And prepare a storeroom for emergency biohazard containment."

While sailors hurried off to take care of it, the captain looked over at Carl and said, "Well, I guess we found out why it launched early."

\* \* \* \*

On the ship to Mars, nearing the point where they either had to start decelerating to go into orbit or commit to a slingshot return to Earth, Melissa and Will were arguing about what to do. "Look," she said for maybe the third time, "The Martians obviously have enough intelligence to recognize a spaceship when they see one. They've got to have some kind of civilization. I say we land and see what's down there. We can get them to help us refuel our ship for the trip home."

"And what if they've got the intelligence of chimpanzees?" asked Will. "What if they're as intelligent as us—and a hundred years behind us technologically? I mean, if they've got a civilization capable of producing liquid oxygen, why haven't we heard of them before this?"

"Maybe they live underground," said Melissa. "Maybe they don't use radio."

"And don't build roads and don't till fields and don't herd animals and don't—"

"I get the picture."

Will shook his head. "If you did you wouldn't want to risk going down there and depending on their abilities to get us home."

"Look," said Melissa. "We're risking our lives already on this mission, but now we know without a doubt that there are Martians down there. Isn't that worth a little more risk to be the first people to talk to them?"

"A computer tech named Carl Chapman was the first person to talk to one. By now a couple dozen others probably have. More likely we'd be the first people to be stuffed and mounted in a Martian museum."

She snorted in disgust at his paranoia. "We have no indication that they're hostile."

"They don't have to be hostile. They can stuff us after we die of starvation."

"Where's your sense of adventure?" she asked. "We're explorers! We should be jumping at the chance to meet the Martians."

"I'd love to meet Martians," Will said. "I just want to make sure I survive the experience."

"Mission Control says the one who took our return ship rebuilt the air recycler to provide its own

atmosphere instead of ours. That argues for a pretty good understanding of technology. Anybody who can do that can make liquid oxygen."

Will scowled. "I don't know. That's a pretty slim piece of evidence to stake your life on."

"What do you want to go down in history as?" Melissa asked him. "The first guy to land on Mars and meet the Martians, or the guy who gave it a miss and went back home because it was too dangerous?"

"I don't know," he said again, and Melissa suppressed a smile. She'd spent enough time with him to know what he really meant when he said that. To him, "I don't know" meant "Convince me."

"The Martian had freeze-dried ration packets," she reminded him. "He had his own pressure suit. They've got technology."

"Hmmm," he said. This time Melissa did smile.

\* \* \* \*

Tnaxis knew he was in trouble the moment he saw the quarters they had prepared for him. He hadn't been thrilled with being cooped up in a tiny space capsule during the long trip between planets, but he had at least hoped for a friendly welcome when he reached his destination. It was probably unfair to judge these two-legged creatures by his own standards, yet a windowless room furnished with only a cot and a bucket hardly seemed generous treatment.

And the air was actually worse than on board the spacecraft. They had apparently taken their cue from the modifications he had made to its recycling equipment, not knowing that he'd never succeeded in getting the mix right. Oxygen was like breathing acid vapor, so he was glad they realized he didn't need that, but they apparently thought he needed carbon dioxide. He didn't, and the stuff smelled awful. How could he tell them that all he really needed was methane?

He had nearly run out of food, too. He'd brought enough for months, assuming that he might have to spend quite a bit of time on the blue-and-white planet before they sent him home, but their spaceship was slower than he had guessed and he had been forced to eat nearly all his rations on the way here. The two-legs had let him bring the last of it with him into his cell, but unless there was something he could eat on this heavy, smelly, unfriendly mistake of a planet, he would starve before he could get home.

He cursed the rotten luck that had led him to crash-land on the red planet in the first place. He'd been about to land next to the fresh outflow gully at the mouth of Fnash's Gash, the enormous canyon that crossed nearly a third of the planet, and everything had been going wonderfully until the last few seconds, when one of the ship's footpads had struck a rock and the whole vehicle had tipped sideways. The crash hadn't breached the hull, but there was no way he could set the ship upright again and fix the damage. He had sent an amplified telepathic burst message for help, but his receiver had been damaged in the crash, so he couldn't tell if anyone had heard him. Nor did he know if they could send a rescue vehicle for him before his supplies ran out. He'd thought he was dead until he'd discovered the mysterious spaceship out in the ancient flood plain. There was nobody in it and no tracks around it, yet it was fully fueled and ready to launch. It didn't look like anything his people would build, but he hadn't had much choice. He'd transferred the last of his supplies into it and pushed what he hoped was the launch button, and now here he was.

Yet from the looks of it, this whole thing had been a colossal misunderstanding. The two-legs hadn't expected him. He wondered what they *had* expected, sending an empty spaceship to a dead world to wait so enticingly for passengers. He would probably never know. They apparently communicated through mouth noise, and their language sounded like a frooxie with a bad case of the jibs. He would run out of food long before he learned it.

The one who had met him on deck now stood outside his new quarters, peering in through the tiny square window in the door.

"I want to go home," Tnaxis said to him, thinking clearly and pointing the multifingered tips of all three tentacles upward. He had taken off his spacesuit, glad at least that he could scratch his back again.

The alien made a coughing sound and pointed at his head. Apparently two-legs called their heads "Carls." Tnaxis pointed at his own head and repeated the same noise as best he could. The language lesson had begun.

\* \* \* \*

Mission Control was not happy with Will and Melissa's decision. "It's too risky," they argued. "There'll be other flights."

"But not for us," Melissa replied. There were dozens of other astronauts waiting for a flight, and she and Will had already received enough radiation en route to Mars to disqualify them for anything beyond low Earth orbit ever again.

Fortunately there was a twelve-minute lightspeed lag in communications, so Mission Control couldn't harangue them during the crucial orbital insertion burn, nor could they try to remotely control the spacecraft. All they could do was watch angrily while their crew put their ship into orbit and took the lander down to the surface.

That, at least, went according to the original mission plan. They set the lander down within a hundred yards of the spot where the return vehicle had come down, figuring that was the one place on the planet that had proven beyond a doubt to be inhabited. Their engine kicked up a lot of dust, announcing their presence to anyone who might be watching.

"Okay," Will said. "Now we wait for rescue. You'd better be right about this."

Melissa laughed.

"What?"

"You realize those are humanity's first words spoken from the surface of another planet?"

He blushed. "Oh crap, they are, aren't they?"

She laughed again. "At least you didn't say anything pretentious."

\* \* \* \*

Larry, the linguist who took over the attempt to communicate with the Martian, had finally gotten it to understand that "Carl" was a name, not a generic word for "head." The Martian was apparently named Tnaxis, though that might have meant, "Oh, forget it," instead. It was hard to tell. They weren't making much progress communicating through the tiny window in the door.

Just when Larry thought they were getting somewhere, Tnaxis would ask for something beyond his comprehension. As near as Larry could tell, it wanted something that would either make its head explode or squirt its brains out its ear. Larry was sure he was missing some key concept, but whatever it was, the Martian was certainly emphatic about it. They had analyzed some of its food and had found that dry cat food was remarkably close to the stuff it had brought with it, but it wanted something else now and Larry just couldn't guess what that was.

They would puzzle it out eventually, he was sure of it. Now that they knew they could keep the Martian



alive, there was time to learn each other's language. If they could just figure out a few more common terms, things would no doubt pick up from there. And Will and Melissa would undoubtedly be learning things from this creature's people on Mars. Between them, they would eventually develop real communication.

Tnaxis was making that expanding head gesture again, holding its multifingered fists clenched near its head, then flinging them open over and over again. "Static electricity?" Larry guessed. "Bad hair day?"

\* \* \* \*

Tnaxis could hardly believe it. These Larrys, as he had learned to call them, were telepathically deaf. He could shout at the top of his brain and this one right in front of him couldn't tell. And when he closed his ear and listened, he heard not even a whisper of activity on the entire planet. The creatures here obviously had no idea that the ability even existed, and without an amplifier there would be no way to contact his own people. Mission Control probably thought he was still in Fnash's Gash, and would send the rescue ship to the wrong planet, if they sent one at all.

He sank down on his cot and dug into the sack of food they had given him. At least the crunchy brown pellets were edible. If he had to live the rest of his days as a zoological curiosity, he could take comfort in the knowledge that he wouldn't starve to death.

\* \* \* \*

Melissa and Will waited by their landing craft for two days before they grew tired of doing nothing and ventured out in search of the Martians.

"They must be waiting for us to come to them," said Melissa as they trudged over the ridge to the south of the ship.

Will snorted. "Unless they're cowering in caves somewhere, waiting for the thunder gods to go away and leave them alone."

"They're intelligent," Melissa said. "They have to be."

"They'd better be, or we're screwed."

They topped the rise and immediately spotted the silver glint of metal against the red landscape. "There!" Melissa said. "What did I tell you? It's some kind of vehicle."

Will squinted. "Looks like a rocket on its side."

"No it doesn't."

She led the way down the hillside. As they drew closer she said, "Okay, so it's a rocket on its side. But it's a rocket! They've got space technology. We'll get our ride back home."

They came up to the engines first. Will saw an open access panel and peeked inside, then said, "This doesn't look like a liquid-fueled engine. That means we can't scavenge fuel from here."

"We won't need to," she said confidently. "Where there's a rocket, there's bound to be support facilities."

They found the airlock and climbed inside. The cabin was eerily familiar, even on its side. Control chair, tool cabinets, food storage lockers—*lots* of food storage lockers, mostly empty—and air tanks the size of small cars. When Will ran some of the air tanks' contents through their chromatograph, it registered nearly pure methane with just a trace of argon. And no carbon dioxide.

"Why would a Martian need methane?" he asked. "And why this much of it? And this much food, too? This looks like an interplanetary ship, not something for local travel."

Melissa frowned. "Maybe there was methane in the atmosphere before the planet dried up, and they still breathe it in their underground cities. We've spotted transient methane plumes here before. Maybe those were from leaks or something."

"Maybe this ship's not from Mars," said Will.

\* \* \* \*

Larry wondered what Tnaxis was doing now. He'd spread cat food out on the floor, a big pile of it in the middle of his bunkroom, then he had set six pieces carefully in a row toward the door. The first three were fairly close to the big pile, then the spacing grew farther and farther apart out to the sixth one. Then Tnaxis broke a piece of cat food into pieces and set one of them next to the third whole piece, two more next to the fourth piece, four of them in a line next to the fifth piece, and five pieces in a line next to the sixth one. Some kind of mathematical series?

Then Tnaxis crunched a piece of food into powder and spread it in a ring around the sixth piece. Was he displaying pi in some alien numeric system?

Tnaxis looked up at him, then back at his display. "Larry," he said in his gravelly voice, and he pointed at the third piece from the big pile. Then he said "Tnaxis" and pointed at one of the small pieces next to the farthest one away. The one with the ring around it.

"Oh, holy mother," Larry said. "You're from one of Saturn's moons."

\* \* \* \*

"Titan?" Melissa said when Mission Control radioed them with the breakthrough. They were still inside the alien spaceship, trying to learn whatever they could about it. "Okay, that would explain the methane, but why did it come here instead of Earth?" It was a rhetorical question; Mission Control would be twelve minutes with an answer even if they had one handy.

"Why did we come here instead of Titan?" Will asked.

"Because it's closer," she replied. "And we didn't know anybody lived there."

"Mars is closer to Titan than Earth is," Will pointed out.

"But Earth is obviously alive."

"Maybe they weren't looking for life. Or maybe oxygen is poisonous to them, so Mars looked more hospitable. The gravity is certainly more like their own."

"Maybe," Melissa said. "Or maybe we're missing something obvious."

They kept poking around in the ship, finding plenty of odd and interesting alien artifacts but nothing that would help them refuel their own ship and get back home. Will had another look in the engine compartment and decided it had to be a fusion drive, which would be very cool for the people back on Earth when somebody figured out how it worked, but not much use for Will and Melissa.

"I'd give anything to meet these guys," Melissa said. "We were so close. If we'd gotten here a couple of months earlier, we'd be exploring side-by-side with a genuine Titanian."

"We'd be wondering how to get him to Earth is what we'd be doing," Will said. "As it is, he's at least

safe. And now that we know there's life on Titan, we'll be sending a mission there as fast as we can build the ship. He's the lucky one; he's got a decent chance of getting home alive."

"Point taken," Melissa said. "I'm ... I'm sorry I talked you into this."

He snorted. "Water under the bridge. We're on Mars with a year's worth of food and we've got a genuine alien spaceship to examine as well. A lot can happen in a year. Maybe we'll figure out how to—"

There came a loud roar from outside, which, given the thin Martian air, meant something really loud was happening. They rushed outside, expecting to see a landslide or a flash flood or a meteor strike, but stopped dead in their tracks to watch another rocket just like the one beside them descend from the sky and land in a swirl of red dust. They waited breathlessly for someone to emerge, but when nothing more happened they stepped closer, climbed the ladder that led up one of the landing legs, and banged on the hatch.

Nobody answered, so they opened it and stuck their heads inside. There was an empty chair facing a window and a small control panel on which half a dozen lights blinked. The switches and lights were labeled in a script neither of them recognized.

"What do you think, is this the Titanian's rescue vehicle?" Will asked.

Melissa pointed at the single large button in the middle of the control panel, the one that blinked most insistently. "I don't know," she said, "but I'll bet if we push that, we'll find out."

Will looked out through the window at the barren Martian landscape. There would be no rescue from out there. Earth had enough resources to fund a mission to Titan or to Mars, but not both. With a live Titanian waiting for a ride home and an entire civilization to explore once they took him home, he knew which way they would choose. He and Melissa had sealed their fate when they'd decided to land.

Or had they? "Can we fly this thing back to Earth?" he asked.

They looked at the controls. There were maybe a dozen buttons on the entire panel. "This thing's as automatic as a toaster," she said. "We have one choice: Go where it takes us and hope the people on the other end can keep us alive until NASA gets their ship out there."

\* \* \* \*

Mission Control didn't like the idea, but the only alternative they could suggest was for Melissa and Will to wait on Mars until their food and air ran out. The alien rations would probably extend their lives a while, but they looked and tasted like cat food.

"The way I see it," Melissa said, "we can either wait to starve or suffocate on Mars, or we can take this thing to Titan and beat the rest of humanity there by at least a year. We'll not only be the first people to land on Mars, but the first ones on Titan as well."

When she put it that way, Will couldn't think of a single reason to say nay. Besides the risk of dying horribly along the way, or of being vivisected once they got there, of course, but to a person facing certain death in a little over a year anyway, that risk didn't seem so bad.

So they emptied the alien ship's food lockers and filled them with their own supplies, brought in a second acceleration couch and their personal gear, and patched in their own air recycling system from their backup habitat module so they could regenerate oxygen on the way. The system wasn't 100 percent efficient, but they were able to transfer enough of their portable oxygen supplies to replenish what they needed.

They spent a couple of weeks exploring the floodplain at the mouth of the Valles Marineris—it was, after all, what they had originally set out to do—but when they found no sign of life other than the alien spaceships, they climbed inside the functional one, closed the airlock behind them, and pushed the “go” button.

The ship roared off the planet and headed for deep space. They had no idea how long it would take to get to Titan, nor what they would find when they got there, but that was okay. After all, facing the unknown was what exploration was all about.

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[\[Back to Table of Contents\]](#)

Reader's Department: **THE ALTERNATE VIEW: LESSONS FROM THE LAB** by Jeffery D. Kooistra

The most important thing for a successful business is location, location, location. The most important thing for a successful experiment is calibration, calibration, calibration. That having been said, location can also be critical in an experiment.

For instance, at our house, we know that if we set the thermostat, which is located in the living room, at 71 degrees, that the room temperature in the family room, where we spend most of our time, will be a comfortable 70 degrees. However, if one day I decide to do my reading in the living room, and start using the lamp next to my favorite chair, then we'd soon find that the house was routinely staying too cold. Why? Because said lamp is within a foot of the thermostat, and the increase in average temperature at the position of the thermostat renders the previous calibration useless.

When you work in experimental physics, you have it drilled into you that without proper calibration, at the end of the experiment you will have, as my professor one time screamed at me, no data. (I'll get to that story in a minute.)

When I was working with Dr. Van Zytveld to measure the thermopower of liquid rare earth elements, recalibration of our instruments had to be done all the time. One reason for this was that the thermocouples we used to measure temperatures were essentially consumed after each experimental run. Even if not visibly damaged, after one use where they were called upon to measure temperatures above a thousand degrees C for many hours, they were unlikely to survive a second run, let alone remain accurate. Also, we frequently rebuilt the ovens we used to achieve those high temperatures. After each experimental run, I would have to *experiment with my rebuilt rig* and make sure it would track along the same curve as the previous runs had. That is, I had to calibrate it with the previous work.

When doing experimental physics, the test rig used to make measurements is a separate experiment in its own right. If you haven't experimented with your test rig enough to know exactly how it works, you will never be satisfied that the measurements you make with it are valid, or at least you shouldn't be.

For my junior year laboratory requirement, I measured the speed of light in gases. The methodology for this experiment was quite clever. I had to fill a small cylindrical chamber with various gases, then pass a laser beam through it, the chamber being in one arm of an interferometer. When the split laser beam was recombined, it formed an interference pattern. As the gas was slowly pumped out of the chamber, I could see fringe shifts in the interference pattern, and the number of shifts allowed me to calculate the speed of light in the gas.

The experiment was an interesting mix of high tech with low. The interferometer has been around since the 1800s, the laser since the 1960s, and to count the fringe shifts I used a very modern (for the 1980s) trace storage oscilloscope attached to a light sensor. To measure the pressure, I used a U-tube mercury manometer, which goes back to the Middle Ages.

The way you read a manometer is to measure the difference in height of the mercury column between the right and left sides. What I did was to measure the height on *one* side from the unpressurized position and then double it. I thought I was saving time. Unfortunately, this method would only be valid if the right and left sides were volumetrically uniform, and they were not.

I was a bit slow in accepting that all my labor might be worthless, at which point Professor Van Baak screamed at me, "You have *NO* data!" (Fortunately, there was a simple, albeit tedious, way to recover my data and so save my experiment.)

As embarrassing as it was at the time, now, 25 years later I'm glad I made that mistake and learned that lesson. It greatly sensitized me to the need to examine all the assumptions that go into a measurement, and helped me notice when others were less than punctilious about it.

Speaking of less-than-punctilious measuring, I'd like to call your attention to a report available at [SurfaceStations.org](http://SurfaceStations.org) entitled "Is the U.S. Surface Temperature Record Reliable?" The short answer is *NO*. And along with the unreliable data goes much of the case for global warming.

The report is written by Anthony Watts, who has been doing broadcast meteorology for 25 years, both on TV and radio. He is currently chief meteorologist for KPAY-AM radio and also runs the website [wattsupwiththat.com](http://wattsupwiththat.com). The site provides a welcome dissenting side in the global warming debate and I encourage you to check it out. Watts founded [SurfaceStations.org](http://SurfaceStations.org) in 2007, "a Web site devoted to photographing and documenting the quality of weather stations across the U.S."

Why do this? The answer to that is stated in the executive summary:

The reliability of data used to document temperature trends is of great importance in this debate. We can't know for sure if global warming is a problem if we can't trust the data.

The official record of temperatures in the continental United States comes from a network of 1,221 climate-monitoring stations overseen by the National Weather Service, a department of the National Oceanic and Atmospheric Administration (NOAA). Until now, no one had ever conducted a comprehensive review of the quality of the measurement environment of those stations. (Pg. 1)

The story of what prompted Watts to begin this study is interesting in its own right. As Watt says, "It began when I set out to study the effect of paint changes on the thermometer shelters, known as Stevenson Screens, used by the National Oceanic and Atmospheric Administration's Weather Service (NOAA/NWS) to track changes in the climate of the U.S." (Pg. 4)

From 1890 until 1979, Stevenson Screens, which are just wood-slatted boxes, were specified to be coated with whitewash. In 1979, this was changed to semigloss latex paint. In 2007, with some time on his hands, Watts decided to find out if this change in coating affected the temperature readings inside the Stevenson Screens.

He went about it this way (although I can't show the picture of Figure 2, it looks as described):

I purchased three new Stevenson Screen thermometer shelters, shown in Figure 2. One is bare wood, unpainted, as a control; the middle one is painted with latex, as sent by the supplier; and the third is painted with a historically accurate (for early twentieth century) whitewash mixture that I obtained (both materials and formula) from the head chemist at the National Lime Company. Whitewash was mixed after conferring with chemist Richard Godbey of the Chemical Lime Company in Henderson, Nevada, and after reading a paper he authored on the history and home creation of whitewash. (Pg. 4)

I must point out that this account represents a level of attention to detail, particularly with respect to the whitewash formula, that should be emulated in any kind of experimental replication, but seldom is.

This is what Watts found:

This test showed that changes to the surface coatings did make a difference in the temperatures recorded in these standard thermometer shelters, shown in Figure 3. I found a 0.3 degrees F difference in maximum temperature and a 0.8 degrees F difference in minimum temperature between the whitewash and latex-painted screens. This is a big difference, especially when we consider that the concern over anthropogenic global warming was triggered by what these stations reported was an increase of about

1.2 degrees F over the entire twentieth century. (Pg. 5)

\* \* \* \*

Having discovered that the switch did significantly affect temperature readings, Watts “set out to determine if the Stevenson Screens of the U.S. network of temperature-monitoring stations had been updated to latex paint as required by NWS specification changes in 1979.” There were three stations relatively close to his home base of Chico, California. Here is what he found. “The first station, at the Chico University Experiment Farm, had been converted to latex, but it also contained a surprise. It had two screens, one of which was converted to automated radio reporting. I was surprised to find NWS had installed the radio electronics just inches from the temperature sensor, *inside* the screen.”(Pg. 5)

The second station, in Orland, California, was well maintained and properly painted with latex. Unfortunately, this is what he found at the third site: “The third station, however, in Marysville, California, revealed the Chico University station was not a fluke. As I stood next to the temperature sensor, I could feel warm exhaust air from the nearby cell phone tower equipment sheds blowing past me! I realized this official thermometer was recording the temperature of a hot zone near a large parking lot and other biasing influences including buildings, air conditioner vents, and masonry.” (Pg. 5)

The rest is history. Two of the three stations Watts visited were not measuring what they were supposed to be measuring. As he puts it for the Marysville station, “Yet here we had an official climate-monitoring station, dubbed part of the ‘high-quality’ USHCN (U.S. Historical Climatology Network) network that provides data for use in scientific studies, actually measuring the temperature of a parking lot with air conditioners blowing exhaust air on it, and missing more than half of its data for the month of July!” (Pg. 6) So it was obvious there was a need to survey the rest of the stations in the USHCN, and the Surface Stations project was set up to “create a network of volunteers to visit USHCN climate-monitoring stations and document, with photographs and site surveys, their quality.” (Pg. 8)

What the Surface Stations Project found is deplorable. The report details, with lots of color photos of actual stations in the network, just how haphazard and inept our attempts to accurately measure the surface temperature record in the U.S. have been. For instance, there are guidelines for how close a measuring station can be to a parking lot or other “artificial heating or radiating/reflecting heat source.” The Surface Stations Project surveyed 70% of the stations in the U.S. This is what they found: “(W)e found that 89 percent of the stations—nearly 9 of every 10—fail to meet the National Weather Service’s own siting requirements that stations must be 30 meters (about 100 feet) or more away from an artificial heating or radiating/reflecting heat source. In other words, 9 of every 10 stations are likely reporting higher or rising temperatures because they are badly sited.” (Pg. 1) The report concludes, “the raw temperature data produced by the USHCN stations are not sufficiently accurate to use in scientific studies or as a basis for public policy decisions.” (Pg. 17)

Obtain the report, read it, dissect it, and refute it if you can, or accept it if you can't. That's the honest thing to do. I have long wondered why most of my fellow physicists haven't been as skeptical of global warming alarmism as I have been. I think one reason, perhaps even more important than their politics affecting their judgment, is that they naturally assume other scientists are as careful in how they obtain data as physicists are. I've been a global warming skeptic for some time now, and it didn't even occur to me that most of the time the thermometers would be “sited next to a lamp.”

What's really ironic is that, if someone claims to see a flying saucer, which hurts no one and costs nothing, debunkers come out in force. But let a former vice-president claim environmental apocalypse is upon us, and suddenly we're appropriating billions and changing our lifestyles.

Cripes.

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[\[Back to Table of Contents\]](#)



Short Story: **THANKSGIVING DAY** by Jay Werkheiser

People in an unprecedented situation will have to deal with problems both old and new....

Kev's stomach curled around emptiness, embracing it as a constant reminder that the colony's Earth food was almost gone. Another three months, four at the outside. *Then what? How will we die?*

He bent down to look into the nearest cage. "Maybe you'll tell us why the food here is poisonous," he said to one of the rats inside. It rolled its dull eyes listlessly toward him. Rust-brown clumps matted its fur, and the metallic odor of dried blood hung in the air.

*Is that how I'll go, clutching helplessly at alien dirt, coughing up blood?* His gut clenched tighter.

"They are not going to tell you anything," Ahmet said from across the toxicology lab.

Kev looked up from the cage at the short, dark-skinned man walking toward him. His circular glasses, perched atop a narrow nose, reminded Kev of an owl. "I thought I'd stop by on the way home from the analytical chem lab," Kev said. "One of the grunts said you were looking for me earlier."

Ahmet nodded. "I was hoping you could run some samples for me. Give me a clue what's in them."

Kev frowned. "The biochem team has me running Bradford assays day and night, looking for alien proteins. Did you come up with a new lead?" Hope flared in his chest, then died with Ahmet's reply.

"I'm afraid I'm just grasping at straws. My subchronic rats keep developing the same symptoms—nosebleed, bloody stools, and ultimately internal hemorrhaging."

"Subchronic?" said Kev quizzically. "My field's spectroscopy."

"The subjects receive daily doses of an alien food source over 10 percent of their life span, about three months for rats."

"Three months?" Kev said. "The hydroponics tanks are *dying*, Ahmet."

"Yes, I understand that. You're not the only one living on short rations." Anger flashed behind Ahmet's glasses, but quickly dissipated. "Toxicology is a slow business. I don't think we're going to have results in time." Ahmet seemed to deflate with his anger. "We came all this way, spent all those years on the ship, to fail before we even get started."

Kev put his hand on Ahmet's shoulder. "We're not going down without a fight."

Ahmet nodded, his eyes downcast. "I have learned that mycowood produced the most severe symptoms in the rats."

"Mycowood? They're those mushroom-shaped tree things, right? Smell minty."

"Yes. The organic team tells me the smell comes from salicylate esters. All the local plants produce them."

Kev connected the dots. Salicylates. Aspirin. "Blood thinners?" he asked.

Ahmet's head bobbed up and down. "But only dangerous in quantities much larger than we find here. Still, I think it could be important."

"All right, send some of your mycowood samples over to the analyt lab. I'll squeeze them in first thing in

the morning."

"Thank you. Thank you!" Ahmet's Turkish accent was normally muted, but it thickened when he was excited. "That will be most helpful."

"Save your enthusiasm for tomorrow." A thin smile curled Kev's lips, his first in a long time. "It's nearly fourteen o'clock, time to head home for a few hours' sleep."

The short walk across the colony compound felt longer because Epsilon Indi, settling low on the horizon at this late hour, cast bright sunbeams into his eyes. Two long shadows moved through the glare ahead of him. Kev shielded his eyes with his hand to see who it was—two grunts working late in the reactor building.

He hated the way the word grunt had become a part of the colony's lexicon. He cringed inwardly, remembering that he'd used it himself in the tox lab. *It's hard to fight human nature.*

But he could try. He waited until he could see the nearest worker. "Hi, Logan."

Logan lifted his form straight upright, elevating his square jaw so that it was level with the top of Kev's head. He looked down at Kev with disdain in his eyes.

Kev shook his head and continued walking.

The corrugated aluminum hut that Kev called home doubled as Mandy's office. Her attention didn't waver from her spreadsheet when he entered. Tension lines were clear in the screen's reflection of her gaunt face. Kev tried to remember her during the good times back on the ship, the carefree ecological engineer he'd fallen for before the dieback of nitrogen-fixing bacteria in the hydroponics tanks. The memories of those days, only two years distant, felt like another life.

Did he dare say anything? Interrupting her carried serious risk. He settled on something noncommittal. "Why don't you take a break, hon? Maybe get some sleep."

She shook her head without turning to face him. "No time. Bad news from the soil tests."

His mood deflated further. "It's not going to be able to support Earth crops anytime soon?"

"Maybe not ever." Kev caught the slightest quiver in her voice.

"Working yourself to death isn't going to help," he said.

"Sleep isn't going to save the colony."

"You were elected mayor, not miracle worker."

"They elected a savior."

And that was the problem.

\* \* \* \*

The next morning she was still at her desk, slumped over the keyboard. Kev gazed at her, longing for the life they had planned, for the bright new world they were going to build together. The dieback changed everything. Through sheer will, Mandy had held the hydroponics tanks together long enough for the ship to reach New Hope. When the colony's mayor became the first to die on the new world, Mandy had been swept into office on a wave of adulation. Her dreams were on indefinite hold.

All Kev could offer her was sympathy. It wasn't enough.

He slipped out without waking her. He squinted in the early morning sunlight as he made his way to the analyt lab. Ahmet's samples sat on his workbench next to the UV-vis spectrophotometer. Kev shook his head and started extracting organics from the mash.

By noon his workbench was crowded with protein samples marked urgent. He ignored them. Ahmet's mycowood had his full attention. There was no need to stop for lunch; that meal had vanished with the food reserves.

Better to focus on work than on hunger. The infrared spectrographs of the mycowood samples showed strong ester peaks as expected, but there was also a significant peak showing carboxylic acids that weren't involved in ester bonds. And it looked like there was a sulfate peak in there. The problem was that Ahmet's mycowood had been mashed up and dried to make rat food. Everything was jumbled together.

What Kev really needed was a fresh set of samples. But that meant leaving the colony compound. He blew out a long breath, purposely avoiding the protein samples with his eyes. There would be hell to pay.

He headed next door to the biology lab, looking for a travel partner. He found his target's scrawny frame hunched over a microscope, his clean and pressed white lab coat contrasting sharply with his mahogany skin. A half week's unruly growth lined his jaw.

"How about a trip into the wild, Ben?"

Ben jerked his head up from the microscope, a startled look on his face. "You know those flying bug things that occasionally buzz around the compound? I think they're actually seed packets from one of the forest plants."

"Why would you say that?"

"I got one under the scope," Ben said. "Looks like their skin cells have cell walls."

"Humph. They sure look like bugs," Kev said. "So are you coming?"

"What? Oh. You couldn't drag me out of here. You'll have to go without me."

"You know the rule. No one goes out alone."

"Take a grunt."

Kev sighed. "All right. But you owe me."

It was a bad idea anyway, he thought. He had too much work to do. He took a quick stroll to the mess hall first. No food would be available this early; he hoped to fill his stomach with some water.

Logan and his wife, Marta, were the only other people in the hall.

*Take a grunt.* He found himself standing beside their table before he was aware he had made the decision.

"I'm going off compound, and I need someone to go with me. Interested?"

Marta looked up at him. "I've got a work detail in an hour or so, but Logan's off today."

"Wasn't planning on going anywhere," Logan said.

"Oh, go with him. You're always complaining about being cooped up."

Logan shot his wife a sharp look. "Sure. Anything for the mayor's fiancée." He snorted.

The jab connected. Kev and Mandy were supposed to have married at planetfall, but by then she had taken the weight of the colony on her shoulders. Single-handedly holding a dying ecology together left no time for marriage.

Without a word, Kev walked away with what-ifs swirling around his mind. If only they had brought more soil bacteria. If the old mayor hadn't botched his first shuttle landing. He was surprised when Logan took up a position at his side. His long strides forced Kev to pick up his pace.

Once away from the cluster of corrugated aluminum structures of the colony compound, the hard-packed soil became spongy and loose. The planet's slightly above-Earth-normal gravity pressed Kev's boots deep into the soft loam. The ever-present noises of construction gave way to the sounds of alien wildlife.

A metallic click caught Kev's attention. His eyes snapped to Logan, who had just slapped a clip into his 9mm pistol.

"You won't need that," Kev said. "Nothing on New Hope wants to eat us."

"Says you." He waved the gun. "If the Army taught me anything, it's to trust this more than you techs."

Kev tried to put Logan out of his mind. Tendril-leaf sprouts were already encroaching on the bare soil surrounding the colony. Their whiplike tendrils waved in the breeze, luring unsuspecting prey. Humans had been on New Hope for three months, not enough time to learn much beyond the basics about the native ecosystems. The tendril-leaves seemed to be carnivorous plants that turned the tables on the small crawling animals that came to feed on them. A few mycowoods dotted the area, outliers of the forest that covered the hills a couple of kilometers ahead. Squat fernlike structures and low prickly bushes, members of several yet-unnamed species, surrounded the mycowoods.

Walking into an alien ecosystem filled Kev with a sense of discovery. He felt the tension in his gut dissipate, and soon he was absorbing the sights, sounds, and smells that mankind had never before experienced. The soft wintergreen aroma of mycowood bark hung in the air, mingling with the earthy smell of decaying tendril-leaves. A light wind carried clicking sounds from the distant forest, a scuttlebeast calling for a mate. The exobiologists had been hoping to get a close look at one of them since planetfall, but so far no one had found the time to set up a decent trap.

Kev reached out and touched the first mycowood he came upon, allowing his fingers to sink into the rubbery bark. The squat, barrel-shaped trunk recoiled from his touch, sending ripples through the translucent umbrella-shaped frond that formed its cap. Thigmotropism, Ben had called it, a plant responding to touch. On Earth the term more commonly applied to Venus flytraps and ferns whose leaves curl when touched. Here, just about everything responded to touch in some way.

A handful of small spongy fruits hung under the mycowood's frond. He was lucky; most had nothing more than unfertilized seedpods. The ship had arrived early in the mycowood's reproductive cycle, or so the exobiologists speculated. He plucked one of the green fruits as his first sample. He busied himself with collecting samples, bagging them, and labeling.

Logan radiated tension like a small sun. Kev worked in silence, absorbing stress through his skin. He couldn't wait to get back to the lab. Facing angry biochemists would be a relief.

\* \* \* \*

"Whew! Did you bathe in mouthwash this morning?" Kev spun around in time to see Mandy hurry past, her nose wrinkled. *No time to stop and chat, just a quick one-liner and off she goes.*

"Ethyl salicylate," he said just before she reached the door.

She stopped and snapped her head back to face him. Her auburn hair whipped around her neck with the vigor of the action, coming to rest atop her shoulder. "Hmmm?"

"It's an ester." Anything to get her attention, if only for a moment. "It's similar to methyl salicylate, which is used for mint flavoring of foods back on Earth. I extracted it from mycowood."

She walked back to his workbench, sat on a corner, and gave him a weak smile. It was the closest approximation to intimacy he had gotten from her since planetfall. The hint of the old Mandy awoke his desire for the giddy young woman she had once been. "Is that the toxin Ahmet's been looking for?" she asked.

"Well, anything's toxic in large enough quantities," he said, "but no, this can't be our culprit. It's actually less toxic than most of the esters used as food additives on Earth."

She wrinkled her nose in displeasure, deflating his hopes. "So you found that mycowood tastes minty. Lovely. Do you have anything helpful?"

Two years earlier her scorn would have cut him deeply. Not anymore. He tapped his keyboard and brought up the infrared spectrograph he had been working on. "This is one of the water-soluble extracts I got from mycowood while trying to identify the salicylate ester," he said. *Keep your voice professional,* he thought. *Cold.* "These peaks are fairly standard carbon and oxygen bond vibrations. Here is an amine absorption peak. That broad peak around eleven-micrometer wavelength is produced by a carboxylic acid group, but it generally only shows up there in polymers. If I had to guess, I'd say you were looking at a mucopolysaccharide." He folded his arms over his chest and gave her a smug grin. *Get snippy with me, will you?*

"Um, okay. I know that a polysaccharide is a chain of sugar molecules, like starch," she said. "What's the muco-part?"

"A long strand of amino sugars alternating with acidic sugars. Normally I wouldn't have thought anything of it; similar compounds are found in plant cell walls and pectin," Kev said. "But this tiny sharp peak at nine micrometers really got my attention. It means that the thing is sulfated, but that usually occurs in animal tissues."

"That's odd, all right," she said, eyebrows pressed together in concentration. "I'll see if I can schedule you for some time on the electron microscope. Maybe a good look at its structure will help you out."

It was what he needed, at least professionally.

A shout cut off the thought. His head twisted around to the window cut into the corrugated aluminum shell of the lab. The dusk outside brought the startling realization that he had been immersed in Ahmet's mycowood mystery for the better part of New Hope's seventeen-hour day.

His back stiffened when a terrified shriek followed the shout. He leapt from his seat and followed Mandy outside into the crisp evening air. His breath came in ragged gasps. Not yet adjusted to the lack of light, his eyes caught mere glimpses of running figures. A string of rapid clicks amid the shouts told the story—a scuttlebeast had wandered into the colony compound.

A small crowd had the thing cornered against the sloping shell of the mess hall. Its spongy, hairless flesh was pressed against the aluminum wall. Its flat front teeth chattered together so rapidly that the clicks nearly merged into a single buzzing noise. The glassy black compound eye atop its head glistened in the sudden brightness of a flashlight beam. Kev snapped his head around and traced the beam back to its source. He found Logan aiming a flashlight—and his 9mm—in the direction of the cornered scuttlebeast.

Ben stumbled out of the biology building, most of his slight frame hidden behind the trap cage he carried. No one else seemed to see him as he staggered forward under the weight of the cage. Kev watched, transfixed by the impending conflict. By the time he opened his mouth to call out to Logan, it was too late. Pop, pop. Pop. The beast collapsed to the ground as the echoing reports from the gun faded. Ben dropped the cage and charged past Kev. As he passed, Kev could barely make out the grimace hidden beneath the stubble on his face.

A growing crowd pressed in around the two men, a skinny science geek facing down a hulking grunt. Kev pushed through to get a closer look.

"What the hell did you do that for?" Ben shouted.

Logan stood firm, shrugging his massive shoulders. "Better safe than sorry."

Ben stepped forward and thrust his finger into Logan's face. "Safe?" he shouted. "Safe? We could starve while we try to figure out what's safe and what's not. We had an opportunity—"

Logan ground his teeth and slapped Ben's hand away. Kev worried he was about to witness New Hope's first case of assault and battery. He turned to Mandy, waiting for her to step in. *Lead, damn it!* She stood transfixed, her eyes darting back and forth.

*Do something. Now.*

Before he could change his mind, Kev stepped between the two men. He wrapped an arm around each man's shoulder. "You'll learn plenty by dissecting it, Ben." His pulse was racing, but he spoke as calmly as he could. "And I wouldn't mind passing a few samples through IR. It may turn out that Logan did us a favor." Turning to give Logan a hard look, he added, "Now that we know they're not dangerous, we'll make sure to take the next specimen alive."

He held his breath. Ben glared at him for a moment, then hissed, "When did you start apologizing for grunts?" He twisted from Kev's touch and stalked away into the darkening evening.

Logan pushed Kev's arm away. Kev looked up at piercing brown eyes set into a face that could have graced the cover of a cereal box back on Earth. "Nice going, hero," Logan said.

Kev shook his head and turned away. He walked toward the analyt lab, mumbling, "There's no pleasing him."

He hadn't intended Logan to hear, hadn't intended even to say it out loud. He felt Logan's meaty hand close on his shoulder and his knees turned to rubber.

"You're right, nothing's gonna please me until we get a fair shake," Logan said.

Kev turned to face him, acutely aware of the hushed colonists huddled around. *Jeez, how did I get myself into this?* "Okay, Logan, tell me. How are the gr—the workers treated unfairly?"

Logan stared down at Kev for a long moment before the fire in his eyes burned down to glowing embers. "Us second-class types don't like being short changed in the chow department."

"What are you talking about? We all get equal rations."

"Yeah, well how many calories do you burn sitting in your lab? Us grunts work for a living. Equal ain't necessarily fair."

Shouts of agreement erupted from the crowd. Mandy stood in place as though stunned. As if Kev didn't have enough to worry about.

\* \* \* \*

Kev got his turn on the electron microscope the next morning. He drifted toward the analyt lab, squinting to read the micrographs in the glare of the morning sun. The molecule was indeed a mucopolysaccharide, but the amino sugars were linked at the sixth carbon. In Earth life, carbon-four bonds were the norm for saccharide chains. The odd linkages coiled the polymer into a tight helix.

"Eh! Watch where you're going, tech."

Kev looked up from the paper to see that he had nearly walked into a grunt. *Worker*, he corrected. Three months ago the man had been the heftiest human to walk New Hope; now his denim work clothes hung limp across his frame. "Sorry."

"Hey, ain't you the hero from last night, gave us some bull about fair rations?" His eyes narrowed, appraising Kev.

"Maybe he should try swinging a hammer for a while, see if he thinks his rations are enough then."

The new voice came from behind Kev, and he wheeled around to see that the speaker did indeed have a sledge in hand. Two more men sauntered toward him. His empty stomach gurgled in fear.

"We can resolve your complaint at the town hall meeting tomorrow." Kev backed away and stepped right into the grasp of the first man.

The man with the hammer pressed the tool into Kev's hand. "I'd like to see you do some real work, tech," he snarled.

Kev's eyes darted back and forth, anxiously seeking a way out. He caught motion off to the left—Logan approaching. *That's all I need.* Marta clung to him, her arm draped weakly over his shoulder, her head hanging limp. He staggered forward under her weight.

"What the hell?" Kev said. The surrounding workers' heads turned as one.

"Gimme a hand over here, will you?" Logan shouted.

Kev ran toward them, burning valuable calories, leaving the bewildered grunts to follow in his wake. He grabbed Marta under the shoulder and helped Logan ease her down onto the packed earth. "What happened to her?"

"Well, I, uh, she didn't..."

Kev noticed a large purple blotch on her upper arm where Logan had gripped her. He bent closer, running his hand over the red markings that dotted her skin. Subdermal bleeding. His mind snapped back to the hemorrhaging rats in Ahmet's lab. "Did she eat anything unusual? Damn it, Logan, tell me!"

Marta's hand closed on Kev's wrist in a feeble grasp. "I ... I've been adding tendril-leaf shoots to my rations." Kev could barely hear her voice. He waved the men around him to silence and leaned closer to

her. "Just a little with each meal," she said, "enough to stretch my rations further."

"Why, Marta?" Logan's eyes shimmered as he spoke. "Why would you try something like that?"

"I thought if I ate less Earth food there'd be more for you," she said. "You need..." Tears streamed down Logan's cheeks. He buried his face in her hair and whispered into her ear.

"Damn," Kev said. He looked up at the men surrounding him. "We've got to get her to the med hut. Now."

\* \* \* \*

"They said it was like a heparin overdose," Kev told Mandy that evening. "It's a drug they use to prevent blood clots. They gave her protamine sulfate, the same treatment they give to neutralize heparin. The doc said she'd be fine, unless there's some other toxic effect we don't know about yet."

Mandy's eyes lit. "Can we detoxify all the local food with it?" For a brief moment, hope danced in her eyes.

He shook his head. It hurt Kev to take away her first moment of optimism since planetfall. "We'd need a lot of it, administered intravenously after every meal. I can't see how we could make it fast enough."

"Then we're back to square one," she said. "Worse, because we had to use valuable medical resources."

"Maybe not. Heparin's a mucopolysaccharide. There might be a connection—"

"I'm going to put restrictions on grunt movements."

Kev locked onto her icy stare. "What?"

"I'm afraid others might try Marta's trick."

"They're hungry. The rations are barely enough for us scientists, and we don't work half as hard as they do."

"I already cut the work schedule down to the bare essentials—running the power plant, putting up prefab shelters, unloading critical supplies from the landers."

"I don't think they can keep going much longer on the rations they're getting."

"What do you want me to do?" Her voice rose to nearly a shout.

Kev felt his own anger peak, but it didn't last. He didn't have the strength for any more arguments. "No one blames you."

"Yes, they do. Even you. I can see it every time I look into your eyes."

Her words stung Kev. The truth hurts. "I ... I just want—"

"I know what you want," she hissed. "It's what the whole damn colony wants. Well, maybe I'm not the savior everyone wants me to be. Ever think of that?" She flopped onto a chair and buried her face in her hands. Kev could do nothing more than stand next to her. Touch her shoulder? Comfort her? That would just make things worse. The last remnants of his anger drained away, leaving him numb.

When she finally lifted her head, he saw that her eyes were cold and lifeless, hardened against further anguish. "No more leaving the compound," she announced with finality. "Not for grunts. I can't trust them



out there."

"How are you going to enforce it? Honor system? An armed militia of scientists?"

Her voice was a low monotone, devoid of feeling. "If I have to."

"But—"

"I'll announce it at tomorrow's town hall meeting."

"But—"

"It's *not* open for debate."

*This is how we'll die*, he thought.

\* \* \* \*

Kev slipped out of bed early the next morning to avoid another argument. He walked slowly toward the analyt lab, savoring the damp chill of the morning air, the calm before the coming storm.

Samples from the scuttlebeast dissection sat atop his workbench, each labeled by tissue type in Ben's meticulous handwriting. A thin smile played across his lips. He knew Ben couldn't hold a grudge. He hadn't alienated everyone who was dear to him. Just Mandy.

He prepared a quartz cuvette with one of the scuttlebeast samples and popped it into the IR. The spectrophotometer hummed softly as it passed its infrared beam through the sample, leaving him to his worries.

He tried to occupy his mind by fiddling with the software that subtracted water absorption from the sample's spectrograph. After an eternity, a green light flashed on the front of the spectrophotometer. He displayed the spectrograph on his monitor and cursed. He must have mixed up the samples! This was the graph of a salicylate sample taken from a mycowood. He pulled the cuvette from the sample tray and squinted at the tiny letters scrawled in his own handwriting across the top edge. "S-Beast Samp 1." Humph.

The town hall meeting would be starting soon. Was there time to rerun the sample? He decided he didn't care and poured another of Ben's scuttlebeast samples into a second cuvette. More time to worry. Had Mandy announced her new policy yet? Would the divide between techs and grunts become an irreparable rift?

He cursed himself for using the derogatory slang terms. *We're all colonists, not two separate species.*

And that was the answer.

The green light flashed. One look at the spectrograph confirmed his guess. Scuttlebeasts were mycowoods.

Life on Earth had differentiated into plants and animals; on New Hope it had not. All life fell into one kingdom with a life cycle including both sedentary and mobile forms. The biochemistry fell into place. Blood-thinning plant esters. Clot-busting animal enzymes. Individually, the body could process them. Consumed together, in the same organism, their effects were cumulative.

He jumped to his feet and ran toward the mess hall, his heart pounding.

He was one of the last to arrive at the crowded mess hall. The science staff clustered around the tables at

the far end of the hall, near the podium set up for Mandy. The workers milled about near the entrance. Kev could feel the tension permeating the room.

He waded through the sea of grunts, impatient at the slow progress he was making. He had to *tell* someone! His eye caught Ahmet, sitting across a table from Ben. He dropped into an empty seat.

"Sorry about the other night," Ben said, eyes lowered. "I was a little hot about Logan and, uh, well—"

"Not now," Kev said. "I have a theory that just might explain the toxicity of local food sources." At the podium, Mandy called the meeting to order. Ben's eyes and Ahmet's spectacles locked onto Kev as he explained.

Ben snapped his fingers. "That explains a lot about scuttlebeast tissue morphology. Would you believe that the squamous cells in the animal's skin contain chloroplasts? And cell walls, just like the bugs. Deeper inside we found more animal-like cell structures."

Ahmet shook his head in dismissal. "I'm afraid the toxicology doesn't hold up," he said. "Heparin is not toxic by ingestion. It is too easily digested."

Kev pursed his lips, concentrating to hear the soft-spoken, accented words over the growing din. The hope in his chest deflated as Ahmet's objection sunk in. *No, wait.* "The muccopolysaccharide I found is more tightly coiled than you'd find in Earth life. Maybe that makes it resistant to digestion. Enough of it reaches the bloodstream to interact synergistically with the salicylate esters."

Angry shouts erupted from the back of the mess hall. Kev focused his attention on Mandy's amplified voice long enough to hear her say, "...only a temporary measure. The order will be rescinded as soon as we find a way to make local food sources edible."

The shouts grew louder. An empty glass shattered on the wall behind Mandy. She flinched reflexively, drawing loud boos from the grunts. They began inching up the aisle. A new fear gripped him. *They're going to hurt her!*

He felt a tap on his shoulder. He snapped his head around, prepared for the worst. It was Logan. "We gotta do something."

Kev exhaled in relief. "Right. Let's go." He followed Logan as he forced his way through the now-congested aisle toward the podium. Perhaps it was already too late.

"Get away from me," Mandy said as Logan approached. He stepped aside and Mandy's eyes fell on Kev. He saw in those eyes the haunted solitude of a woman betrayed. "Kev?" That meek whisper would haunt him for the rest of his life.

He had no idea what to say to her. But in that moment he knew that her feelings mattered to him deeply. He still loved her. He dropped his eyes and turned to the podium. "Stay calm," he said into the microphone. His voice emerged from the speakers, unsteady and hesitant. "We ... we are working on a way to detoxify the mycowood...."

"Only thing that can save the grunts is a grunt mayor!" Shouts from the crowd grew louder and the menacing workers loomed closer. They began to chant, "Logan! Logan!"

"Hold it! Listen to him!" Logan said, and in a flash he was by Kev's side. "We can trust him," he said into the microphone. *"I trust him."* The chant died down and Kev stared at Logan in shock. Logan invited him to speak with a wave of his massive hand.

Kev cleared his throat into the microphone, breaking the sudden silence. He realized that every single man and woman on the planet was waiting for him to speak. His hands began to tremble. "I ... we, uh, f-found two substances that, when ingested together, inhibit the blood's ability to clot—"

"Tech-babble," shouted a grunt. "That's all they offer. We're the ones who built this colony! Logan should be in charge."

Ben reached the front of the crowd and shouted, "No, wait!" A grunt grabbed him from behind, locking his arms behind his back, while two others advanced on him.

"No!" All eyes turned once again to the podium, where Logan's shout had needed no microphone. "Listen to him." Ben shook off his attackers and stared at Logan with newfound respect.

Kev realized that he didn't have much time to make his point. The worker was right; now was not the time for a chemistry lecture. The colony needed action, not words. With his pulse pounding in his ears, he began to speak. "Me, Ben, and Ahmet think we have it worked out. Logan can oversee our work, make sure we're on the level. If we're right, we should be able to use mycowood as a food source."

As one, the colonists stared at him in stunned silence, eyes wide. Someone began to clap. Soon, the mess hall shook with a deafening ovation. Kev stepped back from the podium, his rubbery knees barely up to the task. Logan had pulled Ben and Ahmet out of the crowd and now stood next to Kev, an arm draped over each man's shoulder.

"I'm afraid I do not see how you intend to make mycowood edible so quickly," Ahmet shouted over the din.

Logan's look hardened. "If you're bluffing—"

Ben flashed a wide smile. "Think about it. The animal-like enzymes are produced inside the body cavity, the salicylates in the bark, or skin, or what have you. It should be easy to separate the two."

"So we just have to be careful to eat the skin separate from the meat?" Logan asked.

Kev's head bobbed up and down enthusiastically. "More or less. We'll also want to find a way to remove most of the mucopoly—uh, the heparin enzyme to be safe. You think that will work, Ahmet?"

His owl-eyed glasses sparkled, and a broad smile split his face. "I'll clone another litter of rats right away. We'll have an answer in a month."

\* \* \* \*

Every colonist on New Hope, save one, was seated in the mess hall for the big day. Kev noted with a touch of disappointment that they sat in clumps, a tech table here, a grunt table there. It will take time, he thought.

Ben, sitting next to him, leaned over and whispered, "Couldn't talk Mandy into coming?"

"Doc Pearson said I shouldn't push her. She needs time to get her confidence back."

Ben nodded and lowered his eyes. "She'd been standing between us and death for more than two years. Anyone would've cracked under that kind of stress."

"She never wanted to be mayor," Kev said. "But we idolized her for keeping us alive long enough to get here. How could she refuse? She has—we have a lot to work out."

Ben hung his arm over Kev's shoulders and smiled. "Buck up. She'll be fine, like the shrink says. Today's *your* moment in the sun. I think it's time to get this celebration started."

Ben was right. Kev clapped him on the back and put on the best smile he could muster. He stood and the murmured conversations faded to silence. He ceremoniously lifted the lid from the large pot sitting on the table before him. His action was mirrored at every table in the hall. A warm mint aroma climbed the short distance to his nose. A rich, textured bouquet lurked beneath the mint, earthy and perhaps a slight bit fruity. He drew the aroma deep into his lungs and the colonists erupted in cheers.

"I never wanted the job, and I'll be glad to turn the reins over to a real leader once we find one," he said, and the cheers turned to chuckles. The colonists' good humor was contagious. "But for now, here I am, your interim mayor and M. C. of this incredible celebration. Who would have thought two months ago that we would be sitting here today in peace, about to share our first native meal?"

"Ahmet thought it would be *one* month!" Logan shouted, prompting a second round of chuckles. The Turkish man stood and took a theatrical bow.

"We'll give him the extra month," Kev said. "In the weeks and months ahead we'll be able to add many more local food sources to our diet. We'll have recipe contests, create dishes unique to New Hope. I personally can't wait to try scuttlebeast meat. Ben here tells me it probably tastes sweet. After all, it's little more than the fruit of the mycowood, like an apple that can go out and find its own mate.

"But for today, let us give thanks for the first native food guaranteed to be safe—mashed mycowood bark, or skin, or whatever you want to call it." Kev picked up a serving spoon and thrust it into the pot. He lifted a heaping spoonful of the steaming yellow-green mash and dumped it onto his plate. It had a pasty consistency, like hummus. He dipped his fork into the warm paste, lifted it, and popped it into his mouth. The colony cheered as one as New Hope provided its very first sustenance to a human guest.

It tasted like a whole new world.

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[\[Back to Table of Contents\]](#)

Novelette: **JOAN** by John G. Henry

\* \* \* \*

*Illustration by Mark Evans*

\* \* \* \*

Real history can be quite different from the legend that grows around it....

Kate paused on her way out of her apartment to adjust one of the pictures adorning one wall. Every picture on that wall had the same subject: a young woman either riding or fighting in medieval armor, or in medieval men's clothing facing hostile questioners, and in one heartbreaking depiction tied to a stake in the middle of a town while flames rose around her.

Her friend Cylene turned a long-suffering look on Kate. "Have you ever thought that maybe you take the Joan of Arc thing a little too far?"

"That depends on your definition of 'too far.'"

"Learning French."

"Lots of people learn French. It's an important language."

"Buying every picture and book about Joan of Arc that you can find."

"She was an important historical figure," Kate argued.

"Joining the Society for Creative Anachronism, buying an entire set of authentic medieval-type armor *and* a sword and devoting plenty of hours to fighting other SCA-type people."

"It's fun, and it helps you understand history better, and SCA-type people are very interesting."

Cylene shook her head. "How many of them mention at least once a week how much they love Joan of Arc and how they wish they could somehow save her from being burned at the stake?"

Kate frowned at the floor. "I don't ... love her that way."

"Right. If you were still in junior high school instead of graduate school you'd spend all of your class time practicing writing 'Kate of Arc' in your notebook. Look, I'm not as up on history as you are, but I'm pretty sure that Joan of Arc didn't have a lesbian bone in her body."

"You can't be certain of that."

"Oh, Kate." Cylene's expression turned pleading. "You should be living your life today, with ... people today."

"Like you?" Cylene blushed slightly at Kate's blunt question. "I'm sorry. You're really great, Cy, but I guess I just wish..."

"It was six hundred years ago, Kate!"

"A little more than that, but, yes," Kate answered in a low voice. "I realize I may seem a little obsessive, but is it so wrong to wish I could have saved her from being burned? She was such a remarkable person and it was such a horrible fate."

"Yes, it was." Cylene sighed. "I guess I'll have to stay the other woman in your life."

The first thing a graduate student learned was that being a grad student consisted of nine parts drudgery to one part learning. Kate and two other grad students were drudging away evaluating undergraduate papers when Professor Barandila poked his head into the room they were using. "Kate, I need some assistance in my lab. Are you available?"

Kate perked up, aware of the other students casting envious glances at her. Prof Barandila's lab was off-limits, leading to constant speculation about what he was working on. Now Kate would be in a position to find out. "Can you guys handle the rest of these?" she asked her fellow grad students.

They nodded with different degrees of resignation, and Kate followed as Barandila shuffled to his lab with a defeated air. "I need the lab papers collected and archived. It has to be completed this week. Don't worry about the equipment. That will be dismantled later."

"Oh." Kate looked from the professor to the massive gleaming hollow cube formed of wires and tubing. "It didn't work?"

"I don't know. Nobody knows." Barandila walked over to the equipment and gazed at it morosely. "There's no sense in not telling somebody now. This should be a working time-travel device, something capable of placing a human being in the past and then recovering that person."

"Isn't that impossible?"

"Anything is impossible if you don't do it right!" Barandila pointed to his device. "Time doesn't even exist if you do the equations properly. The problem was in repositioning someone to a different place, a place they couldn't be in. Have you heard of tunneling? Yes? A particle goes from one place to another place it cannot go, yet it does? That's very simplified, but that's the principle this device uses. It doesn't actually move something through time, it just establishes conditions under which that object is actually in another time."

"But, it doesn't work?" Kate asked again.

"It seems to work." His burst of energy gone, Barandila slumped against a desk. "But we can't use a human test subject unless we know it's safe. Rules and regulations. Animals aren't even permitted unless it's proven safe for robots first. We tried using robots, then just cameras and sound recorders. They were all disabled, none of them brought back samples. Something about the travel device wipes everything on any recording device we've tried. It's just blank. The return device seems to work, but is it really returning them? Are they really going anywhere? The return is the instant after they left. It has to be, so there's no proof anything went anywhere, no proof it is safe, and without that proof we can do nothing."

"Why not just send something back in time a couple of hours? A note or something?"

Barandila mustered a smile at the suggestion. "Good thinking. We tried that. Nothing happened. It may be a problem with trying to make an object simultaneously exist twice, which is what would happen if we sent something back a short time, and there are no conditions we can establish in which an object or living thing simultaneously exists twice. As far as we can tell the universe will not accept that." He shrugged. "One more thing that didn't work. So the machine will be taken apart next Monday."

"Next Monday?" That left six days. Kate couldn't take her eyes off of the device, a wonderful and frightening idea coming to her. "Professor, since they're taking it apart soon, would you mind showing me how it works?"

\* \* \* \*

It felt ridiculous sneaking into the university lab complex after midnight with her armor. Being caught with

a weapon on campus, even a sword, would get her into major trouble. But Kate kept on going, wondering if she really was far too obsessive for her own good.

But then she thought of Joan. Thought of her tied to the stake as the flames rose.

Kate kept on going.

She put on her armor, trying to imagine any possible cover story if she got caught by campus security. The contents of the bag tied to her waist were illegal on or off campus, but she needed what was in there even though the cost had made her cringe. Kate had to leave her gauntlets off to set the controls, specifying the date, time, and location as precisely as she could, making sure the return device was firmly attached to her wrist.

Taking up position on the platform that Professor Barandila had indicated, Kate closed her eyes, took a deep breath, and then winced in shock as sunlight flared around her.

\* \* \* \*

Rouen in May, 1431 AD was crowded, dirty and overrun with English merchants, knights and other soldiers. The city had been controlled by England for more than a decade, so the invaders carried themselves with easy familiarity. Kate, hidden behind her armor, had to talk her way past guards at the city gate who laughed at what seemed to be the spectacle of a knight who was walking because 'he' couldn't afford a horse.

She had an idea for getting a horse, though.

It wasn't too hard to find where Joan's public appearance was going to take place. Many people were heading that way, speculating about the Maid, wondering if the devil or God's angels would appear to save her.

Two elevated platforms had been set up, a small one for Joan and her guards, and a larger one for the inquisitors. The crowd around the platforms seemed a solid mass, but on the outskirts squires stood holding the horses of their masters. Kate walked confidently toward the squires, ignoring their speculative looks.

She stopped in front of two horses that looked very promising, massive war steeds resembling the Belgian draft horses of her own time. The two squires holding them looked at each other nervously, then Kate couched her voice in what she hoped sounded like a man's tones through her helmet, also hoping that the old English phrases she had wheedled out of a fellow grad student and hastily memorized were accurate enough to be understood. "Your masters need their horses to accompany the Earl of Warwick. Come along."

The armor concealed her nervousness as Kate turned with the casual arrogance she had seen in alpha girls on campus, and began heading toward the platform where Joan was already being subjected to public trial, humiliation and intimidation under threat of immediate death by burning. Kate could hear the squires leading the horses behind her as Kate shouldered her way through the crowd, making free use of her armor to plow ahead. The citizens of Rouen and English spectators gave way reluctantly and angrily, but in the manner of people everywhere didn't question someone else who seemed to know what they were doing. Eventually Kate reached a point near the platform holding the Maid of Orleans.

Joan looked awful, weak from illness and maltreatment, worn down by the constant harassment of her inquisitors. In a little while, Kate knew, after holding out against physical and mental torment for a year she would finally bend enough under threat of being burned alive to sign a recantation even though Joan didn't know what the recantation actually said. A few days later Joan would be declared in violation of

recantation, tied to the stake, and burned to death.

That had happened, but none of it would happen, if Kate could help it.

Kate faced the squires again, who were looking around for their masters in puzzlement. "I'm to ride one of the horses and lead the other." She moved to mount the horse that seemed steadier.

"But, sir—!" the squire holding that horse protested as Kate barely managed to hoist herself and the weight of her armor into the saddle.

The English men nearby were eyeing Kate, some of them putting their hands to their sword hilts. A gaudily dressed English noble trailed by three knights was coming toward her in the same manner Kate had seen police officers use to approach a potential trouble-maker.

Kate reached into the bag at her waist and pulled out two of the flash-bang grenades she'd gotten from a gun-nut acquaintance who had bought them over the internet. Everyone watched, trying to figure out what she was doing, as Kate pulled the pins on the two grenades, counted to three, then tossed them to either side into the crowd and gripped her seat in the saddle as tightly as she could.

The grenades exploded with thunderclaps of noise and intensely bright flashes of light designed to disorient people but not inflict injury. Those nearby fell away with startled cries, rubbing their eyes and falling to the knees in surprise. Kate had already seized the bridle of the other horse and now converted their panicked bolt into a charge toward Joan.

Everyone in the area was looking at her now, including the band of religious inquisitors on the larger platform. As her horses pulled up short of the small platform, Kate hauled out more grenades, pulling the pins and tossing them toward the guards and other men near Joan, at the large platform with an unspoken wish that the grenade would blow off the nose of the noxious Bishop Cauchon, and out into the crowd again. The crash and flare of the explosions scattered people everywhere the grenades burst, some fleeing in panic and others disoriented and unable to muster resistance.

"Joan!" Kate yelled. "To me!" Joan hesitated only a moment, then leaped forward and down onto the second horse. More English knights were coming, forcing their way through the terrified crowd. Kate tossed more grenades at them, then her mount and Joan's were stampeding toward and through the fleeing crowd.

It took all but one of Kate's flash-bang grenades to clear a path and throw off pursuit, then she and Joan's mounts were thundering toward the main gate of Rouen while arrows and crossbow bolts flew toward them. The last flash-bang broke up a line of pikemen at the gate itself, then Kate hauled out her last weapon, a homemade thermite grenade courtesy of a design a physics major had obligingly drawn up for her under the pretext of researching a story. She dropped the weapon in the center of the gate as they went through, the grenade flaring to life in an intense blaze that would block the gate for a good while.

*This would make a great movie*, Kate thought through her relief and elation as the two riders tore away from the city.

They kept going until Rouen could no longer be seen and Joan slowed their exhausted horses to a walk, then the Maid turned her eyes on Kate. "Who are you, sir, who hurls lightning from your hands?"

Kate laughed and pulled off her helmet, dizzy with relief. "I'm Kate."

Joan stared. "A woman? Such as myself?" Crossing herself, Joan shook her head. "Or are you instead an angel or a witch?"



"Neither, I'm just a woman."

"That has been my argument," Joan said. "You saw how well it has served me."

"Well, yeah." Kate pulled out the crucifix she wore out of habit and her devotion to Joan. "See? I'm okay."

"Oh-kay?" Joan studied the crucifix. "Can you make the holy sign?"

"Cross myself, you mean? Sure." Kate had been raised Catholic, but had stopped believing in the rituals and the male-dominated hierarchy long ago. She still knew the gestures, though. "See? I can recite the Lord's Prayer, too."

"Without stumbling?" Joan asked in a self-mocking manner. "I won't ask that of you, since I wouldn't yield when they demanded it of me in hopes I would offer them some grounds for their charges. But if you are but a woman, how did you discomfort the English so?"

"The grenades? They're like petards, just better."

"Much better! You didn't have to light them, so the English had no warning of their use. Do you have many?"

Kate shook her head. "I used all of them getting us out of Rouen."

"Then we must fear pursuit, even though your weapons surely delayed the English." Joan turned her horse off the road, leading the way across country at the best pace the steeds could maintain. "We must move fast and along quiet ways, hidden by tree, hillock, and bush. But then you know this."

"Yes. Yes, I do," Kate agreed quickly, looking backwards in sudden worry.

For her part, Joan looked ahead, breathing deeply. "Saint Catherine told me I would be saved, and a woman named Kate has fulfilled her promise. How can anyone doubt the word of God? Surely now His hand will guide us as our enemies seek us."

"We can go somewhere safe now," Kate said eagerly. "Where no enemies can find us. Completely safe." Joan gave her a questioning glance, amazingly bright eyes under dark hair cut short in the current male fashion, as Kate continued. "I can take us both there."

"Where is this place?"

"My home. Very far from here, but we can get there instantly."

Joan's glance was measuring now. "But you are not a sorceress or a demon sent to tempt me?"

"No!"

"Very far from here," Joan repeated. "Your French is odd. Your home must be far from France indeed."

"Yes," Kate admitted.

"Could we return as quickly?"

"No."

"Could we return ever?"

As quick-thinking as her trial record had revealed, Joan had immediately asked the questions that Kate had hoped wouldn't come up until much later. Now Kate willed herself to lie, to assure Joan that yes of course they could, but instead the word "no" came from her.

Joan nodded, took another deep breath, then smiled at Kate. "Then I cannot go there, even if you are an angel. I must go south again, find my friends, and serve the kingdom of France and my Lord."

"Charles? King Charles? Who left you a prisoner and did *nothing* to help you?"

"My Lord is God," Joan said softly, her eyes forward again. "I serve King Charles, who I would ask you not to disparage, I serve the kingdom of France, I serve the people of France, but I serve my Lord first."

"Um, excuse me." Kate hadn't thought it would be hard to convince Joan, who had been betrayed by her own side, treated horribly by the English, and had just narrowly escaped a painful death. It hurt to look at her, to see the marks of illness and maltreatment. "You've already done what you need to do. The English will leave France. It'll take a while yet, but they'll lose."

Instead of answering, Joan had a distracted air, as if listening to something else that Kate couldn't hear. After a few moments, Joan's focus sharpened again and she looked at Kate. "My voices tell me I must stay. My mission is not yet done. God wishes more of me. That is why I was saved."

"No. Wait." This wasn't right. Grateful Joan, smart Joan, clever Joan who had talked rings around her learned inquisitors at her trial, who had been abandoned by supposed friends and allies, who had been beaten down to the point where even her will had been about to bend, was supposed to see the sense of coming with Kate. "I know you credit your voices with telling you things, but women used to do that a lot, because society wouldn't accept that women could have ideas on their own. So women claimed they'd been told things by voices or spirits. You don't have to pretend with me. I know you're smart. I mean, you're barely twenty years old now and look what you've done!"

Joan seemed bemused, though. "You know much of me, it seems, and yet much of what you know does not seem to be me."

"I've studied you for years and admired you all my life!"

"All of your life?" Joan laughed in a halting way, as if she had grown unused to any lightheartedness in her captivity. "You seem my own age."

"I'm twenty-three."

"Then you can only have heard of me for a few years! And I must tell you that what you have heard is not my truth. My voices are true and have guided me honestly when I listened to them. They tell me of God's commands for me."

Kate bit back her first reply. Clearly, Joan wasn't the religious hysteric she had often been painted as, but just as clearly she wasn't going to admit to someone she had just met something so personal as what Kate knew had to be the truth about her voices. "I didn't mean to question you. But, really, God didn't save you, I did. I came here for you."

Joan reined in and Kate stopped her horse as well, the two gazing at each other across the small distance between them. Her face lit with some inner fire, Joan reached across to grasp Kate's hand. "Yes, you came. Do you not see the hand of God in this? You were His instrument in my rescue, and that is how I know you will continue to help me. You are a true companion. There is no falseness in you. My voices told me this, as did my heart. I cannot come with you. But *you* can come with *me*."

Kate stared at Joan, at Joan's shining eyes, at Joan's face glowing with conviction, and felt her own will yielding like a weak dam trying to hold back an ocean of faith. "All—all right."

"Then onwards!" Joan kicked her mount into motion again and Kate followed, slowly realizing as they rode that Joan was now leading, not her.

\* \* \* \*

They couldn't have gone more than an hour longer, following a wandering path along small trails and through low areas, before Joan began swaying in the saddle. "Your pardon, but do you have anything to eat? I have not been fed for two days, nor been allowed sleep in that time."

"Two days?" No wonder Joan had been on the verge of collapse. The inquisitors had softened her up in every way possible. Kate dug into another small bag containing a variety of just-in-case-they-were-needed food bars. Joan eyed the food bars dubiously, but after a tentative taste began wolfing them down.

"Have we anything to drink?"

Kate started to say no, but then began checking the contents of the bags hanging from the saddles of the horses. One contained a leather flask that seemed to have about a liter of liquid in it. "How about this?"

Joan took the flask gratefully, putting it to her mouth and drinking deeply before lowering it with a contented sigh and passing it back to Kate. Taking a cautious swallow, Kate found that the flask was filled with sharp red wine. Finishing the last food bar, Joan extended her hand for the flask again and drained it.

Not long after that, Joan fell asleep in the saddle, Kate riding as close as she could to help prop up her companion when necessary even though Kate's own discomfort from riding was growing with every jolt of the horse beneath her. She had ridden enough to know horses, but never for really long periods and rarely in armor. Despite the aches assailing her, Kate wanted to keep going even when the sun set, but the exhausted horses made it clear that wasn't going to happen. Joan roused long enough to lead them off the path they were on into a stand of trees that shielded them from view, their worn-out horses quietly cropping grass. Kate sat, her arms around her knees, watching Joan and trying to think.

Joan sighed happily before falling asleep again. "I shall sleep free tonight for the first time in many, many days. I can never thank you enough, Lady Kate."

Lady Kate? Apparently Joan had decided that Kate deserved a social promotion. The glow of happiness that brought (*Joan thinks I deserve to be called Lady Kate!*) soon dissolved, though. Kate really hadn't planned for a long time in medieval France. She was supposed to rescue Joan, then Joan would quickly and gladly agree to be spirited back to modern times, and some sort of vague happily-ever-after would follow. But Joan wasn't going along with Kate's perfectly sensible plan, even if that plan wasn't very detailed. *She's amazing, though. No wonder Joan impressed, or scared, everybody who met her. But she's not exactly what I expected.* Kate fell asleep herself while trying to marshal new arguments to convince Joan to come with her.

\* \* \* \*

The next day brought a marvelous variety of dull and sharp pains from sleeping outdoors in armor, as well as gnawing hunger since there wasn't anything left to eat. Joan seemed to be blossoming under the open sky, toughened by her peasant upbringing and well accustomed to privation from her long imprisonment, but Kate felt like death warmed over. The horses, surly from too little to eat and too short a night's rest, didn't help matters. Nor did having to wait while Joan knelt by herself for an extended period of prayer.

Eventually they got on the road, but soon Joan insisted on veering into a small village in search of food. "Have you any coin?" Joan asked Kate, cradling bread and wine that a peasant had brought from a tavern.

Kate reluctantly hauled out the single just-in-case real silver coin she had brought along. The image of Franklin D. Roosevelt on one side of the dime was already worn down quite a bit, so there didn't seem much chance that anyone would be able to recognize the coin by the time actual United States currency came into existence in another three or four centuries. But Kate paused as she started to hand the money over, staring at the coin. *I'm worried about a single anachronistic dime? Yesterday, I blew my way out of Rouen with Joan of Arc, who won't be burned at the stake there on schedule, and I'm worried about a dime messing with history? What will freeing Joan do to history if she refuses to come home with me and keeps rampaging around France? What the hell have I done?*

But it wasn't like she could turn Joan back over to the English. The English would probably burn both of them to death on matching stakes, which wasn't the kind of altered history Kate was interested in being a part of. Without a map, Kate knew only that they needed to go south to find safety, but the winding roads they were following didn't seem to care about cardinal directions. After an hour's ride they reached one crossroads that looked like every other crossroads they had passed. Trying to make out the words on the battered wooden sign to one side of the path, Kate wondered how anyone in this time found their way anywhere. "My kingdom for a GPS."

"You have a kingdom?" Joan asked.

"No, it's a saying." Kate thought it best not to explain that it was from an English playwright, especially since Shakespeare had referred to Joan as a "foul fiend."

"What is a Gee Pee Ess?"

"It's kind of like a map."

Joan nodded, then pointed assuredly down one of the intersecting roads. "We have no need of maps. My voices told me this morning that we should come to this place, and to take this way when we did."

"Your voices?" Somehow that didn't sound to Kate like a good substitute for a GPS. When had Joan talked to her voices? "We need to go south to get to safety, and that's kind of west, I think."

Shaking her head, Joan pointed down the other roads. "The English have many parties out trying to find us. They have every man available on the search. If we go down any of those other ways, our chances of being found are much higher."

"What's so special about that road?"

Joan smiled. "It is the right road."

"Joan—"

"We must go that way. We dare not linger here to debate. Come!"

Kate found herself riding to catch up with Joan's horse as they headed down the road Joan had chosen.

As the morning and their ride wore on, any remaining glow of adventure faded as the pain grew in Kate's chafing thighs and sore butt and her mind worried about what a free Joan would do to change history. The rising summer sun beat upon her armor until Kate wondered just how long it took to broil a human being alive. Just after noon they rode through a village whose inhabitants stared at them both. They had

almost made it out the other side when an old man stepped into the road and gestured for them to halt.

Irritated, Kate started to ride past, but Joan reined to a halt and gave the man a respectful nod. "Good day, friend farmer."

The man came close to Joan, studying her face, then smiled to reveal a mouth with few remaining teeth. Kate had been gradually getting used to the unwashed fragrances of human bodies, including Joan's, but this man was particularly ripe. From the smell, he seemed to raise pigs. "The Maid. You are the Maid."

Joan smiled back as if to an old acquaintance. "I am, friend farmer."

"You still fight for France?"

"I will fight for France to my last breath, friend farmer."

The old man smiled again and gestured them to wait, then hobbled quickly to a house nearby.

Kate glanced around nervously. "Joan, we need to keep moving."

"No. Let us wait."

Setting her jaw with growing anger at Joan's assumption of command, Kate started to argue again, then stopped as the old man reappeared along with two younger men carrying heavy burdens. "You will need these," the old farmer announced, unwrapping the bundles. In one, an assortment of pieces of armor rested, in the other, a sword and scabbard. "Years ago, a drunken Burgundian knight stayed here the evening, attempted to dishonor one of my daughters, and never left. He rests in one of those fields. Now you can make use of his armor and weapon."

Most of the armor didn't fit, but Joan was able to fasten on the breastplate, then belt on the sword. "My thanks."

"Will you touch my sons, Maid, that they may have long lives and find good wives?"

Joan gave a weary sigh, but then smiled and lightly touched each of the younger men on their shoulders. "I have no special powers, but I ask that God grant you long lives and good wives."

The old farmer grasped Joan's hand for a moment and kissed one of her rings. "May God bless you, Maid."

"And may He bless you," Joan replied, before finally heading onward.

"I thought we were in a hurry," Kate grumbled some time later, after stewing since leaving the village.

"But now I have a sword and some armor. The poor people have few who listen to them, who care for them. I do what I can," Joan replied.

It was bad enough that Joan kept telling her what to do, but Joan also had been right to stop for the old man. That just made it more aggravating. *It would be nice if you listened to me even once, you bossy little*—Kate caught herself. This was Joan. She knew what Joan had done, and she knew how Joan had done things. Why had she ever expected Joan, of all people, to be compliant? And any student of the Middle Ages knew that Joan was absolutely right that few with any power cared about common folk. Remorse replaced anger. "I'm sorry. I'm really rotten sometimes."

Joan turned a reassuring smile on Kate. "You are not a bad person, Lady Kate. You came to save me."

Kate stared at Joan as a realization filled her, as clearly as if one of Joan's voices had been speaking a truth that Kate did not want to hear but couldn't avoid. *I didn't come to save her. I didn't really know her. I came to save her for me, for what I wanted her to be. It was all about me, never really about Joan. Not this Joan, not the real Joan.*

"Kate? Are you well?" Joan, who had just endured many months of torment, was watching Kate with real concern.

"I'm fine. I haven't gone through anything compared to you."

Joan shook her head. "I am not an easy person, Kate," she confided in a low voice. "I was raised a peasant, without the fine manners of the court. My mission from God and my devotion to France consume me. I can be impolite and abrupt, and sometimes prideful. I know this, I sorrow for this, and I pray you will grant me forgiveness for my failings."

Kate, consumed with guilt, reached out a hand to touch hers. "Joan, you're a wonderful person. Really."

"Really? But I am a witch, a sorceress, and a heretic, did you not know? The English and the University of Paris have said so." Joan grinned in a sudden mood swing. "In the name of God, it sometimes felt when I was a prisoner as if only God was on my side!"

Kate laughed. "I've run into my share of university professors who think they're God, and the English aren't the best people around these days. But if not for the English we wouldn't have had the Beatles, so I guess they get better."

"The beetles?" Joan's mood shifted again, to curiosity and puzzlement. "Beetles are from England?"

"I mean the singing ones."

"Singing beetles?" Joan laughed this time. "What do they sing? Do the fairies lead them in song? The common folk of your land must have the same fancies as those here." Her laughter faded. "Such things are innocent, I think, yet the learned churchmen tried to use the simple old beliefs as proof I was a witch. My faith in God sustained me, but I hope He will forgive that I wondered sometimes during my ordeals at His purpose." She crossed herself.

Kate's frustration came back, fed by her own clashes with the church she had been raised in. "I don't understand. I just don't get it, Joan. You're so smart. So very intelligent. Anyone talking to you can tell that."

"Thank you, but I can neither read nor write anything but my own name."

"You just weren't taught how to do those things! That has nothing to do with how smart you are. But then you talk about your voices, and God ... and..."

Joan turned a puzzled look on Kate. "And?"

"How can you...?" She couldn't say it, couldn't accuse Joan of mindless superstition, of being the kind of hysteric that history had often painted her as.

But Joan somehow understood, looking first startled, then to Kate's shock laughing again. "Do you think that being smart and having faith cannot live together?"

"But—There's no proof—"

"Proof?" Joan waved her hand. "I am here. Orleans did not fall, Charles was crowned king in Rheims. None of these are proof?" She laughed again as Kate struggled for words. "Lady Kate, my voices do not tell me to deny what is. They do not say 'Joan, ignore what your eyes see, for the sky is red, not blue.' I would not listen to them if they said such things, because by that I would know them false. The churchmen who examined me in my trial questioned my faith and my voices in many ways, but even they never could point to anything and say 'this is proof she is a witch and a heretic.'" Joan gestured to herself this time. "Though they cared not for my male attire, as you may have heard."

Kate couldn't help smiling. "I understand your male clothing and fighting in battle horrified them more than the idea that you were a witch or heretic. It will be a long time before men can accept women wearing so-called men's clothes."

"I do not know that men will ever accept that!"

"Sure they will. If you'd come with me, I could take you to a place where they do."

Joan smiled back, then shook her head again. "No, Lady Kate. I could not betray my mission."

"But how can you still believe in that mission when everyone you helped abandoned you?" Kate burst out.

"There must have been reasons. I must believe." Joan must have read Kate's reaction. "Surely you believe in something, Kate?" Joan spoke confidently, her eyes seeming to glow, her presence so strong that Kate stared wordlessly for a moment. "You may confess to me," Joan whispered with a grin.

"Yes," Kate said, unable to take her eyes off of Joan's face. "There is something I believe in, something that was a lot more than I thought I knew."

"Then follow your heart," Joan advised. "Our Lord gave us both heart and head for a reason. Everything has a purpose." She crossed herself again. "In time, we may learn the purpose."

Every argument that Kate had ever heard against such fatalism popped into her head, but faced with Joan they all seemed inadequate. *Orleans did not fall, Charles was crowned king in Rheims.* Both had been thought impossible before Joan came to lead the French army. The very idea of a teenage girl with sword and armor leading the French army into battle had been thought impossible, would be dismissed as fantasy if the historical record wasn't undeniable. How did anyone refute that those things had nonetheless happened? Would Kate be the one arguing that the sky was red if she tried to refute them? Anyway, fatalism wasn't the right word, was it? Joan might believe that God was dictating outcomes, but she used that faith to motivate her to action on behalf of others. "I just don't know."

"Your heart will tell you if you listen," Joan said again.

\* \* \* \*

Sunset wasn't far away when they rounded a turn and found themselves facing an even dozen mounted knights in battle-scarred armor. Kate froze, knowing they should run, but too shocked at the moment to react.

Joan sat calmly, though, raising one hand in greeting. "Good day. Who do you serve?"

One of the knights rode forward, his battered armor and harsh face telling of long years at war. "We serve France, Maid. It has been long since I saw you last."

"André." Joan smiled. "I was told that one I knew before would find me this day. Who pays you now?"

"Duke Alencon."

The smile on Joan's face broadened so much that Kate felt as if the sun had suddenly come out from behind clouds. "My good duke. He is near?"

The knight shook his head somberly. "Duke Alencon could not come here. Nor could any army he could raise fight its way this deep into territory controlled by the English. Instead, he hired a few small groups of mercenaries such as we who could travel through the nets of the English and the Burgundians. We were to go to Rouen in hopes some opportunity to aid you might arise. Maid, there are English everywhere. They scour the countryside for you." André turned a questioning look on Kate. "I do not know this knight."

"Lady Kate. She is my rescuer and trusted companion."

"Another Maid to fight for France?" one of the other knights asked in a wondering tone.

Kate hoped it was getting dark enough that her blush couldn't be seen. If these knights were looking for another virgin, they had found Kate a few years too late.

But Joan was already answering. "Lady Kate is a stout warrior who alone rescued me from Rouen." The mercenaries all turned impressed looks toward Kate, making her blush even more. "If God wills it, we shall return safely to my good duke. Do you know of a secure place for the night?"

André nodded and, turning his horse, led them onward in the direction that Joan and Kate had been traveling. By the time night fell they had made camp in a small dell well off the road, with trees close enough by to provide a small measure of shelter as well as fallen wood for a small fire. Overhead, the stars came out so thick and bright that Kate couldn't help staring, astounded at their brilliance and finally understanding why people had thought that the heavens really did hold Heaven.

The mercenary knights shared out hard bread and the raw red wine in their flasks while some of their number went scrounging for food, eventually returning with piles of wild mushrooms cradled in their arms. Kate watched with alarm as everyone took thin sticks, spearing the mushrooms to hold them over the fire for roasting. "Are those safe?"

André gave her a puzzled look. "Of course they are. Who wouldn't know a dangerous mushroom from a safe one?"

"Lady Kate is from far away," Joan explained. She seemed in her element among these rough soldiers, trading jokes, asking for news, sharing stories of earlier battles. Every once in a while one of the mercenaries would inadvertently utter an oath and then Joan would gently reprove him, the hardened warriors humbly accepting her admonishments.

Kate ate her share of the mushrooms and bread, taking swigs from flasks as they went around, the red wine warming her insides, watching Joan laugh and talk. The mercenaries listened attentively to her, showing real respect. "I don't get it," Kate finally murmured to herself.

André had been close enough to hear, and now turned to Kate. "Something bothers you, Lady?"

"Yes. You're all experienced fighting men. You're mercenaries. You're *men*, and these days men don't listen much to women. But you really seem to think a lot of Joan."

André looked toward Joan as well. "A wise man listens to women on some matters. My father told me that. Most women confine their concerns to the home and the farm, though. But the Maid is different. It's like this. I'm a mercenary, Lady Kate. I used to believe in other things, but mercenaries believe in only



one thing, and that's money." André nodded toward where Joan sat. "You need to stay alive to spend the money you earn, and that's why mercenaries have no qualms about following the Maid. She's a fine leader, with a good mind for combat."

"Really? I've heard a lot about her, but not much about that."

The mercenary laughed harshly. "Thank the nobility for trying to hide it! They couldn't have it known that a girl was a better leader of men in battle than any of them. The English and the Burgundians want little said of it as well, that a woman beat them soundly again and again. Better for them to call her a sorceress who won her battles through black magic, or to talk about her clothing and her faith. But surely you've heard some of the Maid's military doings, like her advice before the fight at Patay."

Kate managed to dredge up that memory. "Something about spurs, wasn't it?"

"Yes. 'You have good spurs. Use them.' Then she explained that it didn't make sense to wait around and let the English choose where and when to fight. When we saw them, we should hit them hard and fast, before they were ready." André grinned. "We tried it at Patay and slaughtered the English, who thought to have another Agincourt or Crécy. We beat them handily at other places, too. The Maid taught us how important speed is, on campaign and in battle, and in a fight she's always at the fore, leading her men onward. If an attack at one place fails she shifts, seeking better approaches. When she has failed, it was because the rock-heads of the nobility held her back. We would have had Paris easily if not for self-serving truces agreed to by the court. The Maid is the best leader many of us have followed, Lady, and that's why I took Duke Alencon's coin and came looking for her."

"So, it's self-interest."

"You could call it that, Lady." André frowned down at the grass. "That's all it is." But then he looked at Joan again and his expression wasn't that of a man working only for money.

\* \* \* \*

Another dawn on a journey that was only supposed to have lasted a few hours. Kate sat with her back against a tree, trying to understand what had gotten her here. Time travel? That part was easy. What she couldn't figure out was what she was doing following a religious warrior and a band of mercenaries through territory crawling with enemies.

And why did she have a nasty suspicion that she was enjoying this, that she wouldn't leave Joan now no matter how bad things got?

Kate looked at the return control she carried on her wrist, safely under the sleeve of her armored gauntlet when she wore it. Just punch in the code, and she would be gone from here, back to the land of warm showers and fast food and soft beds, where hordes of enemies weren't hunting for her head. But all she did was look.

Joan came around the side of the tree, wearing her breastplate, her sword swinging sheathed by her side, the dawn light gilding her. Kate could only stare for a moment. "God, you look hot," she blurted out.

"Take not His name in vain, Lady Kate." But then Joan's expression turned rueful. "In truth, it becomes very warm under armor, does it not?"

"Uh ... yeah. Yes. That's what I meant. Joan, have you ever been in love?"

Joan sat down nearby. "Of course. I love my parents, my brothers, I love Duke Alencon. There are many I am fond of."

"I don't mean that kind of love. I mean passionate love, like getting married."

Joan gave her a quizzical look. "Do you mean romantic love? But that is not what marriage is about. Parents arrange marriages for many reasons, but romantic love is never one of them! Have you been listening to too many court troubadours and their silly songs?"

Kate looked off into the distance. "Romantic love is real."

"Of course it is," Joan conceded. "But it is not something I could ever have."

Then some of the knights came to tell them it was time to go, and Kate followed Joan to their horses.

\* \* \* \*

They made it through that day, and halfway through the next, riding through a countryside where rumor and news of soldiers hunting the Maid were constant companions. Some of the people they encountered warned them, while others doubtless carried word to their hunters.

Joan had continued to improve rapidly despite the hardships of their road. She spent time with the mercenaries, but she also rode with Kate often, talking of many things. Once Kate asked her about the fabled sign to the Dauphin, but Joan just laughed and would say nothing about it. "You are not to be my inquisitor as well," she chided Kate lightly. "I care for you too much to have you assume such a role, my good Lady Kate."

Just before noon they rode past the ruin of a keep consisting of a small walled court and a tower. Topping a ridge beyond the keep, the lead mercenary halted abruptly. "English!" he called back. "Three score at least!"

André turned his mount. "We ride back and across country." Spurring their tired horses, the party headed back past the ruined keep.

But on the other side, before they could leave the road, they saw another party of hunters coming toward them. This time the English saw the group with Joan, and warning trumpets sounded as they charged, trumpets that were answered from the group on the other side.

Joan drew rein. "There are at least a hundred English knights and men-at-arms there and more than sixty behind us."

"They come on fast. Our mounts cannot outrun them," André replied grimly.

"No, and the English have bowmen with them. A fight in the open would be hopeless. To the keep."

The dozen mercenaries, Joan and Kate kicked their horses into a final burst of speed, into the courtyard of the ruined keep where the knights hastily began barricading the broken gate with any available object. They had barely finished piling up a barrier when the first group of English arrived. Within minutes, the second group joined them. Kate watched with a sinking feeling, certain that there were at least two hundred men facing them, and more trumpets could be heard signaling in the distance as other groups converged on the keep.

There was an elevated stone walkway about a yard off the ground, allowing defenders to stand chest-high to the wall, which was substantially intact but only about eight feet tall. Joan dashed up onto the walkway, followed by Kate and most of the mercenaries.

Everything seemed to pause for a moment, the banners of the English flapping in the breeze the only movement and the cries of birds the only sound. Finally, a herald rode out from the English lines, stopping

well away from the wall. The herald's voice rang out clearly in passable French. "Brave knights, you cannot prevail here. Surrender the witch and you shall all be granted your lives and your freedom."

Her own voice strong, Joan called back an answer. "In the name of God, leave France, go back to your home, and you will have no need to fear me." No answer came from the English. Joan spoke again, much more quietly, so only those on the wall could hear. "There is no chance of victory here. They want me, but I will not willingly be imprisoned by them again for they seek only my death. I ask no more than that you grant me time to fortify myself inside the keep and then you are free to go where you may and say what you will to ensure your safety."

Kate swallowed nervously, looking sidelong down the ranks of the mercenary knights.

But every one of the knights just gazed forward, their faces as hard and uncompromising as the stone of the wall. None of them replied to the herald.

In a little while an English knight in fine armor rode up to the herald and spoke to him, then the herald raised his voice once more. "If you surrender the witch, you shall be granted your lives, your freedom, and one hundred gold crowns apiece, this sworn to on the word of Sir Costain of Kent."

"You may accept the offer as long as you grant me time to get into the keep," Joan murmured to the knights. "This alone I ask of you."

After a long moment, André shook his head, looking disgusted. "We can't, Maid."

"I thought all you believed in now was money," Kate said.

"That's the problem with the Maid, you see." André smiled toward Joan, then turned a grim face back to the English. "She makes you believe in things again. She makes you believe in her, she makes you believe in yourself, and she makes you believe in dying for France." André raised his own voice to a shout. "You won't have the Maid from us while we live, you English pig! You can take your filthy gold to hell!"

The herald and the English knight rode back to their lines. There was another pause, messengers riding down the English line calling out orders, then a line of archers stood out. "Beware the longbows," Joan warned Kate.

The archers bent their bows, then as the trumpets sounded again they launched their arrows as the men-at-arms and knights charged the keep.

*It's not real. It's a game. It's not real. It's a game.* Kate kept repeating that in her mind to keep from running and hiding as the English reached the keep. Most of the French knights had gone down to hold the gate, but five stood with Joan and Kate along the wall as the English soldiers reached it and began trying to boost their comrades up onto it.

Kate's sword was out and she was actually using it in a real fight, trying not to think about the fact that she was really trying to hurt and kill. Men-at-arms fell back, but one of the French knights on the wall took two arrows and fell, then another was stabbed in the throat by an English soldier who had made it up. That soldier died at the hands of the remaining three French knights with Joan and Kate, then in a momentary lull they heard a cry from below. "The gate is going!"

"To me!" Joan cried, and Kate and the other three knights followed as Joan hurtled down the stairs to the courtyard, where the improvised barricade was coming apart under the pressure of the attackers and several French knights already lay dead or dying. Men-at-arms were coming over the abandoned wall. "We cannot hold here! To the keep!" Joan ordered.

The remaining knights at the gate fell back, joined by those with Joan, and the small group backed their way toward the entrance to the keep, fighting the mass of English soldiers boiling through the gate and over the wall. One more French knight fell, then another, then as Joan, Kate and two other surviving knights reached the keep only André stood between them and the English. "Close the entry!" André shouted.

"I'll not leave you outside the door!" Joan cried in return. "I was so abandoned at Compiègne and I will not do the same to a brave and loyal knight!"

But as André raised his sword for another blow at the onrushing English, longbow archers who had entered the courtyard released their arrows, three of their shafts slamming into him, piercing the armor and leaving André swaying for a moment. "I am done," he said in a slightly puzzled voice, then fell forward into his attackers, his final collapse holding back the enemy a little longer.

The surviving two knights joined Joan and Kate in levering closed the broken door to the keep, wedging wreckage around it to help hold as the door began splintering under blows from outside.

Joan looked upward. "Kate, go up and see the state of the tower above. There is too much light there. There may be an opening the English can use to enter above us."

Kate took the rickety, decayed stairs at the best speed she could manage in armor, the wildlife nesting in the tower taking flight. The part of Kate's mind not filled with fear noted the many nests and the dried-out old wood and realized the tower's interior was a tinderbox waiting for a spark.

The first level up was choked with more debris and broken wood, the remains of furniture and chests. Kate staggered up the next set of stairs, which creaked ominously under her weight, and onto the second level, bright with light streaming in through a breach in the tower wall close to two meters wide and just as tall. Reaching the opening, Kate gazed downward to where the English were readying tree trunks with the branches lopped off short to form improvised ladders. She went back to the stairs, yelling down to be heard over the clash of fighting below. "Joan, there's a gap in the tower wall two levels up. They're getting ready to try to come through here."

No answer. Despite her tiredness Kate went back down the sagging stairs to the first level and shouted her message to the figures she could now see below.

Joan looked upward, then to the door. "Lady Kate and I will hold the tower above."

One of the French knights nodded. "We shall hold here as long as breath is in us, Maid. Bless us before you leave us, please, that we may die in God's grace."

"I am but a servant of God, not one of His angels," Joan protested.

"Please, Maid!"

Tears spilling from her eyes, Joan fumbled through a blessing of the two knights as they leaned against the crumbling door. "I come, Kate. Hold the breach until I reach you."

Kate had to pause to rest before lurching up the stairs one more time, one of the steps cracking into fragments and nearly tossing her down. But she made it up again, then to the side of the gap in the tower, where the end of a tree trunk could now be seen just above the bottom of the breach.

She had seen enough movies to know what to do. Kate planted her foot against the tree trunk and shoved as hard as she could. The trunk shifted, to the sounds of yells below. A loud report of metal on stone sounded nearby as an arrow struck the tower. More archers were bending their longbows, aiming

at her, but Kate thought of Joan and the knights holding the door below and somehow nerved herself to stay in the opening long enough to shove the trunk again, so that it toppled to one side.

Then Kate whirled back into cover, leaning against the inside of the tower, breathing heavily as arrows rattled through the opening and struck the far wall.

Joan came up the stairs and to the other side of the breach, smiling at Kate through tears. "There is little time left. If you would leave, leave now."

Kate stared, her mouth hanging open, then she shook her head, aware that she was crying as freely as Joan. "I won't leave you." The words she had never managed to say burst out. "I love you."

"I love you as well, Kate." But then Joan's eyes locked on Kate's, and Joan somehow read the meaning there. Kate waited for the look of anger, of denial, but Joan's smile just saddened. "That is the way of it? Alas, my good Lady Kate, your love is not the kind I could ever return. Even were you a man, my only Lord can be my God."

"You don't hate me?"

"Hate you? I have been judged by others, Kate. I know how little such judgments say of the truth. How could I hate a woman such as you? My Lord bid us love all, and though I have great bitterness toward the English even they would I willingly grant leave to depart France in peace if they would do so. But there is no evil in your heart, Kate. Your love is not such as I could ever feel, but it is pure nonetheless. My voices told me this of you, and now you see again how true they are."

More arrows flew through the breach in the wall, but this time they trailed smoke and heat. Joan took a quick look out, then leaned back, shaking her head, for the first time showing a trace of fear. "They seek to force us out of the tower by setting fire to it."

Kate had thought she couldn't be more frightened, but now realized there was always another intensity worse than the last. "This thing will burn like a torch." A realization broke through her fear. "I can't hear the fighting at the door."

Joan nodded. "You are closer. Check the stairs while I guard here."

Scuttling to the stairs, Kate looked downward. The thud of weapons against wood or their clang against armor no longer came up from below, but she could hear the sounds of movement among the wreckage as well as something else, a crackling sound that she couldn't place for a moment.

Then Kate heard the crackling sound growing louder amid alarmed shouts of "Outside! Outside!" in archaic English, and smoke began curling upward from the ground level in rapidly growing billows as the shouts faded.

Now was definitely the time to panic, but instead as Kate looked toward Joan she felt an odd resolve settle over her.

Kate rejoined Joan at the breach in the tower. "The English won't be coming up the stairs," Kate gasped.

Joan looked back, seeing the smoke now streaming upward through the stair opening. "The fire has caught below."

"Yes. The English were down there, but I think they ran from the fire. The other two knights must be dead."

Joan leaned back against one side of the breach while Kate rested against the other side. The fire venting up the tower was sucking in air through the breach, keeping this spot clear of smoke and relatively cool despite the growing heat. But the edges of the stairwell up here were smoldering, ready themselves to catch fire, and then the floor beneath them would burn as well. "It seems, my good Lady Kate, that you have saved me from one pyre only to land both of us inside another. I confess to you a secret I tried to hide from my captors. I fear death by fire. There is little I fear, but I fear that so very much."

"We can still escape," Kate urged.

"I told you to go, dearest Kate."

"No. Both of us. We can both get away from here."

Joan's eyes locked on hers. "And afterwards to continue my mission?"

Kate longed to say "yes," to lie to Joan, anything to get her out of this trap, but her traitor lips shaped the truth. "No. We'd be gone from France, from this time, forever."

Her eyes momentarily went distant, then Joan smiled at Kate even though her eyes still revealed her dread of the fire. "You must go. You need not die here. But my voices say that here is where I stand, here is where I stay."

"Don't listen to them!" Kate screamed. "They don't care about you!"

"They do care," Joan corrected, her eyes lit with an inner fire now as well. "But they only carry messages to me from my Lord. I always knew it would end. I wish it were not so soon, and I wish it were not to end in fire. But this is my mission, and I will not falter now. Others have died at my command, others have died for France. How can I flee and deny their sacrifice?"

"You have to die so you can keep inspiring people?" Kate yelled. "That's awful. It's not fair!"

Joan turned those intense eyes on Kate. "It is as God wills."

"Then I won't leave you." Part of Kate was screaming in terror inside her, but she couldn't go now. "You won't face the fire alone."

Joan's answering smile held more gratitude than fear this time. She nodded to Kate and raised her sword in a salute. "Thank you, sister."

Another tree trunk thudded against the breach in the wall. Joan and Kate both tried to shove it aside, but it was heavier than the first and soldiers below were holding it in place as men-at-arms climbed clumsily upward. The archers were firing again, trying to hit Joan and Kate as they struggled to move the tree trunk, but then the first of the men-at-arms reached the top.

Kate swung her sword and fought, side by side with Joan, trading blows with the attackers as one man-at-arms after another came up swinging. One, two, three attackers fell back and down, then in a moment's gap before the next man-at-arms could reach them the two women shoved at the trunk again and this time it shifted, then slid away.

Flames erupted through the floor behind them as the tower turned into a massive chimney feeding the blaze. The floor sagged suddenly as a beam gave way, and Kate staggered back on a still-intact portion of the floor, holding up her arms to protect her face against the heat, trying to keep terror from overwhelming her.

"Kate." The voice was weak yet somehow penetrated the noise of the fire.

Looking down, Kate's fright turned to horror as she saw Joan half-sitting, half-lying near the breach. The shaft of an arrow that had punched through Joan's breastplate protruded a good foot from her chest. She must have been hit in the instant the tree trunk had been cast down. "Oh, God, no." Kate fell to her knees beside Joan, momentarily unaware of the fire, the threat of the English forgotten. She reached toward the arrow shaft, then hesitated.

Joan, her face very pale, managed to turn her head to look at Kate. "Don't. It is over ... my sister."

"It—it can't be." Kate shook her head, renewed tears running down her face and splashing onto Joan's breastplate. "That's not what's supposed to happen. You're supposed to live. To come back with me. You're supposed to."

"My mission," Joan reminded Kate, her voice growing weaker. "My voices told me ... it must end in fire ... This is my Lord's will ... but, by His grace ... you have given me a gift ... that I die fighting ... and never feel the flames."

"No," Kate moaned. "In my time you could be happy. You'd belong there. You deserve a better fate than this."

Joan's eyes were shining despite the nearness of death in them. "My fate ... my reward ... is a great one ... my voices tell me ... I shall see my Lord soon ... Take my sword ... Kate, my sister ... live..."

Kate knelt there, shaking, as Joan's breath stilled, her eyes still lifted upward and a smile fixed on her face. "Good-bye," Kate gasped.

Another section of the floor collapsed, and Kate shrank back against the stone wall as the flames burst out closer to her. The wood floor under them was hot and would surely explode into flame at any moment. The cries of the English seemed faint as they kept back from the inferno the tower had become. Kate gazed on Joan's body, the floor around it smoking now, then picked up Joan's sword and gripped it tightly. Every other defender was dead, no one else had known who Kate was, and so no one would carry the tale of Lady Kate into history. "Good-bye, Joan," Kate repeated, then pulled back the cuff of her gauntlet and finally punched in the return code through eyes blurred with tears as fire flickered to life on the floor around her.

\* \* \* \*

Kate moved in a daze through the pre-dawn campus and to her apartment, not really aware of her surroundings, and never afterward able to understand why she hadn't been spotted by campus security on her way out or stopped by police on the walk home. Maybe anyone seeing an armored knight walking through the dark had not wanted to find out what was going on. But at some point, Kate found herself at the door to her apartment, and managed to dig out her keys.

She paused as the door swung shut behind her, staring at the pictures on one wall. Walking stiffly, Kate moved toward that wall, studying the pictures.

The one that had shown Joan being burned at the stake now depicted a fully armored knight rescuing Joan from the site of her planned execution while bursts of smoke and flame cast by Saint Catherine and Saint Margaret dazzled the English soldiers on guard. Next to it hung a print of a medieval picture Kate had never seen, one showing Joan fighting on the top of a tower while flames rose around her, angels hovering ready to take her to heaven as Joan's attackers cowered in fear below.

Beside that was a photograph of a monument near a small, ruined stone keep, Joan standing in her armor

atop a pedestal, gazing heavenward. On the pedestal had been carved the images of knights standing ready to fight to their last with Joan.

Kate just stared at the pictures for a while, then staggered into the bedroom and sat down heavily on her bed, laying the sword carefully beside her and looking at it. She had no idea how long she had been there when a soft knock on the door was followed by a key turning in the lock.

"Hello? Kate?" Cylene's steps sounded softly in the living area, then she peered around the side of the door into the bedroom. "Hey, you weren't on campus this morning and you didn't answer your cell so I wanted to check ... What's the matter?"

Blinking her way back into thought, Kate shook her head. "Nothing." It came out in a hoarse whisper that even Kate knew didn't sound convincing.

Cylene came closer, bending down to look at Kate's face, then wrinkling her nose. "I smell smoke. Have you been near a fire? Your armor is all beat up. God, that SCA stuff can be a little scary, if you ask me."

"Don't use the Lord's name in vain," Kate whispered.

"What? Kate, are you okay?" Cylene snapped her fingers in front of Kate's face. "Do you need a doctor?"

"No. I'm fine."

"Sure you are." Cylene sat down next to Kate, on the opposite side from the sword, looking at the weapon curiously. "You got another sword?"

"Someone gave it to me." Kate reached out to touch the blade. "She belonged here, Cy. In a time when a woman could be smart and lead knights into battle and be herself. But she was needed then."

"Are you talking about Joan?"

"Yes." Kate took a long breath, then finally focused on Cylene. "Joan wasn't what I thought. I mean, she was in some ways. But she wasn't any of the things people think about her. No, that's not right. She was all of those things and different things and most of all just herself. Strong and smart and brave. She was Joan."

"Okay." Cylene looked away. "You know who Joan was now. What did you do, go back in time and talk to her?"

"Uh—"

"Because you've talked about that so many times. 'If only I could be that mysterious knight! If only I could be the one to rescue Joan from execution by the English!'" Cylene smiled teasingly at Kate and tapped her armor. "So, was it you?"

"Yeah. It was me."

"*What?* Kate, this is *not* funny because you don't sound like you're joking!"

Kate made a major effort and tried to look normal. "I've really always said that I wanted to be that knight? Not that I wanted to keep Joan from being burned alive at the stake?"

"Yes. You've said it a million times, that and about how you used to pray you could be one of the knights with her at the keep. But she didn't burn at the stake because that one knight rescued her, so that's the



same thing, isn't it?"

"Not exactly." Kate smiled, feeling a sense of wonder breaking through the numbness. She really had changed things.

Cylene was still talking. "It's not like Joan didn't get to die fighting. How many women has that inspired over the years?"

"It has?" Kate asked. "I mean, yes, it has. Although, if she had died being burned at the stake it would have been harder for her, Cy. Facing the fire alone and never crying out in pain or for mercy. It would have been the bravest and strongest thing she ever did."

"Uh, sure, I guess. You never talked about it that way before."

"I never really understood before, how strong and brave and amazing she was." Kate ran one hand through her hair, feeling the ashes still clinging there. Ashes from a fire that had burned more than six centuries ago.

Cylene spoke hesitantly. "So, what have you been crying about? Seriously, Kate, you look like hell."

"I'm a lot better off than the others." That really sounded wrong, even though it was true. "I mean, I just had some very stressful experiences, and I don't think I'm ready to talk about them."

"All right." Cylene made an uncertain gesture. "Do you want to keep sitting here or go into the living room where it's more comfortable? I can make you some lunch. When's the last time you ate?"

Over six hundred years ago, Kate realized. "It's been a while. I could use some wine. Red wine." Cylene helped her get her armor off, unsuccessfully trying to hide her reaction to the state of the clothes under the armor that Kate had been wearing for days. Kate managed to stand up despite her entire body feeling stiff and sore, then walked into the living room behind Cylene, but once there hesitated, staring once again at the picture of Joan on the flaming tower. "I didn't see angels," she heard herself saying, "but maybe Joan did. Maybe she heard them. She was so calm, so content when she died, so sure she was going to heaven."

"You're scary again," Cylene said. "And since when do you believe in heaven?"

"I don't anymore. No, maybe now I do. I don't know, yet. But Joan believed, and maybe that's what's needed, like a spiritual Schrodinger's cat. If you don't really believe in heaven and angels, they're not there. But if you do ... and Joan made you believe."

Cylene was looking at Kate with a baffled expression. "Where have you been, and what did you do there, and what did you do with Kate?"

"Kate is still here. I've just learned a few things. It's a long story." Should she tell Cy? *Listen to your heart. Live.* Kate reached a decision. "There's probably only one person on earth I could tell it to, and I want to tell you. You may decide I'm crazy, but I'll tell you. I swear it's true."

"You'll tell me? Only me?" Cylene smiled with delight. "Okay. Long story? Maybe I should order pizza delivered. You want mushrooms, right?"

Visions flooded Kate's mind, images of a night distant in time now, a small fire, figures in armor sitting around it roasting wild mushrooms on sticks, Joan's eyes in the firelight as she laughed, a skin of raw red wine being passed around, the dark sky above brilliant with stars more numerous than the modern world could now see. The memory could have brought tears, but instead Kate found herself laughing at the joy

of it all. "Yes. With mushrooms."

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[\[Back to Table of Contents\]](#)

Reader's Department: **THE REFERENCE LIBRARY** by Don Sakers

When you think about it, science fiction is a lot like food. It comes in many different varieties, those who consume it have very strong likes and dislikes, and (for some of us) it is a necessity for life.

In science fiction as in food, we all have our favorites ... but a steady diet of the same thing gets to be boring. This month I have a diverse menu; I hope you'll find something to please you.

\* \* \* \*

*The Lost Fleet: Relentless*

Jack Campbell

Ace, 320 pages, \$7.99

(mass market paperback)

ISBN: 978-0-441-01708-9

Genre: Military SF

Series: Lost Fleet 5

\* \* \* \*

I'm not one of those who believe that every sf book has to be stunningly original and deeply meaningful. Sometimes you're just in the mood for something familiar, something dependable: comfort food. In the old days, you could count on Mack Reynolds, Gordon Dickson, or Poul Anderson for a basic good, entertaining story. Nowadays there are many options; one of them is a nice military sf series.

It just figures. Military sf usually has a familiar plot; good guys vs. bad guys. The social trappings are familiar—military rank, command structure, character motivations. A multi-book series generally implies that you're going to be following the same characters through a succession of adventures. And if the series is by a familiar author whose work you know, so much the better.

Jack Campbell's *Lost Fleet* series meets all the criteria for good, solid comfort food.

To begin with, Jack Campbell is a name that all *Analog* readers should be familiar with—although you have to look on the copyright page to learn this. “Jack Campbell” is a pseudonym for none other than *Analog* regular John G. Hemry, and you *know* he can tell a good story.

Here's the basic set-up for the series: The Alliance and the Syndicate Worlds have been at war for a long time. Captain John (“Black Jack”) Geary, commander of the Alliance heavy cruiser *Merlon*, is the last to enter an escape pod when his ship is defeated and destroyed. The pod automatically puts him into suspended animation until he reaches rescue.

A century later, Geary's pod is found by an Alliance fleet, and he's reanimated. The fleet is deep in enemy space, reeling from defeats and desperate to get home. And here's the legendary hero Black Jack Geary, back to lead them to safety. Before he knows it, Geary is in command of the Lost Fleet, and the adventure has begun.

Except that Geary knows he is only a man, not an all-powerful hero. The ships of the Fleet (there are hundreds of them) include various squabbling captains, an officious politician, an underground resistance, and an unknown number of enemy agents. Geary struggles with his own doubts and demons, uncertain

that he can ever succeed in bringing the Fleet safely to Alliance space.

Geary's doubts and weaknesses only make him all the more interesting and sympathetic, which is a good thing in a series protagonist: if you're going to spend multiple volumes with a guy, you want him to be someone you like.

Through four previous books Geary and the Fleet have struggled on through nonstop pursuits, battles, food shortages, and betrayals, limping from one star system to another with barely time to nurse their wounds.

The four previous books are *Dauntless* (1), *Fearless* (2), *Courageous* (3), and *Valiant* (4). And if I may digress for a moment, here's where sf series writers and publishers could take a lesson from mystery writers such as Sue Grafton (*A is for Alibi*, *B is for Burglar*, etc.) and Janet Evanovich (*One for the Money*, *Two for the Dough*, and so forth). Would it be so hard to give the hapless reader a break and make the titles go in alphabetical order, or include numbers?

Ahem. Back to the *Lost Fleet*. In *Relentless*, Geary takes them to the Heradoo system to rescue Alliance prisoners of war. Of course, Heradoo is also the location of a great number of enemy vessels. Meanwhile, there's the question of what happens when the Fleet gets home—turns out that a sizable contingent wants Geary to overthrow the corrupt Alliance government. Oh, and there are these saboteurs loose in the Fleet...

*The Lost Fleet* isn't just mindless action. As you'd expect, Hemry/Campbell writes space battles that conform to the laws of physics; no right-angle turns or shields down by x% in these books. Unsurprisingly, his military officers also ring true; you aren't going to see third-year cadets inexplicably put in command of any flagships here.

Does the Fleet eventually get home? Does Black Jack lead a revolt against the evil politicians? Are there going to be more books in the series? I'm not going to spoil the fun by telling.

With a ragtag fleet fleeing implacable enemies, it's hard not to be reminded of *Battlestar Galactica* (whichever version you prefer). Don't be fooled; this is no warmed-over television show. *The Lost Fleet* books are real science fiction, as filling and nutritious as a meal of your favorite comfort foods.

\* \* \* \*

*Star Wars: Fate of the Jedi: Omen*

Christie Golden

Del Rey, 250 pages, \$27.00 (hardcover)

ISBN: 978-0-345-50912-3

Genre: Star Wars

Series: Fate of the Jedi 2

\* \* \* \*

Sometimes you don't want a big meal; you're more in the mood for something less substantial ... maybe some kind of fruit-gelatin salad with those little marshmallows, or something involving things dipped in chocolate. In this mood, you might want to try a *Star Wars* novel. The background and characters are familiar enough, and you can't beat ultimate good vs. absolute evil.

It's 40-plus years after the original *Star Wars*, and there's been a lot of water under the bridge in the

meantime. Don't worry about catching up; Christie Golden is an old hand at this sort of thing and she rapidly fills in the blanks for any reader who's missed the dozens of novels that have come before. In particular, you won't miss much if you haven't read *Fate of the Jedi: Outcast*, the volume that immediately precedes this one.

In the wake of a galactic civil war, the Jedi Knights are facing multiple problems. For one, a mysterious disease is turning responsible Jedi into raving lunatics. For another, the head of the Galactic Alliance has turned against the Jedi and is trying to reduce their influence in the government. Finally, uber-Jedi Luke Skywalker is trying to find out what turned his late nephew, Jacen Solo, to the Dark Side. Meanwhile, mad Jedi threaten Jacen's parents, better known as Han Solo and Princess Leia.

As if all this isn't enough, a long-lost tribe of the evil Sith have surfaced, using their Dark Side powers in a bid to subjugate the whole galaxy.

It's all great fun. Fair warning, though: *Omen* is the middle book of a trilogy, so although it comes to a satisfactory ending, don't expect every loose thread to be wrapped up.

\* \* \* \*

*Vixen*

Bud Sparhawk

Cosmos, 304 pages, \$6.99

(mass market paperback)

ISBN: 978-0-8439-5945-1

Genres: Religious/Philosophical SF

\* \* \* \*

Sometimes you're hungry for a dish that rings changes on a familiar recipe, adding a little spice or an unexpected ingredient. If you're in a mood like that, you might want to give *Vixen* a try.

Take one colonization mission, the good ship *Covenant*, two hundred years from home with its cargo of frozen colonists. Add a planetary system with a beautiful, perfectly Earthlike planet. Awaken the crew, starting with expedition leader Tam Polat, and set them to work exploring their new home.

Stir in a moon that suddenly disappears, and then an alien ship of unimaginable power, and you have the makings of a standard new-planet-settlement, first-contact sf novel.

But this book is by Bud Sparhawk, and Sparhawk does nothing standard. This is where the spice comes in.

*Covenant*, and Tam Polat, are on a mission from God. No, really; the society they come from is a religious one, with social roles rigidly defined. Tam and his lieutenants are Men, superior to the Halfling worker class who tend the ship and do all the manual labor. As Hadir, or leader, Tam is divinely appointed and infallible. In this world, everyone has their proper place and their appropriate work, and all work together to accomplish the will of God.

God has sent Tam and his people to settle Meridian, the system's sole habitable world, and to prepare it for the arrival of further waves of colonists. The work will be easy; Meridian is a delightful Eden.

But every Eden has its apple, and there's the matter of that missing moon and those super-advanced

aliens. God, you see, never mentioned them to Tam. And according to his crew, if God didn't mention them, then they don't exist.

*Vixen* is about more than colonizing a new world and meeting an alien race. It's about what happens when a person—and a whole society—is brought face-to-face with a reality that contradicts their most firmly held beliefs. And *that* should certainly be enough to whet your appetite.

\* \* \* \*

*Open Your Eyes*

Paul Jessup

Apex, 144 pages, \$13.95 (trade paperback)

ISBN: 978-0-9821596-0-6

Genre: SF/Horror

\* \* \* \*

What about those times when you're in the mood for something completely exotic? New taste sensations and unfamiliar cuisines? When you're ready to take a chance on a dish that's totally unfamiliar? It could be a disaster, or it could be your new favorite food.

There are certain writers who instantly transport readers into new, unfamiliar worlds that are completely different from the universe we know. After only a few bites, the reader sits back, gasping, and reaches for the water glass. Then, eyes watering, he or she dives back in, licking the plate clean and asking for seconds. Think of Samuel R. Delany or Cordwainer Smith.

Welcome Paul Jessup to the ranks.

*Open Your Eyes* is billed as a cross between horror and science fiction, which is a little like describing filet mignon as a cross between cows and the laws of thermodynamics. More to the point is the publisher's description of the book as “surrealist space opera.” Suspension of disbelief? It's best to nail your belief to the ceiling for the duration.

The book opens with Ekhi, a woman alone in a spaceship watching her lover die. Her lover is a star, and in going supernova he takes whole worlds with him. But he leaves Ekhi with child, a galaxy growing in her womb.

Ekhi's ship is all but destroyed, and is boarded by scavengers who take her on board their own ship ... the Good Ship Lollipop. This crew of scavengers are easily dysfunctional enough to justify the “opera” in space opera.

The captain, Itsasu, is a little girl who's lived for over 400 years, mourning her dead husband and on a quest to find a way to bring him back. She huddles in a preservation tank near the ship's heart, sending out dolls to be her eyes and nanomachines to be her hands. Itsasu guards a secret, a hidden cargo of incredible potential ... but one that makes her ship a target to anyone who learns of its existence.

Navigator Mari is half woman, half metal. Half her face is a metal cage with silver butterflies fluttering within. She befriends Ekhi, but is also a threat.

Hodei is a sex-obsessed young man who bears the memories of a pinup girl. His brother, Sugoi, is a hulking brute who is in love with Mari. Sugoi is subject to violent rages, which he takes out on poor Hodei.

Shortly after Ekhi comes aboard and is nursed back to health, another ship appears and locks onto the Good Ship Lollipop. Invaders enter, doing damage and looting. Itsasu fears that they are after her secret cargo, but it turns out that they have come for Hodei and his hidden memories.

In this world of bone-ribbed ships and animated wax dolls, death is rarely permanent. But Ekhi and the crew of the Good Ship Lollipop have come upon a frightening force that brings final and painful death: a sapient linguistic virus that forces victims to utter phrases that kill. In the end, as Ekhi's child comes to term, creation and annihilation meet in a catastrophic coda.

By now you're either intrigued, or you think someone has lost their mind. That shows the limitations inherent in trying to describe a groundbreaking book in a few paragraphs. It's like reciting a list of unlikely ingredients to a friend instead of giving them a taste of a delicious, exotic dish. Sure, the book sounds like one absurdity piled on top of another .... but the genius of Paul Jessup is that he makes the reader believe every bit of it. The language is forceful and lyrical, the characters engaging, and after only a few pages the reader falls completely under Jessup's spell. The language of the book is as infectious as any sapient linguistic virus could ever be.

*Open Your Eyes* is not for everyone. But if you're ready to step outside your comfort zone and try something delicious and exotic, you just might want to give it a try.

\* \* \* \*

So there you have it, a smorgasbord of books fit for a variety of tastes. Auntie Mame famously said "Life is a banquet, and most poor SOBs are starving to death." Don't let yourself be one of them.

\* \* \* \*

Don Sakers is the author of *A Rose From Old Terra* and *Dance for the Ivory Madonna*. For more information, visit [www.scatteredworlds.com](http://www.scatteredworlds.com).

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[\[Back to Table of Contents\]](#)

## Reader's Department: **IN TIMES TO COME**

David A. Hardy's spectacular December cover illustrates a story as hard to capture in a single image as it was to imagine in the first place: “Formidable Caress,” the latest of Stephen Baxter's “Tales of Old Earth.” Old Earth, you may remember (though you don't have to) is a most peculiar place where time is layered, running at different rates at different altitudes. That's what makes it possible to experience a drama on such a colossal scale that it would at first seem intrinsically beyond the scope of individual human lives—but both author and artist succeed admirably.

We'll also have a new entry in H. G. Stratmann's “Paradise” series (about another quite peculiar place), plus stories by Carl Frederick and (in a seasonal vein) Jerry Oltion. Richard A. Lovett's fact article, “Plate Tectonics, Goldilocks, and the Late Heavy Bombardment” sheds new light on why the Earth isn't Mars or Venus. And G. David Nordley continues the “peculiar place” theme with the mind-stretching conclusion of *To Climb a Flat Mountain*.

[\[Back to Table of Contents\]](#)



Reader's Department: **BRASS TACKS**

Dear Mr. Schmidt:

Your editorial on the ease at which we contemplate the extinction of a species is right on point.

However, there is a larger point here. It is the risk-free society. If memory serves, Larry Niven wrote a short story (I think the title was "Safe at Any Speed") to end his Known Space series. We had gotten to the point that all risk had been eliminated from society. He felt there was no reason to write any more, as it would be too boring. Our technology hasn't progressed to that point, but our attitudes are there.

We used to be content with protecting children or those things that are impossible for the public to detect, such as tainted food. Now, the thought is that anytime things go wrong, someone will bail us out. Courts have made this a get-rich lottery.

No one wants unnecessary risks. But life must have some risks to offer rewards. A few years ago, my wife and I took a trip to Nepal. We stayed at Temple Tiger for a few days. They had wild tigers roaming the grounds. After dark there were no lights. We had to walk back to our cabin with only a flashlight. To be sure, there were few tigers and they tend to shy away from humans, but there was an outside possibility that we might meet one on the path. I would not have wanted the tigers to be caged. That would have made the trip a great deal duller. We need some amount of risk in our world.

Phil Trice

Oak Park, IL

\* \* \* \* \*

Dear Stan Schmidt:

The July/August issue arrived yesterday, with your editorial citing the reaction to birds vs. airplanes. The afternoon when the US Airways plane landed in the Hudson River, I was in the Amtrak first-class lounge waiting to board the train for Chicago when the story unfolded on television.

Our Seattle papers didn't dwell on Canada Geese as the "offending" birds. They are pests here, and I've even seen them on the Isle of Man. A pretty good way to control them has received little publicity: bring in herding dogs like Border Collies or Shetland Sheepdogs. They will round up the geese to [the geese's] great annoyance. A few days of this treatment will persuade them to move somewhere else. The downside of this treatment is that you have to repeat the process every few weeks, as otherwise the birds will return. Probably one permanent handler with a half-dozen dogs can patrol LGA Airport, eh? Cost: around 1/4 million a year.

John Aurelius

Indianola WA

\* \* \* \* \*

Stan,

I read your editorial in the July/August issue, and noted that you agree with the newspapers (etc.) that the pilot of the airplane damaged by geese was a "hero." I'm somewhat surprised; I thought you would be more discriminating in the use of that term. In my opinion, the term has been so diluted in meaning by being applied to people in all sorts of relatively ordinary situations, that it has almost lost what meaning it had, and I felt I had to speak out, to try to restore some luster to the meaning of that word. While I

certainly agree that Mr. Sullenberger did a superb job of piloting his damaged aircraft down to a safe landing under almost-impossible conditions, I still have to ask: does that make him a “hero”?

If we check dictionaries for the meaning of “hero” (even online dictionaries) we find meanings like these (ignoring meanings having to do with “hero sandwiches” and the like):

1. A person noted for feats of courage or nobility of purpose, especially one who has risked or sacrificed his or her life: soldiers and nurses who were heroes in an unpopular war.
2. A man of distinguished valor or enterprise in danger, or fortitude in suffering; a prominent or central personage in any remarkable action or event; hence, a great or illustrious person.

I think those go closer to the heart of what we'd really like to think makes a person a hero, especially the second definition. Even so, by these definitions, Mr. Sullenberger's heroism is marginal.

My own definition for what I consider a hero is even more restrictive. My definition is “a person who deliberately puts himself in harm's way, for the benefit of another person.” By that definition, Mr. Sullenberger is not a hero; he is someone who suddenly found himself in a dangerous situation (i.e., the situation was thrust on him, it was not due to a deliberate action on his part), and was able to successfully deal with it. He deserves accolades, but I do not consider him a hero.

Thus, not even every soldier who is sent into battle is a hero, but a soldier who leaves cover to pull a fallen comrade into a place of safety, a fireman who goes into a burning building to rescue someone, a secret serviceman who throws himself in front of the president to take an assassin's bullet—those are *heroes*.

Howard Mark

Suffern, NY

\* \* \* \*

*Hrm. You seem to be splitting hairs somewhat: I'd say the pilot certainly seems to fit the definitions you give—"a superb job of piloting his damaged aircraft down to a safe landing under almost-impossible conditions" parallels "a man of distinguished valor or enterprise in danger" pretty closely—and I'm not one who uses "victim" and "hero" interchangeably. After all, if the pilot was just doing his job, isn't that fireman who goes into a burning building or the secret service agent who takes a bullet simply doing the same?*

—Trevor Quachri

\* \* \* \*

Dear Dr. Schmidt,

"Failure to Obey" by John G. Henry in the July/August 2009 issue is a truly excellent story. It is tightly written: there seem to be no extraneous pieces and the pieces that are there fit together very well. The subject matter is (to the best of my knowledge) accurate: the engineering seems plausible and the courts martial procedures match what I remember of my course in the subject (with parts that were not required for the story being left out—see point 1). It is a fine, gripping piece of story telling: the court sequence is just as attention holding as the action sequence. The people are well fleshed-out (for this short a piece of work). Finally, the “moral” of the story is very well justified and is not contrived.

If you could find just one story of this quality for each issue, you would improve the already high quality of *Analog*. (I read the Departments and science articles first, then from shortest to longest. Therefore I

haven't yet read the Hatch or Longyear stories.)

Dean Hartley

Oak Ridge, TN

\* \* \* \*

Dear Dr. Schmidt;

I just finished reading "Failure to Obey" and, as a Chief in the Navy Reserve, naturally found it very interesting. Mr. Henry apparently had some good sources for Navy rank structure and the like, but I felt the term "Chief Petty Officer" was used a bit more often than has been my experience. Now, I don't have any experience with courts-martial (knock on wood), but in most cases, Chiefs are referred to as just that, Chief (with Senior or Master prefixed as appropriate; e.g.: Chief Sharpe). Usually, when using a longer form of address, the Chief is referenced by his or her rate (e.g.: Chief Master-at-Arms Sharpe). I understand that your authors have to write for the general audience, and certain esoteric items may get missed, watered down, or altered so as to make it more palatable for that audience. Mr. Henry is not alone. I do the same thing to TV shows that have passageways in ships a good six (rather than, at most, four) feet wide, etc. All in all, a good yarn, well told, with interesting characters. I earnestly hope never to be examined by CDR Carr; quite a force!

Don Harrington

Maple Valley, WA

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*The author replies...*

Chief Harrington is correct as to routine usage and as to the reasons why I didn't always use the informal "Chief" in the story. The first time a Chief was introduced as a character, I used the full title "Chief Petty Officer" so that readers without Navy backgrounds would know the full name of his rate, and understand in subsequent references to him that Chief was shorthand. Most of the other uses of the full title Chief Petty Officer occur within the court-martial, where the protocol and legal requirements call for the use of formal titles. For example, in the specifications to the charges, the Uniform Code of Military Justice requires rank or rate to be spelled out precisely, along with other details, and when the specifications are read, they have to be rendered exactly as written. May I add that as a retired Navy officer myself, it's always a pleasure to have a Chief tell me that I did a good job. (Though such praise from a Chief more typically takes the form of "for an officer, you didn't screw that up too badly, sir.")

John G. Henry

\* \* \* \*

Dear Stan,

Let us have more of Hatch. He managed to weave Luxemburg theory into his story ("Seed of Revolution," July/August 2009) without bogging down, which I think is an accomplishment.

Good story too.

Max Stalnaker

Scio, OR n

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We welcome your letters, which should be sent to *Analog*, 475 Park Avenue South, Floor 11, New York, NY 10016, or e-mail to [analog@dellmagazines.com](mailto:analog@dellmagazines.com). Space and time make it impossible to print or answer all letters, but please include your mailing address even if you use e-mail. If you don't want your address printed, put it only in the heading of your letter; if you do want it printed, please put your address under your signature. We reserve the right to shorten and copy-edit letters. The email address is for editorial correspondence *only*—please direct all subscription inquiries to: 6 Prowitt Street, Norwalk, CT 06855.

[\[Back to Table of Contents\]](#)

Reader's Department: **UPCOMING EVENTS** by Anthony Lewis

**13-15 November 2009**

TUSCON 36 (Baja Arizona SF conference) at InnSuites Hotel, Tucson, AZ. Guest of Honor: Weston Ochse; Toastmaster: Ed Bryant. Membership: \$45, one day \$20/\$35/\$15. Info: [basfa@earthlink.net](mailto:basfa@earthlink.net), [home.earthlink.net/~basfa/](http://home.earthlink.net/~basfa/), 520-571-7180 (fax); PO Box 2528, Tucson, AZ 85702-2528

**12-15 November 2009**

ILLUXCON 2 (Fantastic illustration symposium) at Altoona, PA. Guests include: Boris Vallejo, Julie Bell, Michael Whelan, John Jude Palencar, Justin Sweet, John Picacio, Brom, Todd Lockwood, Donato Giancola, Greg Hildebrandt, Bob Eggleton; Art Directors: Jon Schindehette, Lou Anders, Ben Thompson. Membership: \$150 (limited to 200). Info: [www.illuxcon.com/](http://www.illuxcon.com/); [info@illuxcon.com](mailto:info@illuxcon.com)

**4-6 December 2009**

SMOFCON 27 (Convention runners convention) at Hilton Garden Inn Downtown, Austin, TX. Theme: Time Management. Membership: \$60 until 1 November 2009, more thereafter. Info: [www.alamo-sf.org/smofcon27/](http://www.alamo-sf.org/smofcon27/); P.O. Box 27277, Austin, TX 78755-2277

**2-6 September 2010**

AUSSIECON FOUR (68th World Science Fiction Convention) at Melbourne Convention and Exhibition Centre, Melbourne, Victoria, Australia. Guest of Honor: Kim Stanley Robinson; Artist Guest of Honor: Shaun Tan; Fan Guest of Honor: Robin Johnson. Membership from 1 January 2009 until some later date (see website for latest details): AUD 210, USD 175, CAD 185, GBP 100, EUR 120, JPY 16000; supporting membership AUD 70, USD 50, CAD 50, GBP 25, EUR 35, JPY 4900. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Nominate and vote for the Hugos. Info: [www.aussiecon4.org.au/](http://www.aussiecon4.org.au/), [info@aussiecon4.org.au](mailto:info@aussiecon4.org.au), GPO Box 1212, Melbourne, Victoria, AUSTRALIA 3001

*Running a convention? If your convention has a telephone or fax number, e-mail address, or web page, please let us know so that we can publish this information. We must have your information in hand SIX months before the date of your convention.*

*Attending a convention? When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an International Reply Coupon if the convention is in a different country.*

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