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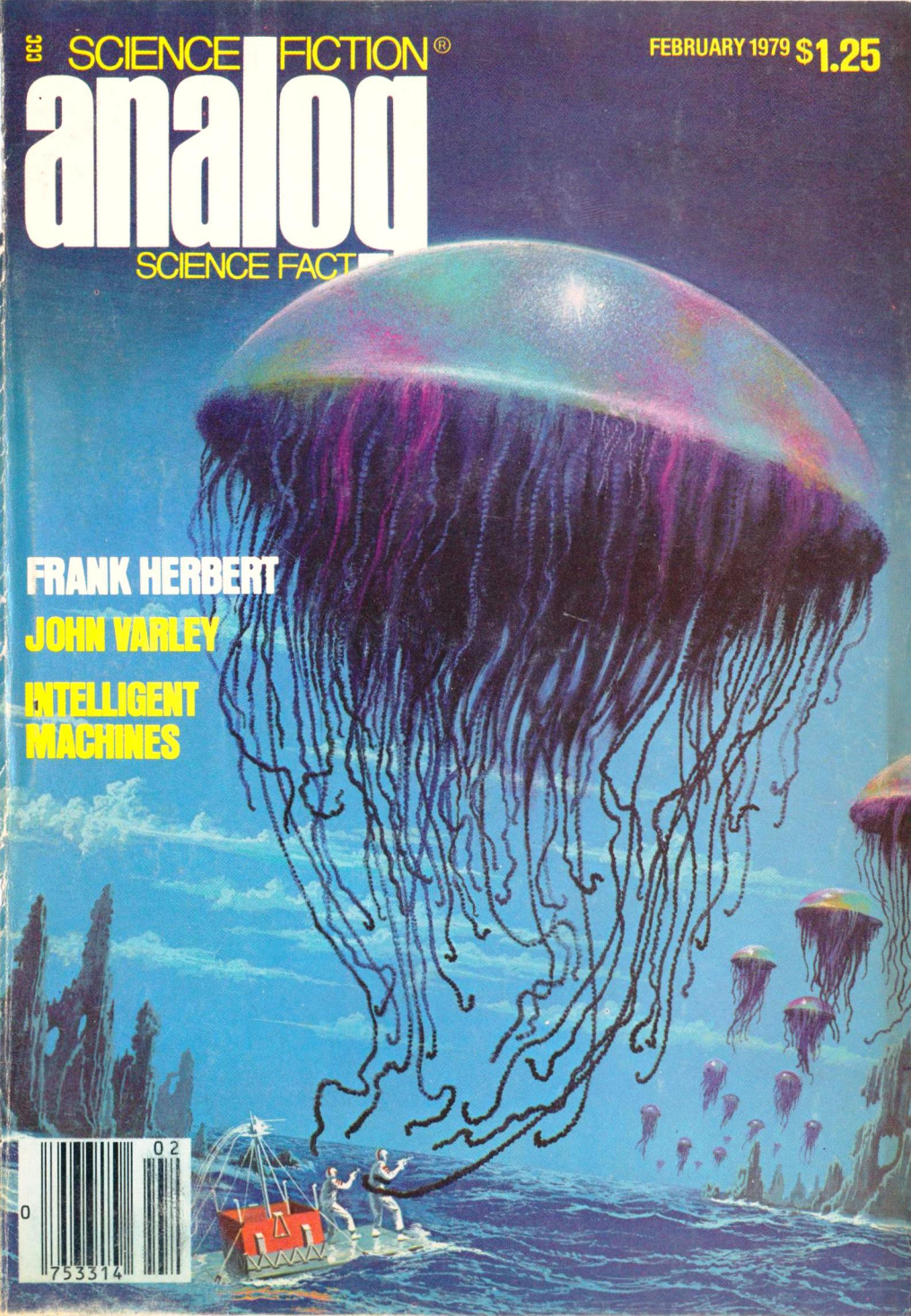

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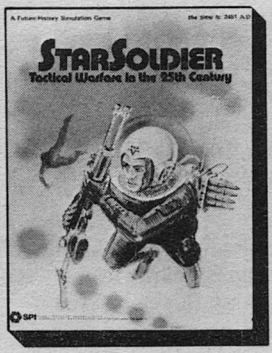

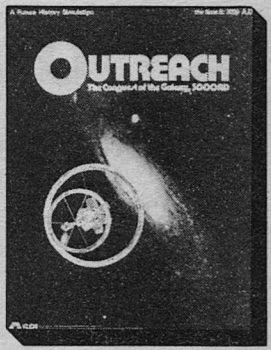

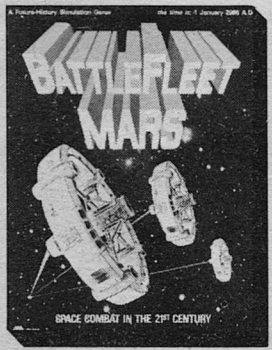

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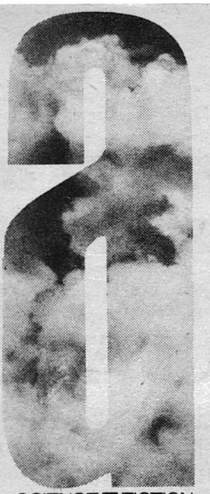

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EX TRA POL A TION

editorial

Faster-than-light travel (FTL) is obviously possible, of course. Consider the following proof.

The kinetic energy of a body may be defined as the amount of work which would have to be done on it to accelerate it from rest to the speed at which it's presently traveling. Any reasonably competent freshman physics student knows that that amount of work is $\frac{1}{2} mv^2$, where m is the mass of the object in question (measured when it is at rest) and v is its speed. So, if you want a thing to go twice the speed of light (commonly called c), you simply have to burn enough fuel to do an amount of work on it equal to $\frac{1}{2} m(2c)^2 = 2mc^2$. It's a lot of fuel, but (neglecting the complications which creep into the calculations if you do this with rockets) only sixteen times as much as you need to get up to half the speed of light, and hardly anybody claims to see any fundamental impossibility in that. Only engineering problems stand in the way. *Big* engineering problems, to be sure, and the faster you try to go, the bigger they get, but in principle nothing that can't be overcome. c is just another speed, with nothing particularly special about it, and if you buy enough fuel and enough engineers, you can go as fast as you like.

Right?

You don't buy that? Good.

Now try this one.

The fallacy in the preceding argument (as any reasonably competent sophomore physics student knows) is that $\frac{1}{2} mv^2$ is *not* a generally correct expression for kinetic energy. It's only an approximation, good at low speeds and only at low speeds. Enlightened by Einstein, we now know that the correct expression is:

$$\text{Kinetic energy} = mc^2 \left(\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right),$$

where all the terms are defined just as they were before. And this form has some peculiar properties. When v is very small (compared to c, which still lets it get pretty huge by everyday standards), the numbers given by this expression are so close to those given by $\frac{1}{2} mv^2$ that ordinary experiments can't tell the difference. (This is rather easy to prove mathematically, with

a trick called binomial expansion.) But when v gets close to c, the kinetic energy calculated by Einstein's revised formula becomes very large, rising more and more rapidly toward infinity as you approach c. *At* c, it's infinite, which means that an object with mass can never travel at the speed of light (though it may, with sufficient expenditure of energy, travel at any lower speed). For speeds *higher* than c, the first term becomes imaginary, which does not correspond to a physically observable reality, so a massive object can never travel *faster* than light, either. (By "massive," I mean having any nonzero rest mass, however small.)

This is, in essence, the argument customarily given as proof that material objects can travel only at speeds below that of light. (Tachyons, recently postulated and still hypothetical, are something else entirely.) Please note, though: there are important implicit assumptions in *both* of the "proofs" I've just given—assumptions which are so closely parallel that, in a very real sense, the two proofs must be considered equally limited. And if that's true, *we sophisticated relativists are no more certain that FTL is impossible than a Newtonian physicist could be that it was "easy"!*

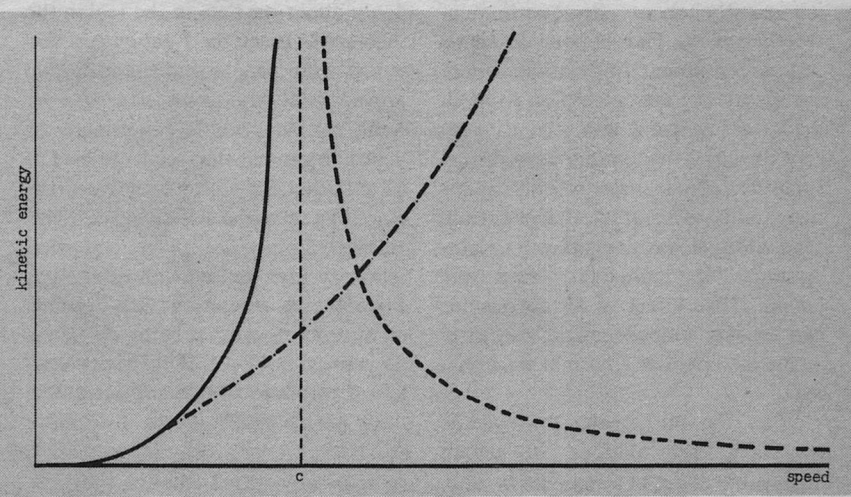
Let me draw the parallel this way. The diagram shows graphically how the kinetic energy of a body (or work required to accelerate it) depends on its speed, according to three different models. The solid curve is the currently accepted Einsteinian (relativistic) model; the dashed curve is the Newtonian or classical version; and the dotted one you should ignore for now. Notice that for speeds well below c, the solid and dashed curves coincide. They are indistinguishable. You might object that that's only because the ink line is wider than the difference between them, but the width of the line has a close analog in experimental physics. Experiments never determine physical quantities with absolute precision; they can only narrow them down to a specified range. If the size of this range—the experimental uncertainty—is comparable to the difference between the predictions of two theories, there is no way to tell which of the theories is "right." Thus in Newton's day, when experimental data was available only up to a small fraction of c, *either* of my two expressions for kinetic energy described the data equally well. So how to decide which to use? Well . . . if something as simple as $\frac{1}{2}mv^2$ worked well, would you even *think* of using something as complicated and unsightly as that other beast?

The fallacy in using $\frac{1}{2}mv^2$ to draw my opening conclusions about FTL consists in assuming that because the data fit the dashed curve at low speeds, they continue to fit it at *all* speeds. When people finally saw some really fast-moving objects, that turned out not to be true; the new data fit better with the solid curve. So far, newer data has continued to fit well with this curve—*but we still only have experimental data up to a cer-*

tain point. That point is now quite close to c, but beyond it we have *no data*—and the relativistic proof that FTL is impossible is crucially dependent on the assumption that that curve (which exists only to the left of $v = c$) is valid for *all* data, including those which we don't yet have.

Just as my opening nonproof assumed that the *dashed* curve fit all data.

The assumption we're now making may well be right—but we don't *know* it. Not yet, anyway—and personally, I'd be delighted to find out that it was wrong in certain kinds of ways. Some such way as the dotted curve, for instance, which shows the kinetic energy dropping off again somewhere beyond the data we have, and making FTL not only possible, but associated with lower energies than slightly sublight speeds. (The dotted curve coincides with the solid for v less than c.) I don't claim this is the way it *is*—but I do claim that I've never seen any data to *prove* that it isn't. (Incidentally, this purely hypothetical curve, while it bears a slight resemblance to some things you may recognize from tachyon theory, is fundamentally different. The tachyon theorists assume that the equations of relativity are generally valid, but special particles may exist which *always* travel faster than light—and have such amusing quirks as imaginary masses to keep the equations happy. My dotted curve, on the other hand, assumes that the relativistic equations are only a special approximation to something else, just as Newton's equations were special approximations to Einstein's—and implies that objects with *real* masses, such as you and I, can travel *either* faster or slower than light. A rather important distinction, for those of us with large-scale wanderlust. . . .)



Extrapolation—assuming that a curve or equation or principle continues to work in regions where it hasn't yet been tested, and predicting the consequences—is a very important tool of science (and science fiction). But it's important to remember that, by the nature of the beast, it always rests on an assumption—and an extrapolation doesn't constitute a *proof* of anything until it's been verified by direct experiment. It's very easy—and very treacherous—to lose sight of this fact. It's tempting, when you've struggled to build a satisfying theory to explain the data in hand, to confuse that theory with Ultimate Law—to believe that its predictions are *proofs* rather than just feelers extended into the unknown to be checked against reality so the experimental findings can in turn be used to build a *better* theory.

Incidentally, though I've been talking mostly about the question of whether or not FTL is possible, that's just a convenient illustration. There are plenty of other examples, from all fields of science. I was recently present during a moderately heated conversation about some recent experiments alleged to prove that a certain food additive was dangerously carcinogenic. "Inconclusive," said one friend. "The effect of an outrageous overdose on a mouse proves very little about the effect of a normal dose on a man."

"But the outrageous overdose is necessary," said another, "to get an observable effect in a reasonable time. And they can correct for it, figure out what a normal dose would do, by extrapolating. . . ."

Can they? It's a lovely theory, and maybe even valid—provided they know what the effect-versus-dose curve looks like in the normal-dose region. But do they? If they need an outrageous overdose to get measurable results, do they have any real data points on that part of the curve—or *only* extrapolation?

The question is not trivial.

A counteradmonition: Just as it's easy to believe the extrapolation based on your own current theory is the only possible extrapolation, it's easy for those who resent apparent limitations to scoff at orthodox theory, seemingly just *because* it's orthodox. Chances are, this will yield only wishful thinking. While the right form of the extension of a curve or theory beyond existing data is uncertain, there's far less doubt about the data in the region the theory was based on. I get quite a few letters from people who think they've proved relativity to be nonsense by some simple thought-experiment or logical argument that seems to lead to a contradiction. Unfortunately, in the cases I've seen, the self-styled debunkers have simply not understood what relativity says well enough to apply it correctly. A refutation that depends on misquoting what is being refuted is no refutation at all. If relativity contained errors as simple and blatant as these people claim, it would not have survived this long. Physicists are not categorically stupid (though they are,

like anyone else, occasionally a bit short-sighted).

It's highly unlikely that relativity is going to be proved wrong at such an elementary level—the body of equations it offers has withstood far too much experimental testing, not just in thought-experiments, but in real-world, hardware-type experiments. Up to the highest velocity for which we have data, those relations seem quite well established. Any new theory has to satisfy a "correspondence principle" requiring it to give the same answers as older ones in the regions of experience where the older ones worked. Relativity had to give the same answers as classical theory at low speeds, and any new theory will have to give the same answers as relativity at least up to very near the speed of light.

Beyond that, we aren't really sure. Results may someday be found which are wildly different from anybody's present guess. If they are, the very foundations of theoretical physics will have to be rebuilt. Physicists have built up a beautiful, elegant, logically consistent picture of how spacetime is built to account for *why* the relativistic equations work, and that picture seems quite incompatible with material beings like us going faster than light.

But "beautiful, elegant, and logically consistent" does not necessarily mean *right*. Newtonian physics was elegant and consistent, too, but not completely right. It was right as far as it went, but not for all circumstances. Generalizing it to give right answers for a larger body of experience required very fundamental changes in our view of the underlying *reasons* for the validity of Newtonian equations at low speeds. The most basic, intuitive, "common sense" concepts of space and time had to be drastically revised.

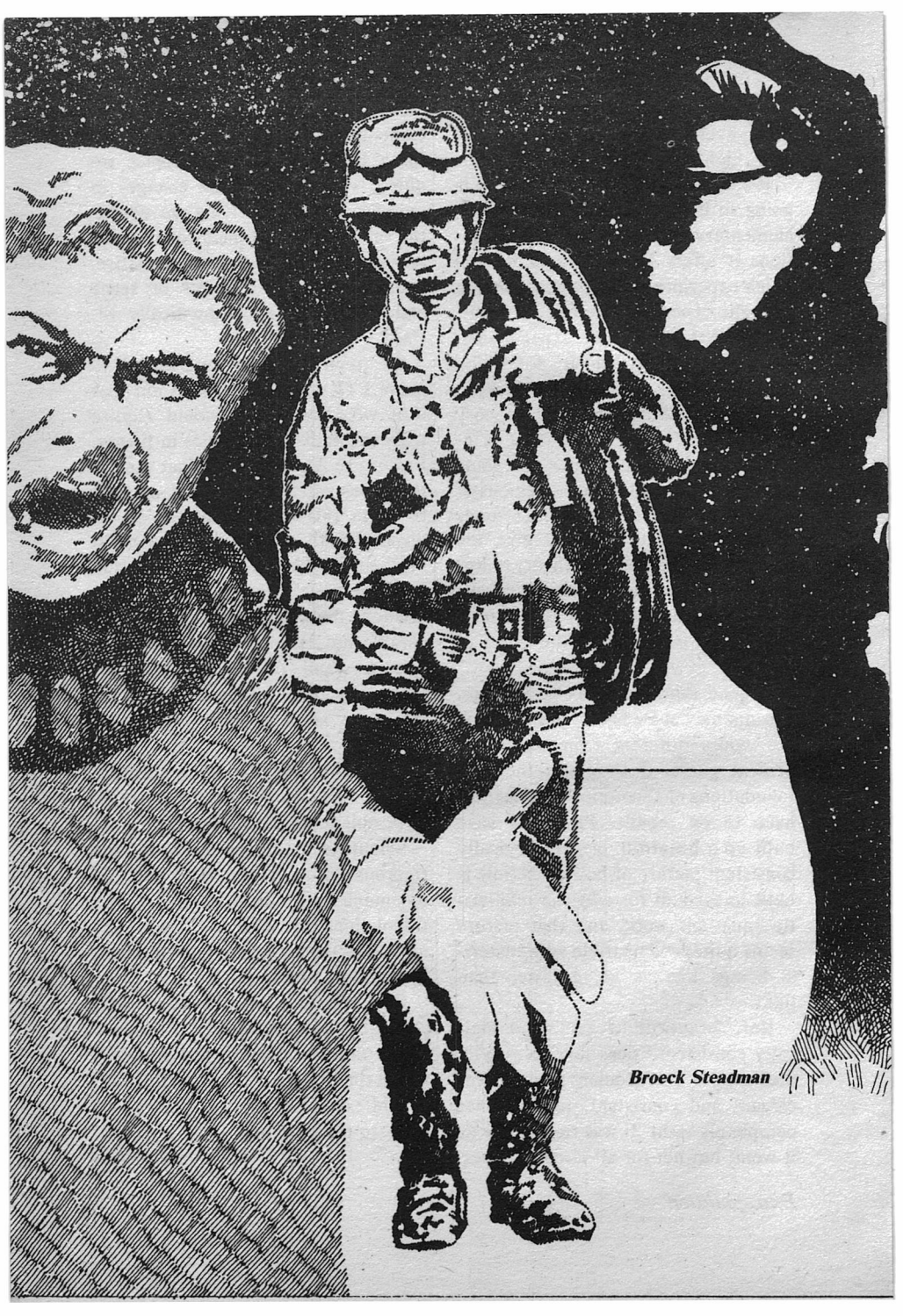
So when someone determined to prove FTL impossible points out that if it were possible it would require truly revolutionary changes in theory, I say: sure, but so what? That type of thing has already happened at least twice in this century alone, just in physics (with relativity and quantum mechanics). There is plenty of reason to suspect we're on the verge of at least one more. There have been comparable breakthroughs (such as plate tectonics and the double helix of DNA) in other sciences. I see no reason to assume there will be no more.

Rebuilding foundations is always a big job—but wouldn't it be worth it, to be able to go to the stars?

Scientists acting as such, by the rigorous nature of their work, can't do too much with wildly alternative extrapolations of theory—anyway not until new data suggests one in detail. But science fiction writers can.

I'd guess that some of those wild alternatives are going to provide some of the most fascinating real possibilities in the future. We in science fiction should explore as many of them as we can—to pave the way.

THE EDITOR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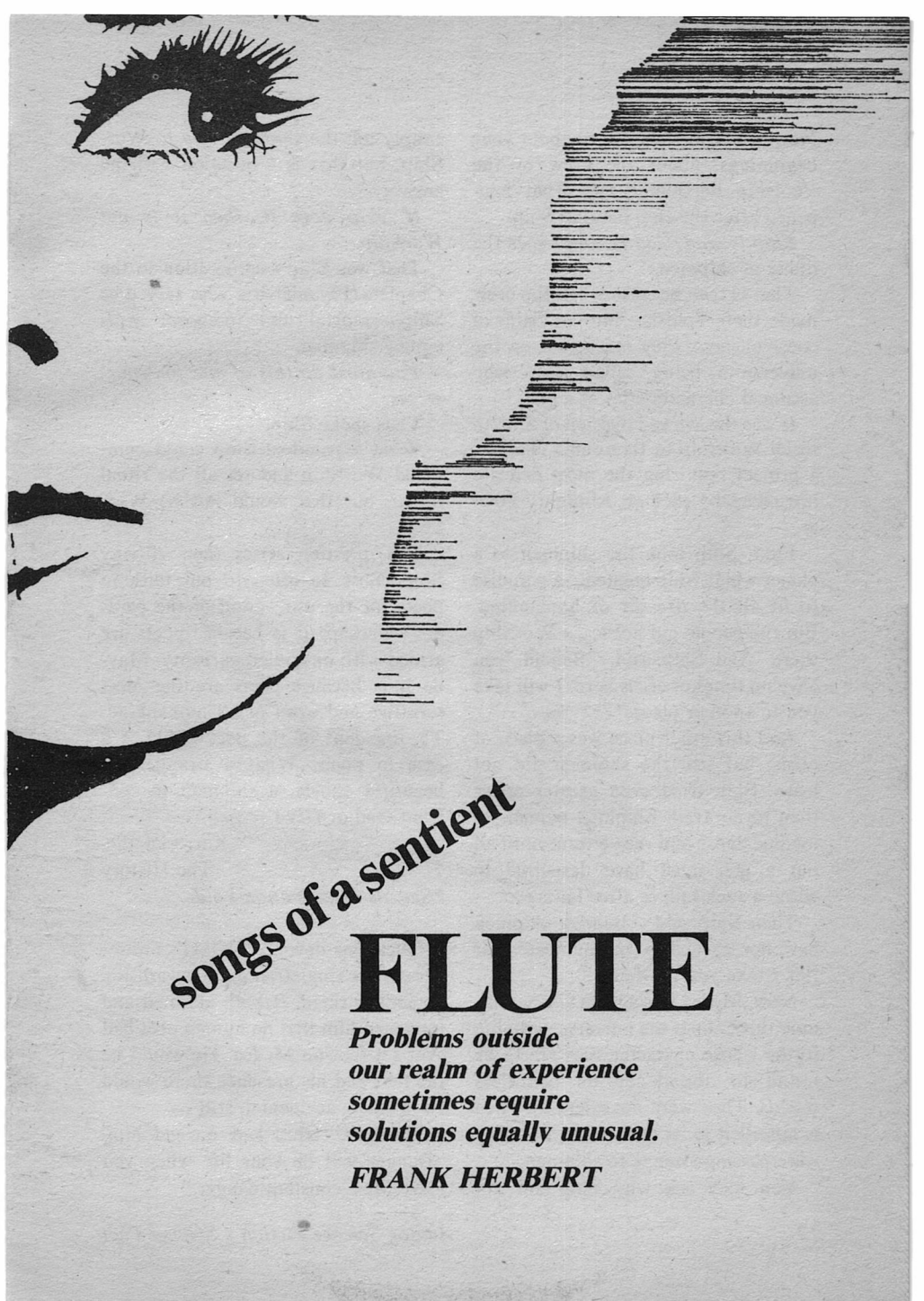


songs of a sentient

FLUTE

Problems outside
our realm of experience
sometimes require
solutions equally unusual.

FRANK HERBERT

Now, it is time for a story about your beginnings, about the crew of the Voidship Earthling* and what happened after the ship became Ship.

Ship is God/God is Ship, goes the litany of shipmen.

That is true because when the crew made their Voidship into an artificial consciousness, they released upon the universe a being called Ship who assumed characteristics of a god.

It was the avowed mission of Ship to teach WorShip to Its human charges, a project requiring the most delicate intrusions by such an Almighty Power.

First, Ship took the shipmen to a planet which Ship created—a paradise to fit all the dreams of humankind. But the people did not learn WorShip there. And Ship said, "Behold, you have no times of crisis here. I will take you to another place."

And this other place was a place of crisis, but still the shipmen did not learn. Ship tried even greater crises then to no avail. Shipman-human remained dense and recalcitrant until all but a god must have despaired to witness such failure after failure.

Then Ship said, "Behold, shipmen have not learned to communicate. For this I take you to Medea."

Now, Medea was a planet very common throughout the universe, with life forms whose characteristics are to be found in abundance on countless worlds. They were not alien, for alien is not alien in its own home, but they were passing strange to shipmen.

You may ask why Ship did not simply tell the shipmen how to WorShip, but that is a question with no answer.

If Ship does it, then it is not WorShip.

That was Ship's admonition to the Chaplain/Psychiatrists who served as Ship's mortal and temporal arms among shipmen.

You must do this of and for yourselves.

Thus spoke Ship.

What a paradox! Ship could command WorShip and set all the ritual forms, but that would not be WorShip.

The question arises then of why Ship chose so often to put faith in poets for the unraveling of the paradox? Perhaps it is because poets are armed with unbridled curiosity. Maybe it is because poets are the most sensitive and open of all humankind. The incident of the poet Nikki is a case in point. What a strange and beautiful choice, a shipman to confront God or Devil.

Kerro Panille,
The History

**See also Destination Void*

Questions devoured Nikki's awareness as his singletran dove toward the planet's surface. It both alarmed and intrigued him that no human poet had ever set foot on Medea. He would be the first and his presence there would be far from accidental, still . . .

"Danger," Ship had warned him. "Danger will be your life when you leave Me—constant danger."

Nikki had a momentary recall from the briefings: swarms of iridescent airborne globes drifting down on the Medean colony, then explosions, fire—people and buildings in flames, death, pain and destruction all around.

This had happened many times and it was only one of Medea's threats to the human intruders.

Why did the colony (or even Ship) assume that a poet might nullify those flaming nightmares or the other perils?

The singletran slowed abruptly as it neared the ground. Through the webbed crashpad which guarded his vulnerable flesh, Nikki felt his capsule's wallowing passage toward Medea's Integration Central, parts of which were now visible out the port on his left. His gaze took in a circular complex of flameproof structures enclosing a landing dome and tiny patches of transplanted Terra. He knew what it had cost the colony to erect those few structures, but without constant vigilance even these were not impervious to the floating fire and Medea's rampaging demons.

What does Ship want of me here?

Nikki allowed his senses to concentrate on the insulating crashpad. He breathed in a slow, deep rhythm which helped him focus on Ship's last message to him, then on the words of that message (*Go! Be Human!*) . . . then on nothing at all.

He was ready for anything.

For eighteen years Ship had systematically filled his mind with all the raw data he could master. But it was his mother, Tosa Nikki, who had taught him oneness of mind and body, and Ship had not interfered. Perhaps Ship had directed even this.

Tosa Nikki—the almond-eyed recorder who'd been computer-impregnated before hibernation and the long long sleep to Medea—he saw her eyes reflected in his own, and her skin and hair were his. His hair was different from that of the other colonists. Straight, black, it hung in two long braids and reached nearly to his waist. His mother never cut it and after she was gone, neither did he.

"That's the way they did it Earthside," she'd told him, "the poets and the mystics. They kept their hair long and chose their own names as a sign of strength and a badge of their station. Some considered it superstition, totemism, but none violated the custom."

"Was my father a poet?"

"Not likely. Poets are the mules of the mystical world. For all practical purposes, Ship is your father. Ship will teach you all you need. And, once you leave Ship, Medea will be your mother. Take from her what you need, and go beyond even that."

Then Tosa Nikki was gone. Ship did that sometimes when least expected and It never answered questions about such losses.

Now, the black and red shadows of Medea slipped past him, washed and blurred through the port's tinted glass. He'd been twelve when Tosa Nikki left him to Ship and the colonists, and

he'd had six years of training ahead of him before setting foot on real dirt.

Training for what? he wondered. *For what kinds of danger do you train a poet?*

As uneasiness crept in on him, he resumed the breathing exercises and thought back to the six-year blur of vocoder instructions, questions, exercises, viewscreens and holographic projections that pressed datum after datum upon him from thousands of human minds—most of them long since dead.

This day (he reminded himself) he was leaving Ship, his Father, to step out onto the complex shadow-world of Medea. He was eighteen, strong, and already an eccentric mystery among those who knew him Shipside. Despite the sophisticated gadgetry of Ship and the wealth of information this had given him, his real comfort now lay in body-tuning, the breath control and mind control his fleshly mother had taught him.

Curiosity, that was the thing.

He had remained Ship's favorite because his curiosity was total. This curiosity had led him into his first intellectual exchange with Ship . . . another memory-marker from his twelfth year.

Why do I think now of that year?

He had a poet's answer: *Because all separations carry something of the same sadness and the same beauty.*

Yet . . . that intellectual exchange was the only experience that he had asked to be replayed for him as he had prepared for transport to Medea.

Ship: "Today, young Nikki, a theology lesson. What is God?"

Nikki: (long pause) "God is being."

Ship: "Negative. What is God?"

Nikki: "I am God."

Ship: "Negative. *I* am God."

Nikki: "Yes, *we* are God."

Ship: (demanding) "Why do you say such a thing?"

Nikki: "It is my thought and the thought is God."

Ship: (long pause) "Whence comes such an answer?"

Nikki: "It has two roots—one for maintenance, one for growth."

Ship: "Continue."

Nikki: "Self-consciousness and curiosity—if these are imperfections, then they are imperfections breathed into me at my creation."

Then Ship's vocoder had shut down on him—the first time Ship had refused to speak to him. Before leaving his instruction panel on that day of his twelfth year, Nikki had keyed his first poem into the console:

Skin of steel
Skin of flesh
prisoner of thought
or extension?

Ship had merely relayed *accepted* and returned to Its odd silence.

Until Nikki's moment of leaving for Medea, that exchange had not been mentioned, but from the time when the vocoder once more responded to him he never again heard the word *restricted* when he asked a question of Ship. He'd had many subsequent discussions with It on matters ranging

from primitive concepts of nuclear chemistry to music and he was one of the few colonists ever to relate the two.

"What is it you'd like to understand?" one colonist, a biochemist, asked him.

"Harmony," Nikki said, and pressed for the schematic of a nucleic acid.

The thump and hiss of his single-tran against Medea Central's main hatch jarred him alert. In spite of his training and self-discipline he felt chilled by excitement. The capsule's hatch gaped open into a long, enclosed walkway lined with transparent bubbles which looked out on the jumble of wind and shade and biological magnificence that Medea displayed for him.

Nikki released himself from the protective webbing, took up his recorder and bag, and stepped out. His nose told him there were unlabeled things in the air . . . something sweet . . . something damp and smokey. A sign flashed on the air ahead of him.

ALL PERSONS MUST RECEIVE COLONY ASSIGNMENTS AT INTEGRATION CENTRAL. STRAIGHT AHEAD. WELCOME.

Just past the sign, he came on a small hatch opening onto the unprotected face of Medea herself—no plasteel floors and bulkheads, no holographic approximations of sandfans, clouds or the many-legged little sects whispering through rocks and gravel. There was a bright orange warning below the hatch controls.

DANGER: MAINTENANCE AND SECURITY ONLY!

Nikki knew the physical data relayed to Ship better than most of even the older colonists. He knew it was likely that one of the suns was in flare and all over Medea creatures were digging in and covering themselves for their lives. A flare's ultraviolet was danger enough, but the vicious predators hatched by a flare, the lightning-fast demons raging from shadow to shadow, could reduce native species to a memory in seconds, and could strip a human to bone in less than a minute. In five minutes, the bone, too, would be gone.

In spite of this knowledge, Nikki snapped back the latch and stepped outside.

How else can I meet my new mother?

His greatest surprise was the wind. The quick gusts that rustled his hair and collar felt like the soft brush of living fingers tender on his skin. He was surprised, too, at the watering of his eyes precipitated by the breeze.

Nikki nudged the dust with a boot toe and sensed the peculiar sweetness of humus rise with the wind.

Near his toe grew a tiny native bush which the colonists called *Narcissus*. Silver leaves were thick on its short branches. A fine matrix of tiny red veins joined in a knot at the stem. The leaves were arranged in pairs, facing each other, and each pair angled upward and outward in a funneling and reflecting process which captured as much available light as possible. He bent close to the plant and heard the soft, characteristic hum of its brittle

leaves vibrating in tune with the rise and fall of Medea's ultraviolet pulse. He touched a leaf and the plant disappeared into its root system with a metallic *snap*.

Yes, many Medean species maintained an armored retreat ready at hand. It was a lesson the colonists had learned early and copied.

"You!"

It was a shouting voice behind him.

"Get back in here!"

Nikki straightened and turned, saw a maintenance man in a flare suit standing in the hatchway's shelter. The man moved to step outside, but reversed himself as Nikki slipped past him into the walkway. The man's anger remained, however, even after he closed and sealed the hatch.

"What were you trying to prove out there?" He pointed to the warning below the latch. "Didn't Ship teach you how to read?"

Interesting question. Nikki heard the overtones of many fears. It brought home to him that Ship, while teaching him to read, had used this as a lever to teach him how many things there were more important than reading.

Danger.

Nikki glanced back through the walkway's transparent shielding, saw the tips of the *Narcissus* beginning to venture once more into the open. He glanced at the maintenance man.

"Ship taught me that it takes many signs to make a warning," he said, and he resumed his course down the walkway toward Integration Central.

Even Narcissus balances the demands of relative dangers.

He found this thought reassuring.

All through the swift routine of processing, Nikki kept himself as open as possible, absorbing the newness, comparing. He stored his questions, preferring to listen. The chief receptionist was an elderly man, one of the First Down. He had bored eyes and puffy cheeks and there was the fatigue of death in his voice.

The reception room was like a Ship room: functional, two hatches in metal walls, instruments in racks, no ports or windows. It was barred by the console behind which the receptionist sat, a gate on the right leading to the rear hatch. The man grudged every effort of speech.

"Brought your own recorder." He punched a notation into the console which shielded him from the waist down, as though he did not exist except as part of the machine.

Nikki felt the weight of the recorder on its strap over his shoulder. *How odd.* It was as though the man's words had created the weight of the recorder.

The receptionist glanced at the Shipcloth bag on Nikki's other shoulder. "What you bring?"

"Personal possessions, clothes . . . a few keepsakes."

"Hrrrm." The man made another notation, delivered himself of his longest speech. "You're assigned to Tamarack Kapule. Meet her at Quarters." A nod indicated the rear hatch and the

gate swung open. "Through there. Follow signs."

It was a long, brightly lighted passage lined with hatches and punctuated by the signs which flashed on at his approach:

COMMISSARY . . . VITRO LABS . . . RECORDS . . . MAIN SECTION . . . LIFE SUPPORT . . . CLINIC . . . WORSHIP . . .

It was as though he had never left Ship.

This is a test, he reminded himself.

It had to be a test. Ship was God and God was Ship. Ship could do things mortal flesh could not. Normal dimensions of space dissolved before Ship. Time carried no linear restrictions for Ship.

And I, too, am God . . . but I am not Ship.

Or am I?

It was a question he had never resolved, although he knew the history which Ship taught. There had been a time when Ship was *the ship*, a vehicle of mortal intelligence. The ship had existed in the limited dimensions of space which any human could sense and it had known a destination. It had also known a history of madness. Then . . . the ship had encountered the Holy Void, the reservoir of intelligent chaos against which all beings were required to measure themselves. And the hibernating humans on the ship had awakened to find themselves the creatures of Ship.

QUARTERS . . . QUARTERS . . . QUARTERS . . .

He stepped right through the flashing sign while becoming aware of it. The sign obviously had been keyed for his approach. Nikki opened the indicated hatch, stepped through into a half-hub from which many passages fanned out.

Down the passage directly in front of him a woman stood beckoning, impatient. He had never seen a woman of such compelling appearance . . . the *differences* about her jammed his awareness. He responded only to her impatient beckoning until the strong contralto of her voice added emphasis to her gestures.

"I'm Tamarack Kapule, you can call me Tam. You'll be working with me starting in ten minutes down at Behavioral. We're in a rush so I'll fill you in as we go. This is your room." She opened a hatch at her side. "Leave everything here but your recorder."

He peered through the hatch at Shipstyle quarters, a familiar foldout desk . . . but there were differences. He glimpsed a real bed. He'd only seen holos of beds. You slept in a net on Ship.

Nikki tossed his bag inside, closed the hatch.

She was already leaving, talking in that same husky rush as she moved.

"Your records are incomplete. What do we call you?"

"Nikki."

By the time he'd made sure he had spare charges for the recorder and a notebook in his pocket she was well down the passage and she did not look back to watch him catch up.

Her brusqueness was neither cold

nor angry, he decided. She had a job to do and little else mattered. Nikki trotted to keep up with her, working out what her appearance told him. Her hair was as close to absolute white as he'd ever seen. Her eyes were shaped much like his own, and when she glanced at him he saw a quick flash of blue, a cold blue that, he was convinced, expected and got the truth from any other eyes they confronted. Her skin, though pale at a distance, was backlit by a reddish glow when seen this close.

"Well?" she demanded.

Nikki realized that he had been staring.

"Local mutation," he said. "Quite striking."

"How do you know I wasn't born this way?"

"You're too old to be Shipborn," he said. "You have to be one of the originals chosen for this colony."

"So?"

"Preliminary data on Medea showed the occasional high bursts of ultraviolet. People with abnormally low pigmentation would've been excluded."

Her blush deepened.

"What else do you know about me?"

She slowed her pace, tense, face straight ahead.

"Your name, Kapule. That's from one of the old Pacific Ocean nations, probably Polynesian. My eye structure's similar to yours."

She looked at his eyes, turned away.

"Your eyes were brown at one time," he said.

She shrugged, opened a hatch and stood aside for him, then followed. They were in another passage at right angles to the one they'd left. She struck off to the right.

Nikki kept pace, talking as they went. She had asked a question and he was determined to give her a full answer, although he now saw that she regretted her curiosity.

"Tamarack is a variety of tree. It grew in Canada and the northwestern United States of Old Terra. Conifer with deciduous behavior—dramatic color changes each fall and spring. You have changed colors."

They stopped outside a hatch signed BEHAVIORAL.

Nikki looked down at her and smiled with a confidence and maturity which drew her to him despite some deep resistance. He spoke to soothe her.

"My mother's family also was of the Pacific nations."

She looked him full in the eyes. Yes, he was colored much as she'd been when she'd first set foot on Medea. And he had seen this thing about her which neither Ship nor any of the Holy Sciences would explain. She recalled how her questions had ignited nervous words from the experts.

"*Perhaps these changes in you were caused by freak energy bursts from the suns.*"

She studied the face of this perceptive young man. Would some bizarre and undetected pulse from the red

heart of Argo work its changes on him, too? Whatever it was that caused this, it began slowly, an irreversible wash of pigment from the body. First, her hair. Gray at twenty-two, white by thirty. And this Nikki was only eighteen, half her age. By thirty her skin had lightened noticeably and by thirty-five was nearly translucent. Just this year, the curious red tinge had formed deep within her skin and she had grown to like this effect of the changeling process.

"Is there more?" she asked.

Something in the soft *voice* of her question compelled his attention. There was something important, something she needed which only he could supply.

Nikki closed his eyes and tapped into the oneness which his mother had taught.

"You're self-conscious about working with someone so much younger than yourself."

"Do you know how important our project is?" she asked.

Her voice told him she was ready to retreat—like the *Narcissus* . . . like the maintenance man. Where was her place of armored security?

He spoke softly.

"There's confusion in your mind about your project and those working on it with you."

"It's the most important project in the colony," she said. "Life and death are . . ."

"It's urgent," he agreed.

Nikki opened his eyes and looked directly into hers. "And you're self-conscious about working with a male who's so much younger than you."

She lowered her gaze and sighed. The blush faded.

"You didn't arrive at all that through logic."

"That's why I'm here," he said. "Logic's failed."

She reached out and shook his hand—strange antique gesture, the remnant of a caress, and it kept them at a distance.

"In here."

She followed him into a laboratory room. He recognized most of the instruments and knew he'd learn the strange ones soon enough.

Tam was busy swinging out a Voder and its screen. She spoke as she worked.

"You have to learn a Floater's instrumentation and controls. This voder has a mock-up program. Sit here." She indicated a foldout seat at the screen.

Floaters, he thought, his pulse quickening.

The idea of these colony craft, lighter than air, fascinated him. How vulnerable they were, subject to any whim of an atmosphere which could not be completely predicted.

He sat in the indicated place and looked at the simulation of controls and instruments. His stomach felt cold with apprehension. He sensed the prickling of his scalp.

But this is only simulation!

His body continued to send out panic signals which he could not ignore.

"Is something wrong?" Concern edged Tam's voice.

Nikki realized that he was trembling. He put a hand on the control panel to steady himself, found his own muscles pushing him away. He tried to tell himself this was a Medean reaction, the accumulation of subtle oddities for which Ship had not quite prepared him. This peculiar planet set up too many conditions for flight from danger. But he could not prevent himself from standing and backing away from the simulator.

"What's wrong?" Tam demanded.

"Did you prepare that?" He pointed at the voder/simulator.

Tam studied his face. He appeared actually ill. Was this an adverse reaction to something Medean?

Nikki saw her puzzled frown, the way she divided her attention between him and the simulator.

"Answer my question."

"Tom Root prepared this mock-up. He's our project director. Why?"

Nikki groped for words and found this the most peculiar thing of all. Words did not usually evade him.

"This . . . this is *against* Ship," he said. "This is contraShip . . . wrong. It's . . . evil."

There! The word fitted precisely. It was evil, this simulator.

Her puzzlement deepened.

"Nothing here can be against Ship."

He was certain now and not to be deflected. "That is." He nodded at the simulator. "It would teach me to do something wrong."

"It's . . . it's just a machine, a simulator!"

She slipped onto the seat, hesitated, then punched a button marked *balance*. Red lights flashed, a klaxon behind the screen began hooting. Tam whirled to her right, hit the PROGRAM button, began scanning the numbers and other symbols which replaced the red lights to parade across the screen. The klaxon fell silent.

Nikki's fear signals began to dampen out.

Presently, Tam turned and looked up at him.

"How did you know?"

"How did I know what?" His mouth felt dry.

She ran a hand through her hair, glanced at the now empty screen. *Why do I feel angry?*

"There's a fault in PROGRAM acceptance," she said. "I don't know exactly where the problem's located. One of the technical people will have to look at this."

Nikki swallowed, regaining his composure. He realized he had not answered her question, did not know *how* to answer it.

How did I know?

"What are you?" she demanded.

"A . . . poet."

"Until you asked for *balance* controls, this simulator would've conditioned you to do . . . dangerous things."

"Is it supposed to do that?"

"No!" She stood up. "Come along. We've scavenged the console from a wrecked Floater. You can use that

until they find out what's wrong with this simulator. You can at least learn how the instruments are supposed to work and where they are."

The rest of the day went well, although Nikki had to force himself not to question Tam about why she had punched first thing for *balance* on the simulator. Training with the recovered console taught him this was seldom the first thing you asked of your controls. Floaters were built to take dramatic imbalance and the *balance* gyros put a strain on the power system.

And it was disquieting that he could not explain, even to himself, how he had known. What hidden signal receivers did his body contain? Were there petit perceptions for which only he was the sensitive receiver?

He began to suspect there might be an odd rapport between Tam and himself. She remained watchful of him all through the day, suspicious. All of this was held beneath the surface, submerged in the training routine, in the study session which paraded for him the latest records of Medea's bloom behavior.

The gasbags—airborne globes—fascinated him. They behaved as though directed by a single intelligence, sometimes merely beautiful—a display. Other times, they were definitely malevolent, killing . . . maiming.

At the day's end, Tam handed him a torn piece of computer printout.

"Here's a map for your appointments tomorrow and the schedule. See you at early. Goodnight, then."

She left him to find his own way back to the Commissary and his quarters. Nothing unusual about that. Shiptrained people seldom had trouble with enclosed passages.

When he sealed the hatch of his room behind him, only then did he allow himself to accept the accumulated aching fatigue. Was this an accurate forecast of Medean routine? Could her pace be normal here? Could he perform under such pressures? Where was the 'life and death' focus of her project? *Of Root's project*, he corrected himself. When was he going to meet this Tom Root whose name he had only heard today? Why hadn't Ship given him at least profiles on his workmates? Something here went far deeper than the apparent physical threats which Medea sent against the intruders.

Nikki stowed his bag in a locker, examined the bed. There was no enfolding net, no crashbag. The bed was flat. He pressed it with one hand. Resilient. He stripped, doused the light and climbed into the bed. Rough blankets. Medean fabric? So many questions . . . his first night in a real bed and sleep swept over him as soon as he closed his eyes.

There was a loud thump, cold . . . pain.

It took several heartbeats for Nikki to realize that he had fallen out of the bed. Still half asleep, he was as much amused as surprised. He rubbed at a bruised elbow and tried to remember the dream he'd been having. As rush-

rush as everything had been since he'd landed on Medea, he felt that the whole day had been a dream and he was only now awakening. Images from the dream fled through his mind:

He and Tam far above the settlement, somewhere so high that all of Medea dropped sharply away from their feet. They hung there holding each other suspended by . . . what?

Then the fall.

Nikki found the light control, sat on the edge of the bed and measured the drop. It was the height of two hands from the top of the bed to the floor. He touched the floor with fingertips, then increased the light. The floor was hard, sturdy. It was made of long strips of intricately stained material patterned like the tidelands of a wide sea. He'd never seen a sea except in holograms . . . repros.

And in the dream.

Then, as each hair on the back of his neck and scalp prickled and raised, the patterns, the stains, the strips disappeared.

Once more, he awoke on the floor, rubbed his elbow and sat on the edge of the bed. The bed felt more *immediate*, its covers more resistant to his pressing palms. He knew that he'd better be careful. Sometimes it was difficult to tell one reality from another, but Medea was playing tricks on him.

In the morning, he used Tam's map to locate the small commissary used by Floater personnel and found her there seated at a corner table, alone. Only one other table was occupied—three older men in gray singlesuits. Eyes turned toward him with curiosity at the new face. Tam already was eating her early. He called it "breakfast" and she turned to him, startled.

"Why'd you say that?"

He scanned her, saw only curiosity and mild amusement.

"It surprises you?" He sat across from her and signaled the autocook for service.

"Perhaps it shouldn't." She sipped her juice. "Language is your life. But that's such an *old* word. We were calling it 'early' three generations and two planets ago."

"Four generations and three planets ago we were sipping *juice* at *breakfast* whether breakfast was eaten early in the wakeday or late."

"But I haven't heard that . . ."

"Some words have more inherent wisdom than others. Juice . . ." He pointed to the glass in her hand. ". . . is, after all, a fluid naturally contained in plant or animal tissue."

The autocook took this moment to disgorge his food onto the table. He began eating and, presently, took up his own glass, tasted it. Acid . . . faint sweetness.

"This concoction we're drinking is damned near anything but what we call it."

She examined her glass against the light.

"But what if it's a pretty word? What if . . ."

"What if we stop playing with words to avoid more important things? Have you discovered what

went wrong with that simulator?"

"They've torn it down completely and can't find anything wrong with it. Nothing."

She put her glass down too hard, was surprised to find her hand trembling. *Why does his question anger me?*

Nikki drew in a deep breath. It was what he had expected.

She was accusing now. "But there *was* something wrong and you knew it. How?"

The answer came to him as though he had worked out the details during the night. *I knew because she knew.* And she had concealed this knowledge even from herself. The knowledge was there just the same.

When a thing was true and beautiful he recognized it. The false and ugly betrayed themselves to him with the same clarity. This was a thing about himself which he'd never before put into quite this framework. He found it a heavy burden, as though peering through flesh to entrails.

She pressed him. "How?"

"It's what I was trained to do. I have this . . ."

The commissary speakers blared: "Tam! Nikki! Fly time!"

She was halfway to the exit hatch before he left his seat. Something about Medea conditioned the older colonists to a quickness that jarred against his comforting, steady Ship-style pace. Nikki caught up with her in the hallway and they jogged side-by-side through the warren passages.

"*Fly time.*"

It came to Nikki that he was headed toward his first flight out into Medea's unpredictable wildness. One day of training—vague training where many of his questions were left unanswered or diverted. The message of Medea was clear to him: Anything he learned here he had to learn on his own, trust his own senses. The realization elated him. That was what a poet did: he learned quickly to stop asking verbal nonsense and to begin detailed observations of everything and everyone around him.

Tam pulled up outside a hatch marked READY ROOM. Her breathing was no more labored than Nikki's. She was glad to note that Nikki's youth gave him no physical edge on her. But his ability to see things which she could not, this filled her with disquiet. She feared it.

"That voice on the speaker was Tom Root," she said. "You'll meet him in a minute."

Nikki remained silent, watchful. His silence upset her.

"Root has extraordinary skill in the air and equal skill in the lab," she said.

"You're defending him as though I were attacking," Nikki said. "Why?"

She blinked, then: "Root's an accomplished cell surgeon, biochemist and meteorologist. I don't have to defend him. I'm just warning you. He doesn't say much but when he talks, listen."

She cracked the seal to the Ready Room and Nikki breathed a deep lungful of unprocessed Medean air. It

was somehow different from the sample he'd inhaled the day before: a taint of ozone in it and undercurrents of lubricants, but there was no escaping a dominant sweetness, thick and aromatic. His lungs drank deeply. For eighteen years his body had been prepared, conditioned, cajoled to deal with the variant Medean environment. He associated bitterness with hostility and was reassured by that aromatic sweetness.

He followed Tam through the hatch, felt his body tingling on alert. They emerged into a low room with no wall opposite them. The opening led directly out onto the hangar floor and Nikki's attention went immediately to the display board across the hangar. The board projected a numeral twice the height of a man—a large number "1" edged in flame red.

Nikki knew that signal: *Heavy radiation; both suns in flare.*

Tam tugged at his elbow, directed him to the near wall on their right, through an opening into a small locker room. She indicated a locker and he saw his name on the door tab. It seemed strange there, alien to him: Nikki.

Her voice prodded him. "Hurry it up!"

Wondering if he would ever adjust to these demands for speed, he opened the door and read the instructions inside for Code One dress: field pants, shielding slicker with hood, glasses, gloves. The gloves went onto his hands like a second skin. He objected only to the glasses; they filtered out this new world that he'd only just glimpsed. He slipped them into his slicker pocket.

"Hey, poet!"

It was Tam from the next bank of lockers.

"Yeah?"

"Hop it. Less than three minutes to lift."

"What's the rush?"

"New flares. Bloom started early."

"But don't we . . ."

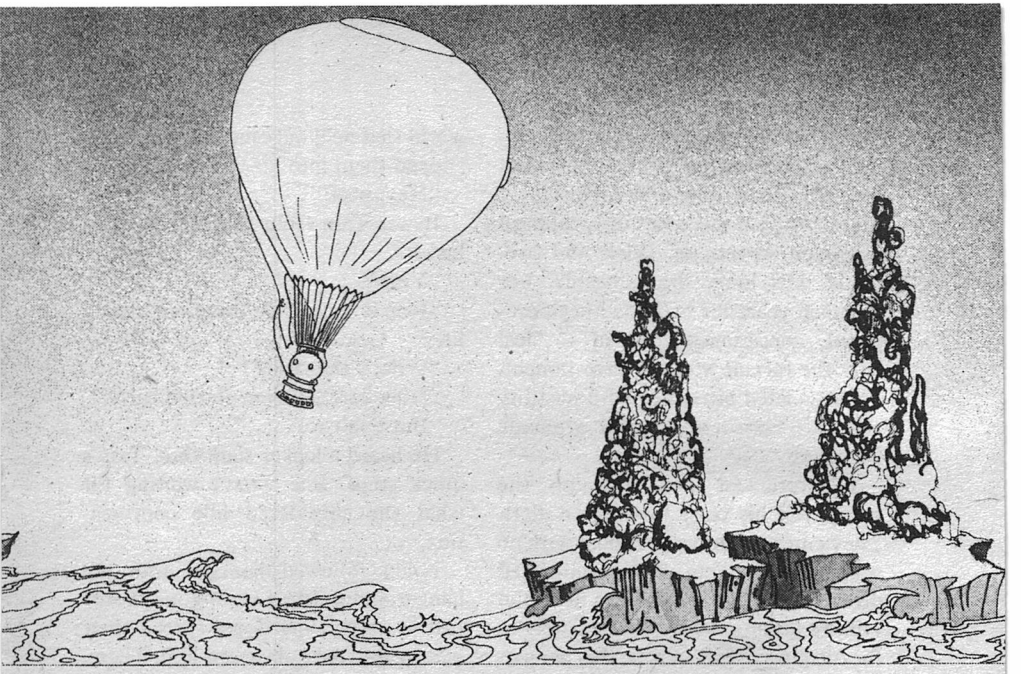
He heard a locker slam shut, Tam's quick steps. She wasn't waiting for what she considered idle conversation.

Nikki followed her out into the hangar and finished sealing his slicker just as the ceiling doors spread their metal jaws. Awe absorbed him. There, stained and dented but humming smoothly, their floater hung framed against a wildly banked background of clouds. The colors! Morning light of two suns played reds, purples, silver . . . umber . . . orange.

Sentries at the opening's perimeter scanned the surrounding area for demons and, as Nikki turned to follow Tam's peremptory summons, he caught the flicker of a demon in the dim light. In what seemed part of the same flicker, a sentry raised, fired and lowered his weapon. None of the other sentries paid the slightest attention to this.

What incredible speed these people develop.

Nikki was daunted by this thought as he followed Tam out into the hangar, his attention once more on the floater. It nearly filled the open area



and the hangar was at least fifty meters on a side. The reddish-orange bag hugged the ceiling while ground lights played against it. The crew's nest, a web of plasteel and transparent bubbles, scraped the floor, oscillating back and forth like an animal impatient against restraints.

"Root." It was Tam's voice.

Nikki turned from looking up at the bag and the suspension lines. Tam had her head into a side hatch to the nest. She pulled back and a man's head appeared in the opening: red hair beginning to go gray, a sense of wiry quickness about the eyes. The face and body were thin. Nikki was struck by the fact that Tam called this man Root to his face, but called him Tom when Root wasn't present.

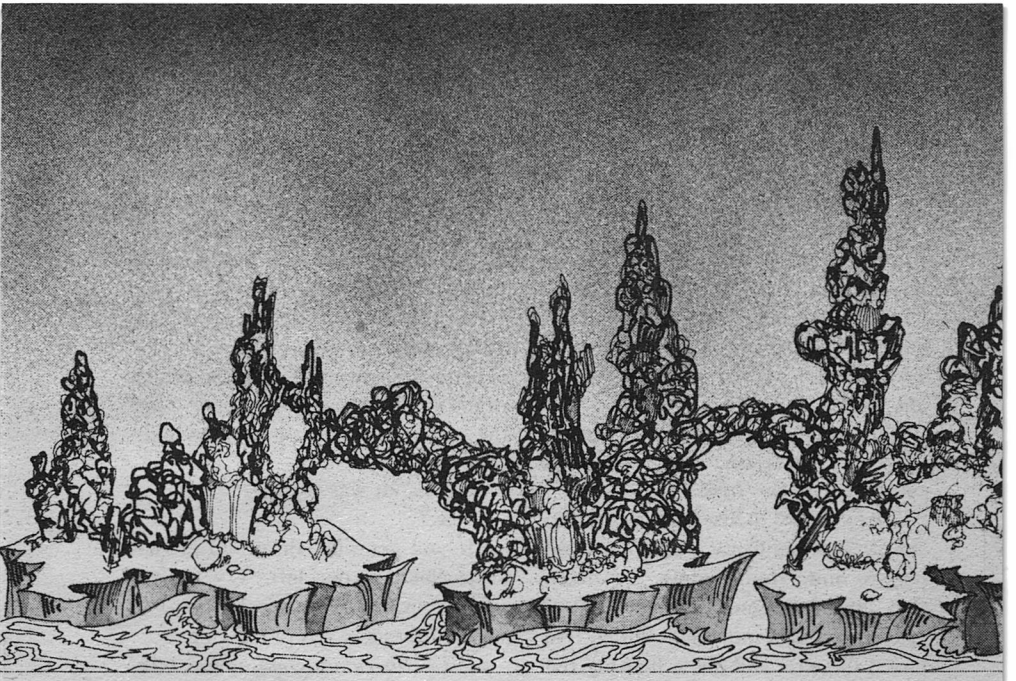
"We haven't time for introductions or any other nonsense," Root said. "Get in here, both of you."

It was a Ship-trained voice, almost devoid of emotion.

Nikki followed Tam up into the nest. The metal edges of the hatch were cold even through the gloves. It was dim inside, cramped quarters. Root already was strapped into the seat at the bow bubble. Tam was securing herself in the seat at Root's left. Nikki recognized a console on Root's right identical to the one he'd used the day before. He slipped into the seat, brought the web harness over his shoulders and around his waist.

"Just the three of us this trip," Root said.

"That means we have to be both crew *and* observers," Tam said. "Got that?"



Nikki looked over his shoulder, saw that Tam was addressing him. "Got it."

She was already busy at her console. Nikki knew he should do the same, check the instruments, renew his acquaintance with this control board he'd seen for the first time only the day before. Instead, he took a moment to study Root as subtly as he could.

Why do I feel apprehensive?

The older man was not as tall as Nikki, but there was a sense of enormous energy about him. He moved with confident sureness, agile but reserved. Root was not a man to reveal all of his resources. And his voice . . . there was a haunted sense about it . . . a feeling of familiarity. *Where have I heard that voice? He reminds me of somebody.*

Forward of Root was the large transparent bubble which gave the whole nest a wide-angle view of terrain. It showed the hangar floor and the display board with its Code One warning. The nest's transparent ceiling curve was dominated by the suspension lines and the bulging undersurface of the floater bag. Directly in front of Root was his instrument hookup and the omniviewscreen which, Nikki belatedly realized, was reflecting his own face for Root to examine.

I don't trust him, Nikki realized. *And he probably knows it.*

It came to Nikki then that Root was a man with secret plans which would not be diverted even if they projected pain or death for others.

To cover the momentary feeling of

entrapment which this realization brought, Nikki said the first thing that came into his mind.

"I thought Floaters usually ran with a crew of five."

"*Floater,*" Root corrected him. "This is it. None of the others is operational. Too unreliable in these winds. The other crews have gone to choppers."

Tam glanced quickly and uneasily in Root's direction, said: "We're a special little crew here."

Nikki turned to his own console, ran the preliminary check which Tam had taught him. Immediately, he noted that all communications to Central and Ship were not responding. He tested HOOKUP and got a flashing red OFF.

"Why aren't we hooked up to Central?"

"No time for storytelling now," Root said.

The nest lurched, scraped and bumped hard on the hangar floor, then lifted slowly through the open ceiling. The giant bag above them began to angle off to the right as soon as it cleared the dome and the nest barely missed the lip. The colony outbuildings, wildly colored by the early light, were passing beneath them within seconds.

Root's fingers flew over the controls, adjusting sway, changing the bag's surface contour to form a great, sweeping sail.

"This might be a rough ride," Tam said.

She sensed potential conflict between Root and Nikki, was confused by her own ambivalent sympathies. *I'm too old to be a mother hen,* she told herself. *The project's too important for colony survival. Nikki has to make it on his own.*

Root began activating bag jets, metering precious fuel. The nest took on a bouncing, swaying motion which swept broad expanses of cinder crags and ocher ponds across the bow bubble's view.

"Nikki." It was Root.

"Yes."

"If you get sick, throw up in that waste box to your left. Try not to; we're going to need all the help we have and besides, it's distracting."

He's deliberately goading me, Nikki thought. *I'm damned if I'll get sick.* And belatedly: *Maybe that's the reaction he was triggering.*

There was deliberation about Root's behavior, about every voice tone. The man had said: *"You're a nuisance here but try not to be too much of a nuisance."* Something more ominous lay just under the surface.

Danger . . . constant danger. That was Ship's warning and Nikki told himself never to forget it.

The nest was flying swiftly now at about a thousand meters above undulant sandhills with fans of gnarled scrub in the depressions. The ride was a twisting bounce with a sharp lurch at each end. Hellfire lights rimmed the horizon.

Nikki had experienced rough rides on Ship simulators, but nothing quite like this. And why were they isolated

from Ship and from Central? If Root had been doing this for some time, there might be important data which wasn't in Ship's banks. Was that possible? Nikki could not ignore a sense of contraShip evil in everything Root did.

Why did Ship let me believe I was fully prepared for Medea?

It was quite obvious that basic survival rules had been changed. Nikki felt a tightness in his chest, a sense of betrayal.

"Nikki, you'll have to be our systems monitor," Root said. "I can fly us through anything and Tam's the best DataMaster we could want. Homeostasis is your department. You understand homeostasis?"

"An organism's tendency to maintain constant internal environment."

"Good. Without Central we can't automatically monitor some important floater systems." Root depressed a key on the far right of his board. "Your viewer will now read out all the necessary levels and their priority. Tam."

She took it up as though they'd practiced a training presentation. "If it's Priority One, like our helium supply, run a check at the indicated intervals. If it's Priority Ten, like the cooler motor in our drinktank, ignore it. If you have questions, ask."

Hesitantly, Nikki keyed for helium readout against their lift, read it and shot a questioning glance forward at the terrain. They were lifting far faster than the readout indicated. He checked it. Even the best of thermals could not change the basic properties of the floater's helium. He looked up at the billowing bag, back to the readout.

"Root?"

"What is it?" The man didn't even try to conceal irritation.

"My helium readout rates our Kg/m^3 at two point nine adjusted. What gives? We should be at no more than two point seven-six."

Instead of answering, Root concentrated on his own controls and viewer. The ride *was* getting rougher. The sharp lurch at the end of every twisting bounce had become a jarring deadweight drop. Through the transparent ceiling Nikki watched a series of four-meter ripples run the width and length of the bag. The nest banged and slewed, forcing him to bring up the web hood to steady his head. Against these restraints, he peered forward and had his first view of the seacoast with a play of angry colors in the offshore clouds. The floater had reached the upper winds growling in from the sea.

"Root?"

"I heard you. Ignore it."

It was an unmistakable reprimand.

As though to counter this, Tam said: "We aren't very lucky today, Nikki. To make the bloom we have to beat this wind and move out over the water."

The next lurch gathered the nest up against the floater bag and dropped it the full length of the fifteen-meter lines. Both Tam and Root appeared unruffled by the jolt, going right on with their work. Nikki smelled the

taint of blood in his nose, wiped red with his sleeve.

"Nikki, what're your compressor specs?" Root asked.

He punched for them, still shaken by the jolt and still wondering why neither Tam nor Root appeared interested in the helium discrepancy. Helium was a floater's life. A leak, a loss of heat control, bad valves—any of a hundred related details—could drop them into deadly sea, desert or mountaintop. To drop out here over land meant certain death. No human could negotiate the shadow zones with their rim of blind-fast predators. Not without support from Central or Ship . . . and Root had isolated them from that support. Why?

"What're those compressor specs?" Root demanded.

"Safe levels."

"Don't make me ask twice."

Nikki accepted this and thought: *We are lifting.*

He decided, at least for the moment, that he would not worry about the helium discrepancy if the others didn't.

Root was making course corrections now. The floater tacked its way into the wind toward the white-edged shoreline.

Whenever he could take his attention from his controls, Nikki peered forward where winds and Medea's oblique tides whipped the sea surface into a thrash of dark water and foam. He saw that they were approaching a large bay. Nikki guessed its width at ten kilometers, then twenty, then realized one of his ship-bound limitations: he could not estimate large distances.

The bay's shoreline appeared high and rocky, difficult for human or demon to negotiate. Between rocks and water stretched a thin buffer of tidelands and then, as the floater drew closer in its angle toward the sea, Nikki saw a thick bank of kelplike growth just below the surface. It furled and unfurled as far out as he could see. The water at its edges curled green and yellow.

Between system checks and corrections, Nikki divided his attention—now on the kelp-covered sea, now on the helium discrepancy. Still two point nine adjusted. They were operating at about one hundred and ten percent efficiency and he couldn't understand it.

Tam, busy with her own duties, tried to divert Nikki. He must not see through the helium discrepancy—not yet. She spoke quietly, forcing him to concentrate on her voice.

"Whatever generates the bloom's gasbags does so at times of intense solar activity. And we know that somehow they communicate. Root and I feel that they possess an extremely complex, high-order communications system."

"Fully sentient," Root said.

"But their cellular base is vegetable," Nikki said.

"Would you limit intelligence to animals?" Tam asked.

Root was scornful. "This is a new world and if there's one unwritten law of the physical-biological-social uni-

verse it's that anything can happen, given the conditions, and given time, probably will happen."

"They communicate," Tam said. "And they exhibit social behavior which has to be based on communication. You've heard their songs."

Nikki had thought himself the only human to call the sounds of the globes *songs*. He thought back to the Shipside times when he'd listened to the records of those odd sounds—moans, wails, squeaks and grunts. Shipside people played them briefly for amusement, but Nikki had played them often, lulled by . . . what? Rhythms? He'd often wondered about those sounds. Ancient poets had enjoyed the poetry of many languages—even when they did not understand the language or its literal world.

Belatedly, he focused on Tam's words. She knew he'd listened often to the records of the songs. Was that why he'd been chosen?

"Song implies singer," he said. "Why not capture a few for a short time or study older ones that drift close to the base?"

Tam darted a quick glance at him. Was he serious?

"They lift by hydrogen," she said. "How do you capture and confine a firebomb? And even if they don't explode they disintegrate. Capture's out of the question."

"What're we studying?" Root demanded. "We need accurate data. The less contact we have with them, the truer our data. We're like physicists getting down into the world of particle physics to study it."

"How much is our influence and how much original behavior?" Tam asked.

All of this was true, but Nikki could not evade basic misgivings. *Root is trying to misdirect me and Tam is following his lead consciously and unconsciously. Where are they pointing me?*

"You never know when you might be giving your subject subtle clues about what you expect, thereby influencing the outcome," Tam said. "Besides, Root has discovered some startling facts about our vegetable friends down there."

Nikki expected them to expand on this, but Root was forced to concentrate on a course change as the wind shifted, backing around to their stern. First the jets, then the compressors were shut down and they drifted silently before the wind. The view ahead filled with a thick yellow-brown froth breaking across the kelp.

"Thousands of them come off the water at the bloom," Tam said. "But wind and electrical activity allow only a fraction of them to make it inland."

Root was busy venting gas, dropping their floater closer to the sea. It was now less than five hundred meters below them and the high walls of the bay's surrounding cliffs created a pocket of deceptive calm at the sea surface.

"Look! There!" Tam pointed.

"At seven o'clock," Root said.

At first, Nikki saw only waves and froth churning over the kelp. Then,

slowly, bubbles in the froth began to swell and rise, each in its own violet, green or yellow. Each trailing a long thin strand of itself, much like its tentacles, that appeared to be attached to the kelp. As they rose, the umbilicus stretched thin and broke. The bags floated free and, within seconds, began to play every color of the visible spectrum across their surfaces. Water and air swirled with dancing colors.

Root keyed in the external sensors and, above the high-pitched shriek of wind through the floater's lines, they heard the tentative flutings of the gasbags—clear whistles and odd cadences.

Nikki felt deep within his shoulder blades that those whistles were directed at him. He was both stimulated and upset in ways he could not define. He found it hard to imagine danger in that airborne display of beauty, but knew they could drift down on a colony installation and, unless thwarted, could engulf with flame everything they touched.

"They're a dream," Nikki whispered. "They're all the beauty of a child's best dream."

Neither Root nor Tam responded. All three of them sat enthralled within the nest, rocking in the wind, and watched as thousands of the colorful bags broke the sea's drab surfaces, swelled and lifted.

Nikki listened to the siren fluting of the bags as they lifted closer and closer, hearing distinct voices waver through the colorful mob. He spoke in a whisper.

"They sound like Ship children when they get up in the morning. They come out of their cubbies and into the dressing room and they jabber themselves awake."

Tam looked at him with a curious softness.

"I would like to see children. I haven't seen a child in almost ninety years."

Root laughed, oddly harsh and when her blue eyes snapped a demanding look at him, he cleared his throat, spoke placatingly.

"Tam, you slept more than fifty of those years in the hib tanks. Look down there." He stretched his hand across the view, alive now with gasbags tumbling over themselves in the fits and starts of the wind. "These are children that only we three have seen. We saw them born . . . or hatched."

"I find no comfort in that," she said.

What an odd turn of phrase, Nikki thought. He felt that he'd been an eavesdropper on an exchange with deep and portentous meanings.

Once more, Nikki scanned his console, still curious about the helium but even more curious at this realtime observation of a bloom.

"Tam and I have watched four blooms this year," Root said. "Are you superstitious, Nikki?"

He's goading me again, Nikki thought. When he spoke, he couldn't conceal resentment.

"There are certain things . . . powers we can't measure. And you're right that all things are possible; maybe luck

works somewhere in that. But I wouldn't call myself superstitious."

"Good!" Root sounded elated. He glanced at Tam who was busy adjusting the external monitors. "Out of four trips here and a total crew of fourteen, we're the only two survivors."

Nikki felt as though the bottom had dropped out of his stomach and it was not the lurchings of the floater. He was in genuine physical danger with no Ship to guard him. He was actually exposed to dangerous elements.

Constant danger.

Is this what Ship meant?

Even as he thought this he knew it was too easy to be true. Ship had something else concealed in that warning. Nikki knew this with a sure instinct.

"Listen!"

It was Tam, speaking as she increased the volume on the external sensors. The hesitant, youthful jabber of the rising globes was being replaced by babbling confusion. Quickly, it built into the short, unmistakable sounds of creatures in panic.

As though the sound threw a switch within Nikki, he felt the panic in his own breast.

Evil!

Evil!

Evil!

He didn't know whether he was crying it or just thinking it. But there were screams in his throat and he saw his own gloved fists pound at the console in front of him, then move toward the release catches of his safety harness, fingers clawing.

Through all of this, he was aware of Root watching him with a distant, clinical coldness. Root made no move to help, no comment.

Tam threw a switch on her panel to take over Nikki's controls. *The Floater first!* In the same motion, she kicked the safety interlock which secured Nikki in his seat. Nikki thrashed and twisted there like a tortured animal, screaming and crying.

Why wasn't Root doing something to help?

But Root had turned his attention to the forward bubble and its view of the colorful bloom.

"Tam, please observe," he said.

She turned her attention to the view and saw thousands of whirling bags as one boiling mass of visible scream. Color flamed in them. The external sensors relayed a diminishing babble. Only a scattered few of the bags had escaped the destructive dance and she knew from experience that those few would assemble and guide themselves toward the colony with violent intent.

The wind was picking up, tearing at the whirling mass below them. The babble of screams faded and most of the bags emptied, scattering like torn fabric across the surface of the sea. Only the few survivors moved inland.

Nikki had subsided into moaning unconsciousness.

"How very interesting," Root said. "We were correct in asking for this young man."

"His hands are bleeding. Shouldn't we do something?" Tam asked.

"Yes. We should save ourselves by returning to the colony. The young man will be all right until we deliver him to the medics."

"Why is it you're always right?" Tam demanded.

"Careful, Tam. It's my function to be right. And that's why we're alive while the others are dead."

"I still wish we could warn our people." She nodded toward the surviving globes which were now beyond the cliff tops headed toward the distant colony.

"It's only a small attack," Root soothed her. "Security will handle it quite easily."

Nikki awoke to the low sound of murmuring voices. They were sickroom voices filled with well-trained concern. A female voice said: "All right. We'll leave him with you now."

He opened his eyes and saw a beige wall only a few millimeters away. Rough blankets covered him. A bed. He was in a bed. His hands ached and there was a smell of disinfectants in the air.

Slowly, he turned onto his back, saw Tam seated on the edge of the bed reading his biostats from a console attached to the footboard. Nikki recognized his own quarters. The hatch was open to the outer passage and Root stood just inside it, leaning against the wall, a look of intense observation on his face . . . calculating. Root's attention was on Tam.

"I'm glad you're awake," Tam said. There was real concern in her voice.

Root smiled.

Nikki felt a knot of sickness in his stomach. The pain in his hands. He lifted them, saw the transparent swathing of celltape. The curved edges of many cuts smiled up at him through the tape and he remembered once Shipside, a fall at play and a cut leg, his real mother applying celltape.

"You'll learn to like celltape," she'd said. "It makes you heal faster and you can watch yourself mend at the same time."

Tosa Nikki . . . whatever happened to you?

"Whatever it was, you left it back there at the bloom," Tam said. She switched off the biostat console, turned that searching blue gaze on him. "We have to know what happened."

Nikki turned his head away toward the wall. Her words called back the panic . . . horror. He remembered pounding the floater console, screams . . . trying to escape from . . . what? From his own body? How was that possible?

"Come, come. We have to know." That was Root.

Nikki knew the questions they would ask. Afraid of heights? Afraid of closed spaces? Of people? Death? They would have pulled all of ship's records on him by now and none of the answers to these questions would be *yes*. Except for death. Something animal responded to that threat and Ship would never explain it.

"It was a rough ride," Tam said,

"and your first. Were we too rough on you?"

Nikki recalled a brief instruction record Ship had provided him when he was sixteen:

For five hundred years of Earthside history, most humans prejudged poets to be biologically inferior. Remnants of that judgment tend to cling to the human psyche.

Nikki turned his head, stared across the room at Root. "You don't seriously believe that?"

The man appeared genuinely surprised.

"Maybe not. But remember we were not in *simulated* danger out there. It was real."

Tam touched his shoulder. "We lost you when Root told you about the other crews. Could . . ."

"No. I don't know what happened to me; I just know what it *wasn't*. How long have we been back?"

"About five hours," Tam said. "Are you hungry?"

The thought of food made his stomach churn. "No. No food. Do you have the nest recordings from our trip?"

"Complete tapes," Root said. "Would you like to review them?"

Was that a protesting glare Tam directed at Root?

"Shouldn't we let him recover completely?" she asked.

"The decision's his," Root said.

"Bring them," Nikki said.

"We have to take you to them," Root said.

What was that pouncing expectancy in Root's manner?

"Why?" Nikki asked.

"We have to use the floater consoles. All others are linked to the colony and . . . Ship. Only the floater is independent."

"Why?"

"We think Ship has been influencing our project."

"Ship doesn't have to *influence* such things. Ship is God."

Root leaned toward Nikki. "So Ship says. But Ship alone knows what Ship sees for Itself. Like any other being, Ship must choose to see some things and ignore others."

"But Ship's immortal!" Nikki protested. "Without any limits of time, Ship could . . ."

"Ship had you for only eighteen years," Root said. "How long will you have yourself? Five hundred years? A thousand? More than . . ."

Root broke off as Nikki turned away and rubbed his forehead with a celltape swathed hand.

"Shall we go?" Tam asked. "Or would you rather . . ."

"No. Let's go review those records."

She helped him to stand on wobbly legs and he was surprised to see that he still wore the clothing he'd worn on the floater. They had stripped off only the slicker and the gloves which he'd torn injuring his hands.

None of them spoke on the walk to the hangar, not until they were alone in the floater.

"What if Ship *chose* to hear what you said back there?" Nikki asked, confronting Root.

"I think Ship is bored," Root said. "At the very least, we're entertaining."

The answer filled Nikki with confusion. He stood in the confined nest unable to respond while Root readied the replay. How confident Root appeared! He moved with such sureness, not slinking around like someone who felt the least bit guilty. And Tam—while matter-of-fact, she wasn't cold. She assisted Root as though she understood a definite timetable. That was it! They were on a timetable toward some specific goal. But Tam, while committed, was afraid of something . . . or someone.

She's afraid of Root!

"Is there evidence to support your notion that Ship is influencing your project?" Nikki asked.

"I'm afraid it's not a notion," Tam said.

"But even so, if Ship . . ."

"We're ready for the replay," Root said. He turned and stared at Nikki. It was the stare of a technician toward a test animal.

"Evidence," Nikki insisted.

"We'll show you later," Tam said. "It became clear when we questioned Ship about the purpose of the colony."

"You questioned *Ship's* purpose?"

"Are you horrified, repelled?" Root asked.

"Ship and I used to play a question and answer game," Nikki said. "If I asked a question, Ship always answered truthfully. But Ship didn't always answer in terms I could understand."

"Are you trying to delay the replay?" Tam asked. She indicated the console which Root had readied.

"No, let him go on," Root said. "Was Ship trying to confuse or mislead you?"

"That would've broken a basic rule of the game," Nikki said. "That would've been untruthful. No . . . Ship was teaching me that the answers

In times to come

Vardos Vayan, Sam Nicholson's Bard Laureate, is back in March's lead story, "Minding the Business"—with a cover by Mike Hinge that represents a bit of a new direction for our cover art.

Inside, M. David Stone has some hard facts—and harder questions—about "Funding the Future." We also have a most unusual short story by Ted Reynolds, plus a diverse collection of stories by quite a range of authors.

And, of course, the third part of John Varley's TITAN, and all the usual features.

are always somewhere in the formation of the question."

"How trusting you are," Root said.

"In the question . . . the answer?" Tam asked.

Root leaned forward, peering at Nikki. How did the poet understand his own role in Ship's purpose . . . whatever that purpose? "Continue."

"Ship might answer me philosophically in conversational terms," Nikki said. "I soon learned how to play the philosophy game. Then It shifted to complex mathematical constructions which I had to learn to discover the answer."

"You were providing your own answers," Tam said.

"In a way. I had to learn how to ask my question in a specific enough way that I could be sure of understanding the answer. And *then* I found that the form of the question carried the language of the answer. Even more: a sufficiently precise question carried the *information* of the answer."

"Why do you now recount this game?" Root asked.

"Because . . . however you asked your questions of Ship, the form of your questions imposed the role that you insisted Ship play. That's the rule of the game."

"The better you get at asking questions, the fewer questions you have to ask," Tam said. She stared at Nikki as though seeing him for the first time. She felt that she was poised on the edge of a new, liberating awareness.

Root was glowering, rubbing at his chin.

Nikki glanced at the ready console, recalling a question he'd asked during the flight to the bloom.

"When I asked about helium today, for example, my question carried the form *and* the language of the answer. Helium adjusted to a Medean sea level referent should read two point seven six Kg over m cubed. I got two point nine. That's the figure for hydrogen."

Root glanced at the sealed hatch on his right, returned his attention to Nikki.

Tam was holding her breath.

"Are you trying to say that we're flying hydrogen?" Root asked.

"Yes. We're flying what the globes fly. Highly flammable in this electrically active atmosphere. In effect, we're a giant flying bomb."

Surprisingly, Root chuckled.

Tam shuddered.

"What amuses you?" Nikki asked. He felt that he had just performed precisely as expected and that this boded no good for him.

"Ship has restricted many of your records," Root said. "Tam assumed that this indicated social or moral problems. Isn't that right, Tam?"

She shook her head: negative.

"Then what did you assume?"

"That Ship wants to keep Nikki a mystery."

"Yes! There's no telling what he knows."

"How did you exchange hydrogen for helium?" Nikki asked. "If your ground crew knew about it, you'd be flying a shovel and rake in one of the cattle compounds."

"But they *do* know," Tam said. "It's the lesser of several dangers." She glanced upward at the hovering bag.

"We're the only floater that those gasbag globes won't attack," Root said. "We have a good ground crew, the best. A good ground crew will take big risks to keep its flying crew alive."

"Who else knows?"

"Nobody."

"Maybe Ship knows," Tam said.

"Ship is nobody," Root said.

Tam put a hand to her mouth.

Nikki had heard a measured calculation in Root's voice and studied the man carefully. *Sacrilege to shock us!* But Root's behavior was always seated in many reasons. What else did he want?

"The mystery today," Root said, "is not just that you panicked, but that the bags panicked. Why? There was only one significant difference about our floater today—you."

"You're telling me that when you fly hydrogen the bloom will come right up to you and it won't attack."

"They tend to ignore us," Tam said.

Nikki looked at the console beside Root. "Let's see what happened today."

Root reached down, flicked a switch. The three screens around them came alive with views of the flight and the sounds were played through the sensor relays.

Nikki divided his attention between the screens, was aware that his companions were watching him. He closed his eyes when the replay came to the part where he had lost control. Terror? He felt nothing but the memory of his panic and even that was not immediate. He could extinguish it at will. But as he listened to his own frantic screams and the strident squeals of the gasglobes, another memory image insinuated itself into his awareness. He saw a clear picture of the floater from outside and he thought of it as a giant member of the bloom. The image projected itself into his awareness without compromise and he felt himself falling, falling away from the giant globe . . . the *floater.*

The image ended. It shut off like the stopping of a tape.

He opened his eyes, signaled for Tam to shut down the console. She reached across Root to depress the switch.

"Well, Nikki?" Root studied him, questioning.

"Why did you start flying hydrogen?"

"Because the bloom flies hydrogen."

"What happened when you flew helium?"

"They'd get within about twenty meters of a floater and they'd scream . . . you had the impression of extreme pain, then they'd expel all their hydrogen and they'd die."

"Scream, you say. The way they did today?"

"Similar."

"How were the other crews killed?"

"Some crashes, some trying to recover gasbag skins before they disintegrated."

"You put people out there in the open?"

"Volunteers."

"Did you get any skins?"

"No."

"What about choppers?"

"The bags won't come anywhere near them."

"Why can't chopper crews recover skins?"

"Choppers just scatter the skins and the increased air movement melts them that much faster."

"Or the demons get to them first," Tam said.

Nikki looked at her. "Have you been on the surface?"

"Twice. Root's been down four times."

"What's it like?"

"Not pretty."

"Why'd you want the skins?"

"We need any clue we can get," she said.

"How about the older bags? Have you been able to get close to them?"

"They move off when we get close and somehow they signal others to run away. When we chase, they'll use up all of their hydrogen trying to escape. Then they just drop and disintegrate."

"Why didn't Ship give me this information?" Nikki asked.

"Ask Ship!" Root said.

There was no mistaking the venom in his voice.

"The old ones warn the young ones of our approach," Tam said. "We've watched it many times."

"But they ignore you when you fly hydrogen?"

"From a distance. The significant thing is that they don't attack."

"How do they attack?"

"Kamikaze—one or more old ones from above. Static spark and they explode themselves against the floater bag."

Root pushed a palm downward sharply: *Crash*!

"What happens to gasglobe skins when they fall on water?"

"They melt rather quickly into a sludge which disappears with the first rain," Tam said.

"But on land demons eat the skins?"

"Ravenously," Tam said. "Then an odd thing happens."

"Didn't we come here to find out why Nikki went into panic?" Root asked. It was obvious he wanted to divert Tam from this course.

Nikki was not being diverted. "What's the odd thing?"

She saw Root's displeasure and spoke hesitantly.

"After eating a skin, the creature becomes quite unpredictable. It may lose its fear of higher predators, run in aimless circles, ignore obvious prey."

"We suspect that the skins are hallucinatory," Root said.

"Epiphany," Nikki said. "The visitation of God."

Root shrugged.

"And the older bags prefer to drift over water except that they'll come

inland to attack the colony," Nikki mused.

"Or to lift animals from the surface and drop them," Tam said.

Nikki was surprised. "Don't they eat animals?"

"Not that we can see."

"We've never seen them eat anything," Root said.

"Well, Nikki, what happened to you out there over the bloom?" It was Tam, the DataMaster, performing on cue. She had heard Root's displeasure.

"I'm not sure. I think the bloom's panic was contagious and I caught it."

"How do we know the bloom didn't catch your panic?"

"I've told you what I believe. I wouldn't have said it if it were untrue."

As he spoke, Nikki experienced the swift inner expansion which always accompanied his own poetic revelation. He stared at Tam without seeing her. They'd been playing the question game here! He sensed a subtle perversion in the way they'd played the game, but the form was there, the essential form. It lacked only the right language.

What did he know about the bloom?

Skins dissolved . . . sludge in the water disappeared. The deadly demons of the land ate skins and . . . what? Hallucination? Epiphany? Colors! Globes changed colors as they whistled and babbled. Even in panic they changed colors.

He really saw Tam now: the white hair, the translucent skin—*to change colors and become a Medean.*

"You've been lying to me, both of you," Nikki said.

A swift blush suffused Tam's face.

Root saw this betrayal and scowled. "Is that why you're not telling us what really happened to you out there?"

I deserve that, Nikki thought. He wondered why he felt reluctant to tell them about that externalized scene he'd experienced during the panic. He consulted the image once more. There was a message in it, something basic. The floater was . . . it had to be . . . respected, that was it. Respected. It could not be attacked. But . . . it was deadly . . . dangerous. You were compelled to flee such a . . . thing.

Compelled!

"All you did with the hydrogen was to stop the attacks," Nikki said. "You didn't stop the panic."

"They don't come close anymore," Tam said. "The panic starts farther and farther . . ."

"Tam!" Root was openly angry.

"We have to tell him," she said. "It's not right."

"He's still hiding something," Root growled.

"I don't care. We have to be straight with him."

"Tam, you agreed . . ."

"But we no longer have a reason for that agreement!"

"I hope you're satisfied! You've blunted the one instrument we could . . ." Root threw up both hands in exasperation.

Nikki stared from one to the other. Root remained mostly a closed and concealing person, but every tone, every movement from Tam carried its revealing message.

"Did you feel the panic?" Nikki asked her.

"The first two trips when they came closer, but not these last times. Root though . . ."

"I've never felt a thing," Root said.

It was the most revealing statement Root had made in Nikki's presence. *The man has absolutely no emotions and no sensitivity. He mimics emotion, presents an image of the emotion he believes is responsive.*

Was Root even angry or was it all a calculated performance?

"Why did you ask if I felt the panic?" Tam asked.

"What's a poet supposed to do? You brought me here because I'm supposed to be more sensitive. You hoped I could see through to the reason for the panic."

"And did you?" Root demanded.

"Change the floater's color," Nikki said. "Eliminate the orange."

"Why?"

"Because that's how they identify us as dangerous."

"I won't ask how you arrived at that," Root said. "I don't believe I have time to examine the form of every question." His words conveyed a calculated sneer, but Nikki ignored it. That was part of Root's game. It was the way he played.

First, you have to learn Root's language, Nikki thought. And once more he wondered where he'd heard the man's voice before. It was such an elusive thing. *Why can't I remember?*

"We're scheduled to fly at dawn," Tam said. She looked at Root. "Do you mean you're going to change the floater's color?"

"Of course! Nikki's right. That's why we brought him."

She glanced at a chronometer on the console at her elbow. "But dawn will come soon . . ."

"The ground crew will work all night," Root said. "Help Nikki back to his quarters. He's had a rough day."

There was no feeling of concern in Root's words, only a dismissal. *Nikki has served his purpose and now he's a nuisance.*

Tam felt this, too. The first thing she said after they entered Nikki's quarters was: "Don't be offended by Tom. The only thing that matters to him is the project."

He's Tom again, Nikki thought. *But never to his face.*

He sat on the bed, leaned back and closed his eyes. How good the bed felt. A sharp *click* caught his attention and he opened his eyes to see Tam pulling a cushioned foldout chair from its concealing panel in the wall. She sat down facing him, their knees almost touching.

"Dawn's not very far away," he said.

She shook her head as though his words were insects distracting her.

"Let me see your hands."

He held out his hands and she

examined the skin through the celltape. "The healing's far enough along. This tape should come off."

He nodded.

Gently, she removed the tape. How soft her movements were, how careful and considerate. He watched the intensity of her attention.

"Your mother," she said, speaking without looking up from her work. "I pulled her records while you were unconscious."

Why do I feel a chill? he wondered.

She glanced at him, returned her attention to the tape. A faint smell of healing unguents came from his hands.

"Why was your mother your teacher when you were very young?"

"She asked Ship and Ship consented."

"What did she teach you?"

"Many things . . . how to clear my mind. The mind doesn't work well when it's cluttered up and churning. It jams . . . it's devoured by questions and distractions."

She put the last of the celltape in a disposal chute, but continued to hold his hands.

"How do you clear your mind?"

"I throw things out of it one by one, then concentrate on the last thing, then throw that out, too, and focus on the no-thing that's left. Then I don't think things out, I just know them."

"You mean to say that after all your questions and the emphasis on our data, our *information*, after all that, you really operate on intuition?"

He smiled at her obvious surprise. How warm her hands were, how true and loving.

"Not exactly. I just give the unconscious part of me a role in most decisions. Facts, records, books—they're all obvious learning."

"But there's a lot of subtler data coming in."

"We're bombarded with it all the time and we ignore it for the most part, filter it out."

"As Tom says: the sentient being chooses what it will see."

"Root said that, not Tom," Nikki said.

"What?" She dropped his hands as though he'd hurt her.

"He said it on the floater. That's when he's Root. You never call him Tom there."

She put a hand to her cheek. The skin remained pale and clear, the blood undertone changed.

"I do, don't I. I wonder why I do that?"

"Because you keep him in two compartments—conscious and unconscious."

She stared into his eyes. "You do that so easily. That's what your mother taught you, isn't it?"

"Ship and my mother."

"Can anybody do it?"

"Most can. Very few ever do."

"Will you teach me?"

"It can't be taught, only learned."

"But your mother . . ."

"She talked of it often and her stories were wonderful. She gave me thinking exercises to entertain myself

and these were similar to the game I played with Ship."

"You asked questions and she answered."

"Usually she gave me the question. If I brought a question she might not answer. When she answered, it could be *yes* or *silence*."

She stared at him.

"Silence was an answer?"

"Sometimes. Other times she might answer with a question. If she made a statement that, too, could be no answer."

She leaned back in the chair to absorb this, her head against the cushioning, eyes closed, relaxed.

Nikki didn't move or change his breathing rhythm.

Tam found herself listening to the slow and regular sigh of Nikki's breath. She relaxed her muscles one by one, felt the tension wash out of her stomach and neck and legs. Her breathing fitted itself to Nikki's rhythm and she felt everything go: her body, then her memories one by one, then her thought of self stood apart and drifted down a long corridor to a warm glow with a red wash at the end that was the color of Argo low on the horizon.

"I see," she whispered and all thought of self disappeared.

"Tam. Tam?"

She awoke to his voice gentle but insistent, the light pressure of his hand on her shoulder.

"I didn't want to wake you but if we're getting out to the bloom at dawn . . ."

She stretched and noticed that he was admiring her as a woman for the first time. He found her beautiful. She prolonged her stretching.

He saw this and grinned. "Yes, you're beautiful."

Immediately, she sat up straight, reached for the callbox at the head of his bed and punched in the hangar code. It rang several times before an impatient female voice answered.

"Yes!"

"Is Root there? This is Tam Kapule."

"We're pretty busy here."

"Put him on. It's important."

"I'll see if he'll come."

There was a long wait then Root's cold voice. "What is it, Tam?"

"Have you chosen a color yet?"

"We're about to make it purple."

"Add some red to that. Make it Argo red."

"Why? To appeal to the gasbags' esthetic sensibilities?"

"Argo red," she insisted. "And we come in from the Argo side."

"Where are you?"

"What difference does that make?"

Root's laughter was not companionable. "Tell Nikki I agree. Argo red it is."

She slapped the disconnect switch, blushing.

"He's slipping," Nikki said. "He didn't ask you if we're running a research team or a school of design."

"He thinks the color is your idea."

"Does that bother you? I'll call him back and . . ."

"No!" She put a hand on his knee, jerked it back as though his knee had burned her. "Let it be."

"That's it," Nikki said. "You have to let it be, then you can tell what it is, what it's doing." He leaned forward, cupped her face in his hands and kissed her.

When he released her, she said: "We musn't . . ."

"Why, because you're older?"

"Of course not. Sometimes you're older than Root."

"Nobody's older than Root."

The words had come from him spontaneously and their sense of truth shocked him. *Nobody's older than Root.* Who was this man with the familiar voice?

"It's not that there's anybody else," Tam said. "I have no companion. For a time I hoped that Root . . ." She broke off. "I mean *Tom*, of course, but Tom doesn't exist except in those hopes which I . . . rejected."

He nodded.

"How is it you make people be this truthful?" she asked.

Nikki shrugged. If there was an answer she already had it.

Silence as an answer, she thought.

She wanted to get up but knew that anything she did would only increase the sexual tension between them.

A knock on the hatch startled both of them.

Nikki called out much too loudly: "Open."

It was a young male groundcrewman, dark-haired, grinning. He tossed in an open shipcloth bag crammed with tapes and Nikki noted a splash of Argo red on the man's left sleeve.

"Root sent these. Bloom recordings. He said try to find some interesting rhythms in them."

The hatch was closed before either could respond.

Tam stood up abruptly.

"I will not have him laughing at me . . . at us!"

"How do you know that your present response isn't exactly what he wants?"

She sat down as though his words had released latches in her knees. "This is insane."

"Our worrying about what Root wants?"

"That, too. No!" She spoke quickly as he started to reach for her. "I'm going to leave in just a moment. I'll do that in spite of the fact that I want to stay."

"Is that the insanity?"

"I don't think so and neither do you. No . . . what we need is the right time and . . ."

"And the right place."

"When a thing's right . . ." She hesitated, then. "I see. That's why you didn't even question it when I told Root what color to use on the floater."

"When a thing's right," Nikki said.

Once more, Tam stood. "I would like to've known your mother."

Nikki arrived on the hangar floor almost an hour early. Root already was there with a scattered remnant of

the ground crew finishing up on the floater. The bag glistened in the upper reaches of the hangar, a dark red ball with flecks of purple in it. The ground crewmen were a ludicrous sight, stained varying shades of Argo red.

The bag of bloom recordings slung over one shoulder, Nikki finished fastening his slicker as he hurried up to Root near the nest's entrance hatch.

"Well, poet, will it work?"

Root gave the appearance of being in exceptionally good humor. It was well done, but Nikki suspected it.

"Perhaps it'll work for the wrong reasons—the way I worked for you."

"Have you worked for me?"

Nikki glanced up at the glistening red bag, shrugged.

"Why did we bring you into the project?" Root asked.

Nikki slipped the bag of recordings to the floor. "Perhaps because you knew I'd listened to every globe tape in Ship's records."

"Ahhhh. And what can you teach us from those peculiar noises?"

"To move with caution. If the globes are sentient, any deaths we've caused could be seen as murders rather than errors of judgment or ignorance."

"You expect the gasbags to mount a massive retaliatory attack?"

"Humankind doesn't have a monopoly on preservation of its species or desires for revenge. The globes already have demonstrated kamikaze behavior."

"Indeed! They're highly explosive in more ways than one. And the key to them has to be in their language."

Nikki produced an emotionless smile right out of Root's own repertoire. "And that, of course, is why you brought me into your project."

Was that a flicker of real rage in Root's eyes? Nikki could not be sure. Before he could explore it, Tam came hurrying up. She flashed a personal, no-barriers smile to Nikki, glanced once at the Argo red of the floater bag before focusing on Root.

"Sorry I'm late. I stopped at meteorology on the way. Since we're coming in from the Argo side. They think we stand a reasonable chance of getting a good float."

"Do they have an optimum course?" Root asked. "I told them to plot it as late as they could."

Tam tapped a pocket of her slicker. "It's a wide sweeping loop from the ocean side, but you know how chancey the winds are out there."

"I'll look at it in a moment," Root said. "Nikki is telling me how he learned caution from the songs of the globes."

Tam sensed the sneering tone in Root's voice, shot a warning look at Nikki. He ignored it.

"We're dealing with what may be the first sentient species of plant we've ever discovered. We don't know their language, their customs, how they reproduce . . ."

"And you'll teach us all that from their songs . . . and you'll teach us before we have a disaster because of our massive ignorance."

"If we're going to share limited

territory with another intelligent species, we need a breakthrough before they learn enough about us to take deliberate, concentrated action."

"Stop this!" Tam flared. "We have to work together. Nikki, do you have anything really useful out of those globe recordings?"

"Some technical data viewed from my own speciality."

There was no mistaking Root's quickened interest.

Tam glanced at Root. "Do we have time?"

"The floater has to dry a bit longer. Do give us your technical data, Nikki."

"The shortest whole song is just under six minutes duration and the longest just over thirty. There's a good deal of noise between songs."

"Which means?" Root sounded disappointed.

"It may mean nothing, but it could be chatter—talk, gossip or prose as opposed to the rhythmic, well structured songs."

"Structure is not necessarily language."

"True. And the duration of each song is probably directly proportional to bag size, the volume of gas. They stop when they've expelled gas to a critical point."

"How can you be sure they sing by expelling gas?" Tam asked.

"I assume it, partly because of the way the songs often stop in mid-note and partly because they can be observed to grow smaller as they sing."

"Reasonable," Root agreed. "But what does all this tell us?"

"When a globe's in a singing mood it moves from song to song with pauses between—*rests* in my terminology—that are the same duration as the pauses between the individual notes."

"How does . . ."

"Plenty of concept but little punctuation," Nikki said.

"I see. A high-density communications system."

One of the ground crew was whistling nearby. Nikki hooked a thumb toward the whistler.

"Their songs may be no more than that—self-entertainment, a release from boredom. I hope not because the chatter between songs is very difficult to break into patterns."

"And you're defining pattern as song," Root said.

"They are meticulously regular, complete sequences of tones repeated intact at various intervals. And they are not rote. They vary from individual to individual and incident to incident."

"Tam has detected similar structures . . ."

"Yes, but each song contains the personality or particular interpretation of the singer. And then there are the color changes."

"A semaphore of some kind," Root said. "We have people working on that in another section. Didn't Ship tell you?"

He sounds so derisive when he says Ship, Nikki thought.

"I saw some studies that didn't

seem to be leading us anywhere. At least, not yet."

The floater beside them began a slow scrape across the hangar floor, back and forth.

"They've topped off our bag," Root said. He held a hand toward Tam. "Let me have that course plot." He took a folded paper from her and led them into the suspended nest. As he began strapping himself into the command seat, he glanced back at Nikki, then at Tam. "Oh, by the way, Tam, Nikki suggests that we brought him into our project for the wrong reasons."

She finished securing her web harness.

"Did he?"

She looked across at Nikki who was already secured and running the preliminary checks on his console.

"Yes, that's exactly what he suggested." Root spoke as he ran through his own console preliminaries. "Did you discuss that last night?"

"No."

"I guess you didn't discuss much of anything. I'm told you went to your own quarters rather early."

Tam looked up to find Nikki staring at her, supportive, waiting. She knew that if she made the slightest signal to him, he would shift the attack to Root.

Attack!

That was it. *Something good happened to me last night—from Nikki's mother through Nikki to me. I touched something truly powerful.*

Root had sensed this and that was what he had brought under attack. She looked across at Nikki. Their gazes met. Yes, all barriers were down between them.

Why was Root attacking?

Without knowing how they did it (without caring), Tam knew that she and Nikki shared this awareness of Root's behavior. They held the same question in their minds.

"Perhaps it was a futile discussion and you don't care to share it," Root said. "Stand by for lift."

Nikki spoke directly to Tam.

"My mother once said a strange thing. She said: 'Bring in the sacred fools and we'll fill the well with snow together.' She meant that in times of crisis it's better to do something futile with people of magical spirit than to do nothing at all."

As he finished speaking, they heard the ceiling doors open. The light around them changed to dull gray and the floater lifted out of the hangar, swinging across the colony in the grip of a hard wind.

Magical spirit, Tam thought. *That's what I touched last night. And I'm no longer afraid of Root.*

And the strangest part of this metamorphosis was that she had never recognized her own fear until after she had lost it.

At his console, Nikki sat in the way his mother had taught: head balanced on the living pole of his spine, his attention focused inward. Part of him carried out the routine of his duties to the floater, but a more important part thought back into words that had

passed from his mother's father out of a lore buried in the dark blood of a memory kinship which tracked itself through the mother of her father.

"*Only because of ignorance and attachment to the world are you unable to come home.*"

What am I ignorant of? Where am I attached?

By the time the red grin of Argo spread across their horizon, Nikki knew what he had to do. And he knew where he had heard a voice like Root's. Ship spoke like that.

He saw that they were making good speed in their long loop out over the sea. Root was spending fuel, both jet and compressor, with a profligate hand.

A heavy wall of mist swirled up ahead and was just beginning to clear as they approached the bay where Nikki had seen his first bloom. The water surface about three hundred meters below the nest was choppy, but he could see beneath the surface the pulsing expanse of kelp.

Where will the bloom begin?

Root spoke in a quiet, conversational tone.

"What was the wrong reason for bringing you here, Nikki?"

"To sense the panic and signal you when it happened."

"Why should you be here?"

"Because I'm young and comparatively uninfluenced by previous data, by any information other than what you give me or allow me to see."

"How do you know that's not why we brought you?"

"Because your behavior and your questions try to divert me away from anything which springs spontaneously out of my own creative understanding."

"Creative understanding!"

"The globes that bloom here today will be much like me: minimal information to begin with, perhaps some skeletal data to improve their survival chances, but open receptors with little to block their gathering of new facts."

Abruptly, Nikki felt that he had floated free of his seat and the restraining harness. He could see nothing clearly but there was light all around, beautiful light. He was not afraid. The beginning of great joy sat somewhere within him. And out of some dim corner of his consciousness, he heard Root say:

"Here they come!"

From where she sat, Tam could not see Nikki's face unless he turned. And Nikki was her barometer. She felt a deep necessity to see him. One touch to a key and she had linked a corner of her viewscreen to a receptor on Nikki's panel.

She stared at the face of her screen. Nikki's features were trancelike, still—filled with a calm such as she had never seen before. A smile twitched at the corners of her own mouth and the anxious knots which usually cramped her stomach during these flights washed away. It was several heartbeats before she realized they were in the thick of the bloom. The iridescent globes lifted all around, colors flashing. When she activated the external sensors, the sounds of joyful fluting filled the nest.

Root's voice was like cold water dashed in her face.

"There's a storm coming, lightning."

As though his words had created the scene, she looked out and up toward the bay's landward rim, saw tentative yellow flickers licking back and forth between clouds. A boiling black mass of storm lifted off the land. It rolled closer as she watched and flickering streaks began touching the crags and chimneys and buttes that were Medea's testimony to her violent past.

"What do we do now?" Root asked. His voice was gloating.

He peered back at Nikki and his lips drew away from his teeth. It was a voracious look, a predator's look and Tam felt that her breath froze in her throat.

As though her fear alerted him, Nikki turned. His face was beautiful in its stillness.

"We will go down to the water and stay here," Nikki said.

"Are you crazy?" Root demanded. He turned toward his controls. "We have to try to run for the colony. Tam, restrain him if he tries to interfere."

Tam heard the false notes in his voice and made her choice. The magical spirit must have its chance. She reached under Root's elbow, grasped the interlock cable from his console and ripped it out. Now, each floater console was locked into its function

and Root could not override from his position.

"What're you . . ."

But Nikki already had depressed the DUMP switch on his console. Hydrogen began valving out of the bag above them and the floater started a swiftly controlled descent. The bag above them billowed out like a giant parachute.

"You fools!" There was real rage in Root's face. He had been thwarted from an unexpected direction. "Tam! How could . . ."

"She knew instinctively what I know consciously," Nikki said. "You didn't leave us enough fuel to reach the colony. You never intended us to get back."

The nest was swinging wildly now, caught by the leading edge of the storm. The hiss of hydrogen valving from the bag was a monstrous serpent sound all around.

"You!"

Root struck out at Nikki.

It was an anticipated blow and Nikki met it with an open hand which grasped Root's arm just above the wrist. The arm felt insubstantial, as though it were something less than flesh. There was a writhing, twisting strength in it, though, and Root jerked free. He began unfastening his harness.

In that instant, with less than twenty meters left beneath them to the bay's churning surface, Nikki stiffened. Tam saw his eyes go wide. He said: "Ohhh . . ."

An explosive *clap* stunned their nest. It came simultaneously with a blast of sulfurous golden light which engulfed the world all around them.

The fall, though short, plunged the floater under the surface in a twisting dive.

Tam gripped the sides of her seat, praying for the chemically activated pontoons to inflate. Dim green light suffused the nest but there were no spurts of water. The hatches were holding.

Root whirled and hit all of the keys on his console.

Nothing.

In a suspended silence, they turned and looked out the bow bubble. Strands of kelp all around. The floater's descent slowed, stopped. It slewed itself upright and they heard the pontoons filling with air beneath them. They began a gentle ascent. Long whips of kelp caged their world and they saw clumps of polyps on the leaves. Each clump sent out slender tendrils and at the end of each tendril small bulbs swelled, drifted to the surface.

Nikki imagined those bulbs breaking free of the mother plant and the sea, drifting away in the magnificent colors of the bloom. The entire system snicked into place within his awareness.

"What do you propose to do now?" Root asked. There was a charged calm in his voice.

"I'll continue learning their language," Nikki said. "I have the key to it."

The nest popped to the surface,

draping remnants of the exploded bag over the transparent ceiling. It rocked violently in a wind-whipped tidal rip and, through the shreds of the red bag, they glimpsed the bay's distant shore, forbidding black cliffs. The wind had them now and it drove them toward the open sea, but a vagrant current caught the pontoons, whirled them and swept them into a kelp-subdued pocket of calm beneath the headlands.

"The nest can take it," Tam said. "we could float here forever."

"Forever is a long time," Root said. "I don't think you grasp quite how long." He turned toward Nikki. "What do you intend doing with your little patch of time—besides perfecting your grasp of the gasbags' language?"

"Do you really have the key to it?" Tam asked.

Root was scornful. "Don't be a complete fool, Tam. Of course he has it."

Nikki marveled at how subdued Root appeared. How calm. But it was only appearance, a pose, a role, a reflected and insubstantial performance. How lonely the man must be within that shell of limited emotions—his rage was real and, perhaps, jealousy. The vengeful awareness of his own crippled being . . . that was real. Everything else was sham.

"How?" Tam asked, staring at Nikki.

"Planarians," Nikki said. "With a difference." He pointed to the currents boiling up through the kelp around them. "The living, thinking creature is really the kelp. The globes are its eyes, its ears, its arms and voice . . . its contact with the universe through which it learns."

"Planarians?" Tam was confused.

Root appeared lost in thought.

"A small Earthside flatworm," Nikki said. "I once asked Ship about a poem—'Food of the Gods'—and Ship included planarians in the answer."

"I've never heard of them. What are . . ."

"Although primitive, they can be taught to run mazes," Root said. He was looking at Nikki with renewed interest.

How long has he known? Nikki wondered. He said: "And they can learn without being taught."

Tam leaned forward to the extent her harness permitted. "They can learn without . . ."

"They can reproduce whole individuals from just a small part," Nikki said. "Cut out a middle section and your worm will grow a head and tail. The tail will regenerate a new head and middle . . ."

"But you said they learn without being taught . . ."

"Yes. Grind up one that's learned the maze and feed it to a young worm that's never run the maze. The young one learns the maze with remarkable speed. Grind up this young one and feed it to another—the new one learns the maze even faster. Go through the process again and the new worm learns faster yet."

"The skins dissolve in the water,"

Tam said, looking out at bay. "The sludge . . ."

"Food of the immortal kelp," Nikki said. "I wonder how long it's been alive and learning? We must be a fascinating diversion."

"This is all very interesting," Root said. "But we're still trapped here with no way to contact the colony, no means of returning . . ."

"Since you intended to return alone on foot after a tragic crash and heroic odyssey through the demon lands," Nikki said, "what do you suggest?"

"I intend to wait," Root said, grinning.

Ship save us! Tam thought. *He's admitted that Nikki's right. But how,* how . . .

"Tam survived two ventures out there because you saved her both times, didn't you?" Nikki asked.

Root shrugged. It was a pointless question and besides the look on Tam's face was answer enough.

Tam stared at Root. "How?"

"He's not quite human," Nikki said. "I don't know what he is or where he comes from, but he can do things we can't."

"Ship save us," Tam whispered.

"Ship save us," Root mimicked. "You fools haven't the faintest idea of what's happening on Medea, why you're here or what you're doing."

Nikki smiled, a slow, almost sleepy smile. "But we're learning. We see to learn, listen to learn, touch and smell to learn and . . ."

"And maybe someday . . ." Root pointed out at the heaving bay. ". . . you hope you'll drink a broth made from your 'teachers' and *that's* how you'll learn."

Root released himself from the seat, stood up and opened a hatch. A cold ozone-washed breeze blew in the opening. It was a clean, invigorating smell with only a touch of damp decay at the edge.

On the breeze came the sound of rhythmic whistles and moans. In the background there was a fluting song, compelling in its siren beauty. Nikki's head nodded to the rhythm. He released his harness and signaled Tam to do the same.

As she stood and peered out through the remnants of their bag, Tam stifled a gasp. A mob of globes—purple, red, green, yellow, blue . . . an iridescent rainbow play of them was drifting down on the nest. At the forefront was a giant globe almost as big as the floater. It played a symphony of red and purple across its shimmering surface.

A light rain of sweet-smelling dust began to sift through the open hatch. Nikki pushed Root aside and clambered out onto the platform created by the inflated pontoon. Tam followed him. Root remained at the open hatch.

The storm had passed out to sea leaving only a warm breeze and the air filled with disintegrating bits of globes which had been destroyed by lightning. Eddies of pastel dust swirled around the nest and a cloudy mist of them obscured the bay's inner shoreline. More globes were rising from the

water to replace the lost ones.

Now, the onrushing mob swooped on the nest and circled until their dangling tentacles brushed Nikki's upturned face. He held out his arms to them, his expression rapturous, but Tam cowered away. Root moved to join them on the pontoon but a brushing tentacle left a livid streak across his forehead. He screamed and jerked back into the nest.

Nikki gave no sign that he had heard.

The chittering globes continued to rhapsodize around Nikki, singing to him. Tam pressed herself against the nest, fascinated by the rainbow dance and the fluting songs.

Presently, Nikki began to sing back to the globes in a language Tam could not understand. His voice echoed in her breast until she thought she would choke with longing for the beauty of it. A heightened state of excitement filled her. The gentle rock of the nest on the water, the balmy wind, the rhythmic lick of waves against the pontoon—everything blended with the dance and song of the globes.

The circling mob opened a space around Nikki then, and he leaped to the top of the nest where he began to dance while he sang: strange paddling motions, sweeping gestures with both hands, gentle interlacings of his palms.

From within the nest, Root demanded: "What's he doing up there?"

"He's dancing."

The globes moved closer, cradling their tentacles around Nikki while he danced. The play of colors was dazzling. Gently, the movement slowed, the colors shifted to a universal brilliant silver with soft veins of red.

Nikki brought his hands to his sides, bowed his head, shuddered and stood still.

Tam looked at his feet. They were stained with Argo red from the remnants of the floater bag on the nest's roof. Bits of color washed from the bag trailed down the sides of the nest into the water.

Nikki's voice, so matter of fact, shocked her.

"They don't understand why the bag isn't dissolving."

"Why aren't they touching me?"

"Because I told them you were afraid."

"You're talking to them!"

"That's right."

"How do you do it?"

"It's in the no-place, the betweens and in the honesty of the songs."

"Why were you dancing?"

"Talking, more talking. I was talking my ancestors to them: the weavers and gardeners, the samurai, the pottery makers, the canoe people, the commuters and keepers of offices, the warriors around the fires . . ."

"They understood?"

"Oh, yes."

"Why're they keeping Root in the nest?"

"I don't know. That's their idea."

"Do they know what Root is?"

"Yes. Ship made him. He's like a partial God who was made that Ship might understand things better."

She didn't understand this but put it aside.

"Are you through talking to them?"

"No—they've asked me to talk one more thing to them."

"What?"

"The perfect biological principle."

A raucous laugh erupted within the nest.

"I don't understand," Tam said.

"They wish to exchange their information for ours—the perfect biological principle: replication."

She didn't understand for a moment, then: "You don't mean . . ."

"Come up." He held a hand out to her and a gentle golden stir wafted through the slowly circling globes. "You must help me talk to them. We will talk the making of a baby."

Not here! she thought.

A globe dropped close to her and the first tentacle brushed against her shoulder and neck. It was a caress! She leaned into it.

Tam didn't remember taking off her clothes nor seeing Nikki disrobe, but there remained a memory of the globes helping her to the top of the nest and Nikki reclining there, long-limbed, dark and muscular, as though he lay on a grassy Earthside meadow soaking up sun after a swim or a hard day in the fields.

She saw their clothes scattered around the nest's top. A shield of rainbow domes covered the sky.

Slowly, she moved toward him. First, a hand touching hand, then, like the tentacles which brushed them both, they matched touch for touch in the nooks and crannies of their curious bodies. Chittering groans filled the air overhead.

"I want you," Tam whispered. "How can I do this here and say such a thing without feeling self-conscious?"

Nikki kissed her, then: "Where have we put our *selves*?"

He had never been with a woman. Ship urged couplings among adolescents. It helped in the selection of breeding pairs and relieved tensions. But Nikki's creative energies had been focused into the feeling words of his poetry. And Ship had helped in some strange way he had never understood—perhaps something in his food.

Now with tentacles reaching and searching across his body, with the sweetness of the air thick around them, with Tam's silky white skin warm and glowing beside him, he knew there was nothing he'd rather do and no one he'd rather have as a companion in ecstasy. Fingers and tongues joined in the tangle of legs and tentacles, then she was on top of him, moving so very slowly, smiling down at him with tears in her eyes, and Nikki felt that he had been introduced to the most ancient language of humans, a true clear conversation which transcended all words, all dialects, all explanations.

Once more, the globes were a dancing splendor of color and song above them. Tam lay quietly beside Nikki and watched his eyes. How beautiful

they were! He traced soft designs on her breasts. She touched his cheek.

"The globes say we have made a baby, we truly have," Nikki said.

"I love you," she whispered. Then, eyes wide: "How do they know?"

"They know. They say the moment of replication is also their greatest joy and they can measure it."

"But we weren't selected as a breeding pair."

"Except by our Medean hosts." He sat up. "We should get dressed. The ultraviolet . . . the globes won't be able to shield us much longer."

Nikki slipped into his clothes. Presently, she followed his example, her gaze searching all around the bay as she moved.

"We're still trapped here, Nikki."

He stood atop the nest. "No. The globes will take us home to the colony. Five or six of the big ones . . ."

She slipped down to the pontoon and peered through the hatch into the nest.

"Nikki!"

"Yes?"

"He's gone. Root's gone. Where'd he go?"

"Maybe he didn't go; maybe he was protean and merely took another shape."

"Stop that! They've taken him, haven't they?"

"I don't know. I didn't see them. Did you?"

She blushed, then: "How will we explain it?"

"We'll let the globes explain it after I've taught their language to others."

Nikki turned, lifted his arms and began to sing, swaying and gesturing toward the shore.

Presently, eight of the largest globes moved down in concert and, as Nikki sang, they shifted their color to a uniform Argo red, affixed their tentacles to the nest and lifted it gently from the water. ■

This story by Frank Herbert is the last of the MEDEA stories that will appear in Analog. What follows is a statement by its "creator"—Harlan Ellison. (The Editor)

INTRODUCING MEDEA:
HARLAN'S WORLD

Early in 1975, I was approached by the Arts, Humanities and Communications section of the UCLA Extension department. What they wanted, they said, was an evening Extension course on "sci-fi." After I stopped gritting my teeth at that loathesome neologism, I entered into discussions aimed at putting together a series of presentation evenings that would explore in greater scope the *core* of what is best about speculative fiction and fantasy: the use of imagination. In specific, the intent of the series of ten seminars was to present alternatives; to expose a lay (and sf-oriented) audience to nonstructured intellectual "sets" at variance with the accepted societal "norms." The subtext of all the programs, coordinated for ostensibly "entertainment" values, was simply this: *anything is possible.*

The series was titled "Ten Tuesdays

Down a Rabbit Hole," I was the conceptualizer and the host, and the series ran from April 1st, 1975 through June 3rd. The enrollment was in excess of one thousand persons. And apart from the fact that I was forced to fail about three-quarters of the people who took it for credit, it was an unqualified success. It was the largest, most elaborate mixed-media program of sf presentations ever attempted. (And, I must confess, it was intended to demonstrate to those who put on sf conventions that there were an infinitude of alternatives to the usual dull, repetitive, chairs-lined-up-behind-the-lecture-table programming to which most convention committees so slavishly adhere.)

The gem of the ten evenings was the April 15, 1975 spectacular. As announced in the UCLA brochure:

> New Worlds For Sale: Building Novels Before Your Very Eyes
> Where do ideas come from and how do they become realities? Prominent sf writers Robert Silverberg, Frank Herbert, Theodore Sturgeon and Thomas M. Disch will be handed on stage the basics of a new planet (its ecology, physical properties, weather, mass and gravity, place in the solar system), as postulated ahead of time by some of the field's most brilliant innovators including Poul Anderson, Hal Clement, Larry Niven, and Frederik Pohl. Stories will be "imagined" on the spot—an opportunity to watch works being willed into existence.

That was the announcement. The reality of putting together that evening, however, was the work of five months of incredible effort by all the above-named writers, myself, and artist Kelly Freas.

First Hal Clement discovered and named Medea, which everyone persisted in referring to as "Harlan's World" despite my sincere and wholly out-of-character attempt at humility by asking that they *not* call it that. Hal wrote extensive specs on the astrophysics and geology of Medea. Its star-system, its place in the galaxy.

Then Hal's specs were sent to Poul Anderson, who dealt with the primary planet and the major satellites, picking up where Hal's geological extrapolations ended. Further geology, meteorology, oceanography, geography, biology and basic nomenclature—a very long, Anderson-brilliant essay. Then I sent *that* combined batch of specs off to Larry Niven, who concluded the biological specs and went on to codify the ecology and xenology of Medea. He created the denizens of the planet. Fred Pohl received the packet last, and tagged off the xenological study, enriching it with observations on the possible sociology, politics, theology and mathematics of the Medeans.

The entire series of specs were mimeographed in booklet form (a handsome presentation item that I've seen sold at auction for over $100) and one

copy went on each chair in the auditorium the night of the seminar. But before that happened, there was more.

The specs were sent to Kelly Freas. Kelly rendered a sensational painting of the surface of the planet, the major satellites, the aliens and humans who had already made first contact. We took the painting and had it photographed by William Rotsler in whole and in blowup of all sections. These were rendered as slides.

On April 15th, at dinner with Silverberg, Herbert, Disch and Sturgeon, I gave them their first look at the spec booklet, two hours before they were to walk on stage. The dinner conversation—between hurried readings and jamming forkfuls of food into their ears and eyes because they were distracted—was exceptional. But no less exceptional than the evening's seminar. The first hour and a half—with Medea being flashed on the giant screen at the back of the stage—was spent in jackpotting . . . throwing the ideas contained in the specs around and seeing where the minds and imaginations of the four platform participants took them.

Then we took a break, came back and in the *next* hour and a half Sturgeon, Disch, Silverberg and Herbert began plotting the stories they would write about such a world. Then an hour was spent in Q&A with an audience that was dazzlingly alive and imaginative. Fred Pohl suggested there might be a book in that evening. As it was *precisely* what I'd had in mind (and had, in fact, announced to the audience that evening), I went forward with the transmogrification of an evening seminar into a once-in-a-lifetime book that would include the original specs, the transcript of the evening seminar, the incredibly adroit questions asked by the audience and . . . stories by each of the participants. Thus was born MEDEA: HARLAN'S WORLD.

You have seen stories from that book: Pohl, Anderson and Herbert, in Analog. Clement, Niven and Jack Williamson (who stepped in for Silverberg because Bob had retired from writing) will be appearing elsewhere. But these half dozen stories are merely to whet the appetite. The entire book runs to over 190,000 words, including Theodore Sturgeon's longest new story in years, the 26,000 word novella "Why Dolphins Don't Bite," what is in my estimation Thomas M. Disch's most brilliant sf story, the 17,000 word "Concepts," Kate Wilhelm's 14,000 word "The Promise" and a minor offering from the editor titled "With Virgil Oddum at the East Pole."

Bantam Books has bought the huge volume and, using the Kelly Freas painting plus new artwork to illustrate each story, will release MEDEA: HARLAN'S WORLD in a large-format presentation sometime early in 1979.

When this monumental project finally reaches the bookstores, it may, once and for all, put forth an answer to the question that is endlessly asked of us: where do you get your crazy ideas?

Harlan Ellison
1978

Introduction:

The unprecedented opportunities for experiments in complexity presented by the first modern computers in the late 1940s raised hopes in early computer scientists (eg. John von Neumann and Alan Turing) that the ability to think, our greatest asset in our dealings with the world, might soon be understood well enough to be duplicated. Success in such an endeavor would extend mankind's mind in the same way that the development of energy machinery extended his muscles.

In the thirty years since then computers have become vastly more capable, but the goal of human performance in most areas seems as elusive as ever, in spite of a great deal of effort. The last ten years, in particular, has seen thousands of people years devoted directly to the problem, referred to as Artificial Intelligence or AI. Attempts have been made to develop computer programs which do mathematics, computer programming and common sense reasoning, are able to understand natural languages and interpret scenes seen through cameras and spoken language heard through microphones, and to play games humans find challenging.

There has been some progress. Samuel's checker program can occasionally beat checker champions. Chess programs regularly play at good amateur level, and in March 1977 a chess program from Northwestern University, running on a CDC Cyber-176 (which is about 20 times as fast as

today's computers, intelligent machines and our future

Machine intelligence is only ten years away. And human evolution will accelerate exponentially soon afterward!

Hans Moravec

previous computers used to play chess) won the Minnesota Open Championship, against a slate of class A and expert players. A ten year effort at MIT has produced a system, Mathlab, capable of doing symbolic algebra, trigonometry and calculus operations better in many ways than most humans experienced in those fields. Programs exist which can understand English sentences with restricted grammar and vocabulary, given the letter sequence, or interpret spoken commands from hundred word vocabularies. Some can do very simple visual inspection tasks, such as deciding whether or not a screw is at the end of a shaft. The most difficult tasks to automate, for which computer performance to date has been most disappointing, are those that humans do most naturally, such as seeing, hearing and common sense reasoning.

A major reason for the difficulty has become very clear to me in the course of my work on computer vision. It is simply that the machines with which we are working are still a hundred thousand to a million times too slow to match the performance of human nervous systems in those functions for which humans are specially wired. This enormous discrepancy is distorting our work, creating problems where there are none, making others impossibly difficult, and generally causing effort to be misdirected.

In the early days of AI the thought that existing machines might be much too small was widespread, but people hoped that clever mathematics and advancing computer technology could soon make up the difference. The idea that available compute power might still be vastly inadequate has since been swept under the rug, due to wishful thinking and a feeling that there was nothing to be done about it anyway and that voicing such an opinion could cause AI to be considered impractical, resulting in reduced funding. This attitude has had some bad effects, one of them being that AI research has been centered on computers less powerful than absolutely necessary.

The first section of this essay discusses natural intelligence. It notes two major branches of the animal kingdom in which intelligence evolved independently, and suggests that it is easier to construct than is sometimes assumed.

The second part compares the information processing ability of present computers with intelligent nervous systems. The factor of one million is derived in two different ways.

Section three examines the development of electronics, and concludes the state of the art can provide more power than is now available, and that the one million gap could be closed in ten years.

Part four introduces some hardware and software aspects of a system which would be able to make use of the advancing technology, providing a means for achieving human equivalence, perhaps by the next decade.

Part five considers the implications of the emergence of intelligent ma-

chines, and concludes that they are the final step in a revolution in the nature of life. Biological evolution based on DNA, random mutations and natural selection may be completely replaced by the much faster process of intelligence mediated cultural and technological evolution.

(Ed. note: Sections three and four are rather specialized treatments of computer hardware capabilities. Readers who are cowed by this material can skip it if they wish; but *do not skip* Section Five.)

Section 1
The Natural History of Intelligence

Product lines:

Natural evolution has produced a continuum of complexities of behavior, from the mechanical simplicity of viruses to the magic of mammals. In the higher animals most of the complexity resides in the nervous system.

Evolution of the brain began in early multicelled animals a billion years ago with the development of cells capable of transmitting electrochemical signals. Because neurons are more localized than hormones they allow a greater variety of signals in a given volume. They also provide evolution with a more uniform medium for experiments in complexity.

The advantages of implementing behavioral complexity in neural nets seem to have been overwhelming, since all modern animals more than a few cells in size have them [animal refs.].

Two major branches in the animal kingdom, vertebrates and mollusks, contain species which can be considered intelligent. Both stem from one of the earliest multicelled organisms, an animal something like a hydra made of a double layer of cells and possessing a primitive nerve net.

Most mollusks are intellectually unimpressive sessile shellfish, but one branch, the cephalopods, possesses high mobility, large brains, and imaging eyes. These structures evolved independently of the corresponding equipment in vertebrates and there are fascinating differences. The optic nerve connects to the back of the retina, so there is no blind spot. The brain is annular, forming a ring encircling the esophagus. The circulatory system, also independently evolved, has three blood pumps, a systemic heart pumping oxygenated blood to the tissues and two gill hearts, each pumping venous blood to one gill. The oxygen carrier is a green copper compound called hemocyanin, evolved from an earlier protein that also led to hemoglobin.

These animals have some unique abilities. Shallow water octopus and squid are covered by a million individually controlled color changing effectors called chromatophores, whose functions are camouflage and communication. The capabilities of this arrangement have been demonstrated by a cuttlefish accurately imitating a checkerboard it was placed upon, and an octopus in flight which produced a pattern like the seaweed it was traversing, coruscating backward along the

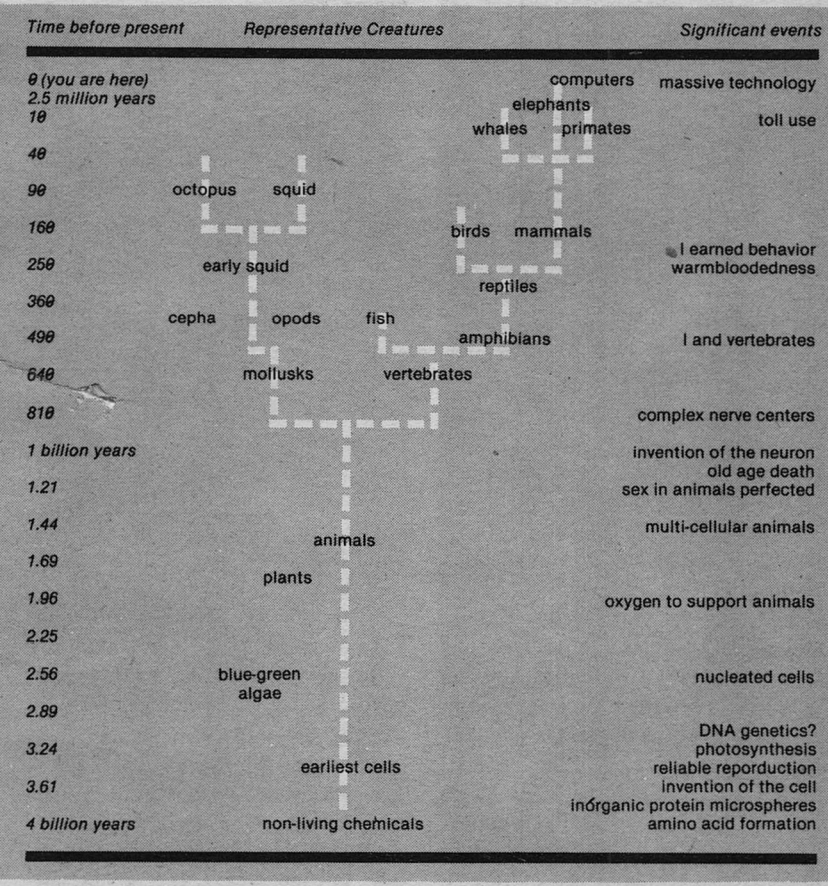
length of its body, diverting the eye from the true motion. Deep sea squid have photophores capable of generating large quantities of multicolored light. Some are as complex as eyes, containing irises and lenses [squid]. The light show is modulated by emotions in major and subtle ways. There has been little study of these matters, but this must provide means of social interaction. Since they also have good vision, there is the potential for high bandwidth communication.

Cephalopod intelligence has not been extensively investigated, but a few controlled experiments indicate rapid learning in small octopus [Boycott]. The Cousteau film in the references shows an octopus's response to a problem requiring a two stage solution. A fishbowl containing a lobster is sealed with a cork and dropped into the water near it. The octopus is attracted, and spends a long while alternately probing the container in various ways and returning to its lair in iridescent frustration. On the final iteration it exits its little hole in the ground and unhesitatingly wraps three tentacles around the bowl, and one about the cork, and pulls. The cork shoots to the surface and the octopus eats. The Time-Life film contains a similar sequence, with a screw top instead of a cork! If small octopuses have almost mammalian behavior, what might giant deep sea squid be capable of? The behavior of these large brained, apparently shy, animals has virtually never been observed.

Birds are more closely related to humans than are cephalopods, their common ancestor with us being a 300-million-year-old early reptile. Size-limited by the dynamics of flying, some birds have reached an intellectual level comparable to the highest mammals.

Crows and ravens are notable for frequently outwitting people. Their intuitive number sense (ability to perceive the cardinality of a set without counting) extends to seven, as opposed to three or four in us. Such a sense is useful for keeping track of the number of eggs in a nest. Experiments have shown [Stettner] that most birds are more capable of high order "reversal" and "learning set" learning than all mammals except the higher primates. In mammals these abilities increase with increasing cerebral cortex size. In birds the same functions depend on areas not present in mammalian brains, forebrain regions called the "Wulst" and the hyperstriatum. The cortex is small and relatively unimportant. Clearly this is another case of independent evolution of similar mental functions. Penguins, now similar to seals in behavior and habitat, might be expected to become fully aquatic, and evolve analogously to the great whales.

The cetaceans are related to us through a small 30-million-year-old primitive mammal. Some species of dolphin have body and brain masses identical to ours, and archaeology reveals that they have been this way several times as long. They are as good as us at many kinds of problem solv-



Highlights in the evolution of terrestrial intelligence. The distance along the edge of the tree is proportional to the square root of the time from the present. This seems to space things nicely.

ing, and perhaps at language. The references contain many anecdotes, and describe a few controlled experiments, showing that dolphins can grasp and communicate complex ideas. Killer whales have brains seven times human size, and their ability to formulate plans is better than the

dolphins', on whom they occasionally feed. Sperm whales, though not the largest animals, have the world's largest brains. There may be intelligence-mediated conflict with large squid, their main food supply.

Elephants have brains about five times human size, matriarchal tribal societies, and complex behavior. Indian domestic elephants usually learn 500 commands, limited by the range of tractorlike tasks their owners need done, and form voluntary mutual benefit relationships with their trainers, exchanging labor for baths. They can solve problems such as how to sneak into a plantation at night to steal bananas, after having been belled (answer: stuff mud into the bells). And they remember for decades. Inconvenience and cost has prevented more elephant research.

The apes are our cousins. Chimps and gorillas can learn to use tools and to communicate with human sign languages at a retarded level. As chimps have one-third, and gorillas one-half, human brainsize, similar results should be achievable with the larger brained, but less humanlike animals. Though no other species has managed to develop a technological culture, it may be that some of them can be made partners in ours, accelerating its evolution with their unique capabilities.

Nervous System Size and Intelligence

A feature shared by all living organisms whose behavior is complex enough to indicate near-human intelligence is a nervous system of a hundred billion neurons. Imaging vision requires a billion neurons. A million brain cells usually permits fast and interesting, but stereotyped, behavior as in a bee. A thousand is adequate for slow moving animals with minimal sensory input, such as slugs and worms. A hundred runs most sessile animals. The portions of nervous systems for which tentative wiring diagrams have been obtained (e.g., much of the brain of the large neuroned sea slug, Aplysia, the flight controller of the locust and the early stages of some vertebrate visual systems) reveal that the neurons are configured into efficient, clever assemblies. This should not be surprising, as unnecessary redundancy means unnecessary metabolic load, a distinct selective disadvantage.

Evolution has stumbled on many ways of speeding up its own progress, since species that adapt more quickly have a selective advantage. Most of these speedups, such as sex and dying of old age, are refinements of one of the oldest, the encoding of genetic information in the easily mutated and modular DNA molecule. In the last few million years the genetically evolved ability of animals, especially mammals, to learn a significant fraction of their behavior after birth has provided a new medium for growth of complexity. Modern man, though perhaps not the most individually intelligent animal on the planet, is the species in which this cultural evolution seems to have had the greatest effect,

making human culture the most potent force on the Earth's surface.

Our cultural and technological evolution has proceeded by massive interchange of ideas and information, trial and error guided by the ability to predict the outcome of simple situations, and other techniques mediated by our intelligence. The process is self-reinforcing because its consequences, such as improved communication methods and increased wealth and population, allow more experiments and faster cross-fertilization among different lines of inquiry. Many of its techniques have not been available to biological evolution. The effect is that present-day global civilization is developing capabilities orders of magnitude faster. Of course biological evolution has had a massive headstart.

Although cultural evolution has developed methods beyond those of its genetic counterpart, the overall process is essentially the same. It involves trying large numbers of possibilities, selecting the best ones, and combining successes from different lines of investigation. This requires time and other finite resources.

Finding the optimum assembly of particular type of component which achieves a desired function usually requires examination of a number of possibilities exponential in the number of components in the solution. With fixed resources this implies a design time rising exponentially with complexity. Alternatively the resources can be used in stages, to design subassemblies, which are then combined into larger units, and so on, until the desired result is achieved. This can be much faster since the effort rises exponentially with the incremental size of each stage and linearly with the number of stages, with an additional small term, for overall planning, exponential in the number of stages. The resulting construct will probably use more of the basic component and be less efficient than an optimal design.

Biological evolution is affected by these considerations as much as our technology. If a device is so difficult to design that our technology cannot build it, then neither should we expect to find it in the biological world. Conversely, if we find some naturally evolved thing, we can rest assured that designing an equally good one is not an impossibly difficult task. Presumably there is a way of using the physics of the universe to construct entities functionally equivalent to human beings, but vastly smaller and more efficient. Terrestrial evolution has not had the time or space to develop such things. But by building within the sequence atoms, amino acids, proteins, cells, organs, animal (often concurrently), it produced a technological civilization out of inanimate matter in only two billion years.

Harangue:

The existence of several examples of intelligence designed under these constraints should give us great confidence that we can achieve the same in a time span similar to that of other

technological accomplishments.

The situation is analogous to the history of heavier-than-air flight, where birds, bats and insects clearly demonstrated the possibility before our culture mastered it. Flight without adequate power-to-weight ratio is heartbreakingly difficult (vis. Langley's steam powered aircraft or current attempts at man powered flight), whereas with enough power (on good authority!) a shingle will fly. Refinement of the aerodynamics of lift and turbulence is most effectively tackled after some experience with suboptimal airplanes. After the initial successes our culture was able to far surpass biological flight in a few decades.

Although there are known brute force solutions to most AI problems, current machinery makes their implementation impractical. Instead we are forced to expend our human resources trying to find computationally less intensive answers, even where there is no evidence that they exist. This is honorable scientific endeavor, but, like trying to design optimal airplanes from first principles, a slow way to get the job done.

With more processing power, competing presently impractical schemes could be compared by experiment, with the outcomes often suggesting incremental or revolutionary improvements. Computationally expensive highly optimizing compilers would permit efficient code generation at less human cost. The expanded abilities of existing systems such as Mathlab, the symbolic mathematics system from MIT, which can be used as a desk calculator for doing algebra and trigonometry as well as arithmetic, along with new experimental results, would accelerate theoretical development. Gains made this way would improve the very systems being used, causing more speedup. The intermediate results would be inefficient kludges busily contributing to their own improvement. The end result is systems as efficient and clever as any designed by more theoretical approaches, but sooner, because more of the labor has been done by machines.

With enough power anything will fly. The next section examines how much is needed.

Section 2
Measuring Processing Power

During the past ten years Digital Equipment Corporation's PDP-10 has become the standard computer for AI and related research, partly because it was designed with advanced techniques, such as timesharing and unusual computer languages, in mind.

When first introduced, the PDP-10 was considered a large machine. By today's standards it is medium size. The PDP-10 dealt with in this section is the KA model, the standard until very recently. The very largest scientific computers, heavily used in physics, chemistry and other fields, made by companies such as Control Data Corp. and IBM, are about 100 times the speed of the KA. When it was new a KA system cost about half a million dollars. Large computers sell for

around 10 million dollars.

Low level vision:

The visual system of a few animals has been studied in some detail, especially the layers of the optic nerve near the retina. The neurons comprising these structures are used efficiently to compute local operations like high pass filtering and edge, curvature, orientation and motion detection.

Assuming the visual cortex (and possibly the optic nerve itself) is as computationally intensive as the retina, successive layers producing increasingly abstracted representations, we can estimate the total capability. There are a million separate fibers in a cross-section of the human optic nerve. The thickness of the optical cortex is a thousand times the depth occupied by the neurons which apply a single simple operation. The eye is capable of processing images at the rate of ten per second (flicker at higher frequencies is detected by special operators). This means that the human visual system evaluates 10,000 million pixel simple operators each second. (The word pixel used here is a corruption of the phrase "picture element." It is a single spot in the picture and represents a particular brightness value. In an animal retina it is represented by the firing rate of a single neuron. More light = higher rate. In a computer is represented by a binary number of about six bits. More light = larger number. A typical image is made up of about a million pixels.)

A tightly hand-coded simple operator, like high pass filtering by subtraction of a local average, applied to a million pixel picture takes at least 160 seconds when executed on a PDP-10, not counting timesharing. Since the computer can evaluate only one at a time, the effective rate is 1/160 million pixel simple operators per second.

Thus a hand-coded PDP-10 falls short of being the equal of the human visual system by a speed factor of 1.6 million.

It may not be necessary to apply every operator to every portion of every picture, and a general purpose computer, being more versatile than the optic nerve, can take advantage of this. I grant an order of magnitude for this effect, reducing the optic nerve to a mere 100,000 PDP-10 equivalents.

The size of this factor is related to having chosen to implement our algorithms in machine language. If we had opted to disassemble a number of PDP-10's and reconfigure the components to do the computation, far fewer (perhaps only one!) would have been required. On the other hand if we had run our algorithms in an interpreted Lisp, 10 to 100 times as many would be needed. The tradeoff is that the design time varies inversely with the execution efficiency. A good Lisp program to compute a given function is much easier to produce than an efficient machine language program, or an equivalent piece of hardware.

As a practical example of the kind of problem this gap poses in current research, consider my work. The task

is to construct a program which can drive a vehicle sensing the world with a TV camera through terrain cluttered with obstacles, avoiding the obstacles and getting to a desired place. The programs are written efficiently and in the spirit of computing only as much as is actually required to track objects from one image to the next, and to judge their distance from the parallax caused by vehicle motion. In spite of this it takes a large program several minutes of computing to process each frame. Differences in performance caused by changes in the program can often be determined only after tens of images have been processed, implying a run time of hours. This greatly limits experimentation. Also, many ideas on how to significantly improve performance cannot reasonably be tried because they slow down the computation by another factor of 10 to 100, increasing typical runs to days and weeks! Many (such as taking pictures at much smaller intervals than the current two foot motions) require very little additional programming, and would be almost certain to improve things.

Entropy measurement:

Is there a quantitative way in which the processing power of a system, independent of its detailed nature, can be measured? A feature of things which compute massively is that they change state in complicated and unexpected ways. The reason for believing that, say, a stationary rock does little computing is its high predictability. By this criterion the amount of computing done by a device is in the mind of the beholder. A machine with a digital display which flashed 1, 2, 3, 4 etc., at fixed intervals would seem highly predictable to an adult of our culture, but might be justifiably considered to be doing an interesting, nontrivial and informative computation by a young child. Information theory provides a measure for this idea. If a system is in a given state and can change to one of a number of next states with equal probability, the information in the transition, which I will call the Compute Energy (CE), is given by

$$CE = \log_2 N$$

where N is the number of next states. The measure is in binary digits, bits. If we consider the system in the long run, considering all the states it might ever eventually be in, then this measure expresses the total potential variety of the system.

A machine which can accomplish a given thing faster is more powerful than a slower one. A measure for Compute Power is obtained by dividing the above sum by the time required for a transition. Thus:

$$CP = \frac{\log_2 N}{t}$$

The units are bits/second.

Slightly more complicated formulas, which give lower values, apply if the transitions probabilities and times are not all equal.

These measures are highly analogous to the energy and power capacities of a battery.

Some properties follow:

- They are linear, i.e., the compute power and energy of a system of two or more independent machines is the sum of the individual power and energies;
- Speeding up a machine by a factor of n increases the CP by the same factor;
- A completely predictable system has a CP and CE of zero;
- A machine with a high short term CP, which can reach a moderate number of states in a short time, can yet have a low CE, if the total number of states attainable in the long run is not high.

A representative computer:

For the KA-PDP10, considering one instruction time, we have (roughly) that in one microsecond this machine is able to execute one of 2^5 different instructions, involving one of 2^4 accumulators and one of 2^{18} memory locations, most of these combinations resulting in distinct next states. This corresponds to a CP of

$$\frac{\log_2(2^5 \times 2^4 \times 2^{18})\text{bit}}{10^{-6}\text{ sec}} = 27 \times 10^6 \frac{\text{bit}}{\text{sec}}$$

This number is reduced by the fact that different instruction sequences can result in the same outcome, and increased slightly by information flowing in from high speed storage devices connected to the computer for a net of about $8.5 \times 10^6 \frac{\text{bit}}{\text{sec}}$ (details in [Moravec]).

The CP is also limited by the total compute energy. If we ignore external devices, this is simply the total amount of memory, about $36 \times 2^{18} = 9.4 \times 10^6$ bits. The PDP 10 could execute at its maximum effectiveness for $9.4/8.5 = 1.1$ seconds before reaching a state which could have been arrived at more quickly another way. The energy can be extended indefinitely, however, by addition of external storage devices, such as disks and tapes.

Overall, the processing power of a typical major AI center computer is at most 10^7 bits/sec. Timesharing reduces this to about 10^6 b/s per user. Programming in a moderately efficient high level language costs another factor of 10, and running under an interpreter may result in a per user power of a mere 10,000 bits/sec, if the source code is efficient.

A typical nervous system:

We now consider the processing ability of animal nervous systems, using humans as an example. Since the data is even more scanty than what we assumed about the PDP-10, some not unassailable assumptions need to be made. The first is that the processing power resides in the neurons and their interconnections, and not in more compact nucleic acid or other chemical encodings. There is no currently widely accepted evidence for the latter, while neural mechanisms for memory and learning are being slowly revealed. A second is that the neurons are used reasonably efficiently, as detailed analysis of small nervous systems and small parts of large ones reveals (and common sense applied to

evolution suggests). Thirdly, that neurons are fairly simple, and their state can be represented by a binary variable, "firing" or "not firing," which can change about once per millisecond. Finally we assume that human nervous systems contain about 40 billion neurons.

Considering the space of all possible interconnections of these 40 billion (treating this as the search space available to natural evolution in its unwitting attempt to produce intelligence, in the same sense that the space of all possible programs is available to someone trying to create intelligence in a computer), we note that there is no particular reason why every neuron should not be able to change state every millisecond. The number of combinations thus reachable from a given state is $2^{40} \times 10^9$ the binary log of which gives $CE = 40 \times 10^9$. This leads to a compute power of

$$CP = \frac{40 \times 10^9 \text{ bit}}{10^{-3} \text{ sec}} = 40 \times 10^{12} \frac{\text{bit}}{\text{sec}}$$

which is about a million times the maximum power of the KA-10.

Keep in mind that much of this difference is due to the high level of interpretation in the KA, compared to what we assumed for the nervous system. Rewiring its gates or transistors for each new task would greatly increase the CP, but also the programming time. If the processor is made of 100,000 devices which can change state in 100 ns, the potential CP available through reconfiguration is 10^5 bits/10^{-7} sec = 10^{12} b/s. The CE would be unaffected. If automatic design and fabrication methods result in small quantity integrated circuit manufacture becoming less expensive and more widely practiced, my calculations may prove overly pessimistic.

Thermodynamic efficiency:

Thermodynamics and information theory provide us with a minimum amount of energy per bit of information generated at a given background temperature (the energy required to outshout the thermal noise). This is approximately the Boltzmann constant,

$$1.38 \times 10^{-16} \frac{\text{erg}}{\text{deg variable}} = 0.96 \times 10^{-16} \frac{\text{erg}}{\text{deg bit}}$$

The reduction is due to the theoretical fact that a "variable," also known as a degree of freedom, is worth $\log_2 e$ bits, about 1.44 bits. This measure allows us to estimate the overall energy efficiency of computing engines. For instance, we determined the computing power of the brain, which operates at 300 degrees K, to be 40×10^{12} bits/sec. This corresponds to a physical power of

$$40 \times 10^{12} \frac{\text{bit}}{\text{sec}} \times 300 \text{ deg} \times 0.96 \times 10^{-16} \frac{\text{erg}}{\text{deg bit}} = 1.15 \frac{\text{erg}}{\text{sec}} = 1.15 \times 10^{-7} \text{ watt}$$

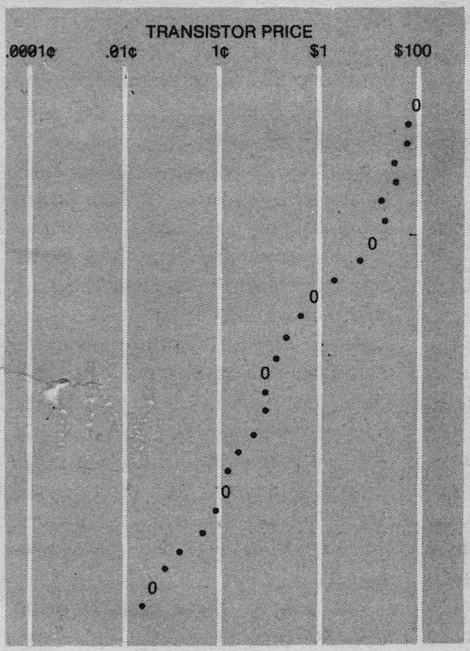
The brain runs on approximately 40 watts, so we conclude that it is 10^{-8} times as efficient as the physical limits allow.

Doing the same calculations for the

KA10, again at 300 deg, we see that a CP of 8.5×10^6 bit/sec is worth 2.44×10^{-14} watts. Since this machine needs 10 kilowatts the efficiency is only 10^{-18}. Conceivably a 10 watt, but otherwise equivalent, KA10 could be designed today, if care were taken to use the best logic for the required speed in every assembly. The efficiency would then still be only 10^{-15}.

As noted previously, there is a large cost inherent in the organization of a general purpose computer. We might investigate the computing efficiency of the logic gates of which it is constructed (as was, in fact, done with the brain measure). A standard TTL gate can change state in about 10ns, and consumes 10^{-3} watt. The switching speed corresponds to a CP of 10^8 bit/sec, or a physicial power of 2.87×10^{-13} watt. So the efficiency is 10^{-10}, only one hundred times worse than a vertebrate neuron.

The newer semiconductor logic families are even better. C-MOS is twice as efficient as TTL, and Integrated Injection Logic is 100 times better, putting it on a par with neurons.



YEAR

1950
1951...*$100 transistor*
1952...*transistor hearing aid*
1953
1954
1955...*transistor radios*
1956
1957...*$10 transistor*
1958
1959
1960...*$1 transistor*
1961
1962...*$100,000 small computer*
1963 *(IBM 1620)*
1964
1965...*$0.08 transistor (IC)*
1966...*$1000 4 func calculator*
1967...*$6000 scientific calc.*
1968...*$10,000 small computer (PDP 8)*
1969
1970...*$200 4 func calculator*
1971
1972...*1K RAMS (1 ¢/bit)*
1973
1974...*$1000 small computer (PDP 11)*
1975...*4K RAMS (.1 ¢/bit)*
1976...*$5 4 func calc (.05 ¢/trans)*
1977
1978
1979

The references above present, among other things, the following data points on a price curve: (see Section 3, p. 72)

Experimental superconducting Josephson junction logic operates at 4 deg K, switches in 10^{-11} sec, and uses 10^{-7} watts per gate. This implies a physical compute power of 3.5×10^{-12} watt, and an efficiency of 7×10^{-5}, 1000 times better than neurons. At room temperature it requires a refrigerator that consumes 100 times as much energy as the logic, to pump the waste heat uphill from 4 degrees to 300. Since the background temperature of the universe is about 4 degrees, this can probably eventually be done away with.

It is thus likely that there exist ways of interconnecting gates made with known techniques which would result in behavior effectively equivalent to that of human nervous systems. Using a million I^2L gates, or 10 thousand Josephson junction gates, and a trillion bits of slower bulk storage, all running at full speed, such assemblies would consume as little as, or less than, the power needed to operate a brain of the conventional type.

Past performance indicates that the amount of human and electronic compute power available is inadequate to design such an assembly within the next few years. The problem is much reduced if the components used are suitable large subassemblies. Statements of good high level computer languages are the most effective such modularizations yet discovered, and are probably the quickest route to human equivalence, if the necessary raw processing power can be accessed through them. This section has indicated that a million times the power of typical existing machines is required. The next suggests this should be available at reasonable cost in about ten years.

Section 3
The Growth of Processing Power

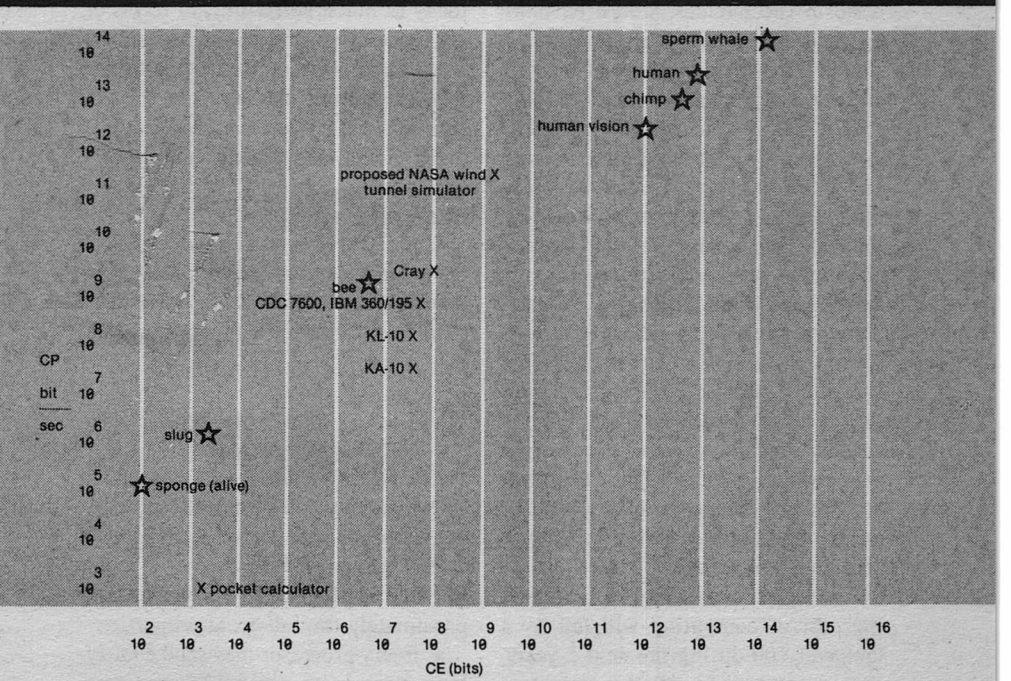
The references on p. 71 present, among other things, the following data points on a price curve:

The numbers indicate a remarkably stable evolution. The price per electronic switch has declined by a steady factor of ten every five years, if speed and reliability gains are included. Occasionally there is a more precipitous drop, when a price threshold which opens a mass market is reached. This makes for high incentives, stiff price competition and mass production economies. It happened in the early sixties with transistor radios, and is going on now for pocket calculators and digital wristwatches. It is beginning for microcomputers, as these are incorporated into consumer products such as stoves, washing machines, televisions and sewing machines, and soon cars. During such periods the price can plummet by a factor of 100 in a five year period. Since the range of application for cheap processors is larger than for radios and calculators, the explosion will be more pronounced.

The pace of these gains is in no danger of slackening in the foreseeable future. In the next decade the current period may seem to be merely the flat portion of an exponential rise. On the

immediate horizon are the new semiconductor techniques, I^2L, and superfast D-MOS, CCD for large sensors and fast bulk memory, and magnetic bubbles for mass storage. The new 16K RAM designs use a folded (thicker) cell structure to reduce the area required per bit, which can be interpreted as the first step toward 3-dimensional integration, which could vastly increase the density of circuitry. The use of V-MOS, an IC technique that vertically stacks the elements of a MOS transistor is expanding. In the same direction, electron beam and X-ray lithography will permit smaller circuit elements.

In the longer run we have ultrafast and efficient Josephson junction logic, of which small ICs exist in an IBM lab, optical communication techniques, currently being incorporated into intermediate distance telephone links, and other things now just



Compute Power and Energy of various devices. Scales are logarithmic. The Cray machine is an extremely fast and large scientific computer. The NASA simulator would probably be a general purpose computer 100 times as powerful as the biggest existing machines. It has not been designed yet.

gleams in the eye of some fledgling physicist or engineer.

My favorite fantasies include the "electronics" of superdense matter, either made of muonic atoms, where the electrons are replaced by more massive negative particles or of atoms constructed of magnetic monopoles which (if they exist) are very massive and affect each other more strongly than electric charges. The electronics and chemistry of such matter, where the "electron" orbitals are extremely close to the nucleus, would be more energetic, and circuitry built of it should be astronomically faster and smaller, and probably hotter. Mechanically it should exhibit higher strength-to-weight ratios. The critical superconducting transition field strengths and temperatures would be higher. For monopoles there is the possibility of combination magnetic electric circuitry which can contain, among many other goodies, DC transformers, where an electric current induces a monopole current at right angles to it, which in turn induces another electric current. One might also imagine quantum DC transformers, matter composed of a chainlike mesh of alternating orbiting electric and magnetic charges.

I interpret these things to mean that the cost of computing will fall by a factor of 100 during the next 5 years, as a consequence of the processor explosion, and by the usual factor of 10 in the 5 years after that. As an approximation to what is available today, note that in large quantities an LSI-11 sells for under $500. This provides a moderately fast 16 bit processor with 4K of memory. Another $500 could buy an additional 32K of memory, if we bought in quantity. The result would be a respectable machine, somewhat less powerful than the KA-10, for $1000. At the crude level of approximation employed in the previous section, a million machines of this type should permit human equivalence. A million dollars would provide a thousand of them today (a much better buy, in terms of raw processing power, than a million dollar large processor). In ten years a million dollars should provide the equivalent of a million such machines, in the form of a smaller number of faster processors, putting human equivalence within reach.

A roomful of isolated small computers is unlikely to prove very useful for our purposes. The next section suggests how to make them work together.

Section 4: Mega Processing

The following discussion is based on an interconnection system for computers described in a more technical version of this essay [Moravec], based on Batcher sorting nets, which has approximately the following properties:

- Every processor may send a fairly long message to any other processor about every quarter of a microsecond. The messages from all the processors are emitted in synchronized waves. A wave takes one microsecond to filter

through the interconnection net, causing there to be four waves in the net at one time.

- Each message includes a priority introduced by the sending computer.
- The network delivers to each processor the message with the highest priority addressed to it, if any. The processor sending each delivered message receives an acknowledgement, the processors whose messages were blocked by higher priority ones receive notices of failure.
- The amount of network logic per processor is small, and grows as the square of the log of the number of processors. This low growth rate ensures that even in a system of a million processors the cost of the interconnection is no greater than the cost of the processors.

A major feature of this scheme is its flexibility. It can function as any of the fixed interconnection patterns of current experimental multiprocessors, or as a hexagonal mesh, or a 7-dimensional cubic lattice, should that be desired, or the tree organization being considered in a Stanford proposal. It can simulate programmed pipeline machines, where numbers stream between units that combine and transform them. What is more, it can do all of these things simultaneously, since messages within one isolated subset of the processors have no effect on messages in a disjoint subset. This permits a very convenient kind of "time" sharing, where individual users get and return processors as their demands change.

Such mimicry fails to take advantage of the ability to reconfigure the interconnection totally every message wave. There are many applications, such as searching a tree of possibilities in reasoning or game playing where this could be used very effectively. Several existing programming languages can be extended to make this capability conveniently available to programmers.

Conventional programming languages consist of strings of commands and conditional commands to be obeyed by the computer. This type of programming can be extended to make reasonably convenient use of a parallel computer by providing means by which the programmer can specify that several strings of such commands can be carried out concurrently, and by providing large data objects such as arrays which are manipulated by operations that work on all the elements of the objects simultaneously. The high bandwidth of the communications net is required to transmit data manipulation commands to multiple parts of large structures (by a chain letter technique), and to pass program segments from processor to processor. [Moravec] contains many more details, and also suggests what may be a more elegant solution.

We will probably want the first versions of such a system to be able to serve several independent users simultaneously. The system's resources would be managed by the system monitor, a program running on several machines which maintains a pool of

free processors, and parcels them out on request, and which also handles file system requests (bulk storage would be connected to a handful of the processors), and allocation of other devices.

Processes belonging to a single user will be initiated by a particular master machine, probably the one connected to his console. This master can create a tree of subprocesses, possibly intercommunicating, running on different machines. It should be possible, for example, to do vision by having one subset configured as an array processor for efficient implementation of retinalike processing, while another is running an Algol/APL for the less structured analytic geometry needed to interpret the image, and yet a third is operating a Lisp system doing abstract reasoning about the scene. Many existing systems permit this kind of organization, but they are hampererd by having an absurdly small amount of computing power.

How is a system of this kind initialized, and how does one abort an out of control process taking place in part of it without affecting the rest? A possibility is to have an "exclusive" class of messages (perhaps signaled by a particular bit in the data portion), which user jobs are not permitted to emit. Reception of such messages might cause resetting of the processor, loading of memory locations within it, and starting execution at a requested location. A single externally controllable machine can be used to get things going, fairly quickly if it emits a self-replicating chain letter.

Now consider reliability. The system can obviously tolerate any reasonable number of inoperable processors, by simply declaring them unavailable for use. Failures in the communication net are much more serious, and under most situations will require the system to stop operating normally. It is possible to write diagnostic programs which can track down defective comparator elements or broken data wires. If something should happen to the clock signals to a given level it would be necessary to wheel out an oscilloscope. If reliability were a critical issue it would be possible to include a duplicate net, to run things while the other was being debugged.

Section 5
The Future

Suppose my projections are correct, and the hardware requirements for human equivalence are available in 10 years for about the current price of a medium large computer. Suppose further that software development keeps pace (and it should be increasingly easy, because big computers are great programming aids), and machines able to think as well as humans begin to appear in 10 years. If the cost of electronics continues to plummet beyond then (and the existence of increasingly cheaper and better robot labor, in addition to scientific and engineering improvements, should ensure that), an additional 15 years should bring equivalence into the pocket calculator price range. I also

assume that sensors and effectors for such devices will be able to match human performance, since even today's technology is able to supercede it in many areas. What then?

Well, even if these machines are only as clever as human beings, they will have enormous advantages over humans in competitive situations. Their production and upkeep is vastly less expensive, so more of them can be put to work with given resources. They can be easily specialized for given tasks, and be programmed to work tirelessly. Because we are not constrained to use any particular type of component in building them, versions can be designed to work efficiently in environments in which sustaining humans is very expensive, such as deep in the oceans, and more importantly in boundless outer space. Most significantly of all, they can be put to work as programmers and engineers, with the task of optimizing the software and hardware which make them what they are. The successive generations of machines produced this way will be increasingly smarter and more cost effective. Of course, there is no reason to assume that human equivalence represents any sort of upper bound. When pocket calculators can out-think humans, what will a really big computer be like? Regardless of how benevolent these machines are made, *Homo sapiens* will simply be outclassed.

Societies and economies are as surely subject to evolutionary pressures as biological organisms. Failing social systems eventually wither and die, and are replaced by more successful competitors, and those that can sustain the most rapid expansion dominate sooner or later.

I expect the human race to expand into space in the near future, and O'Neill's habitats for people will be part of this. But as soon as machines are able to match human performance, the economics against human colonies become very persuasive. Just as it was much cheaper to send Pioneer to Jupiter and Viking to Mars than men to the Moon, so it will be cheaper to build orbiting power stations with robot rather than human labor. A machine can be designed to live in free space and love it, drinking in unattenuated sunlight and tolerating hard radiation. And instead of expensive pressurized, gravitied, decorated human colonies, the machines could be put to work converting lunar material into orbiting automatic factories. The doubling time for a machine society of this type would be much shorter than for human habitats, and the productive capability would expand correspondingly faster.

The first societies in space will be composed of cooperating humans and machines, but as the capabilities of the self-improving machine component grow, the human portion will function more and more as a parasitic drag. Communities with a higher ratio of machines to people will be able to expand faster, and will become the bulk of the intelligent activity in the solar system. In the long run the sheer

physical inability of humans to keep up with these rapidly evolving progeny of our minds will ensure that the ratio of people to machines approaches zero, and that a direct descendant of our culture, but not our genes, inherits the universe.

This may not be as bad as it sounds, since the machine society can, and for its own benefit probably should, take along with it everything we consider important, up to and including the information in our minds and genes. Real live human beings, and a whole human community, could then be reconstituted if an appropriate circumstance ever arose. Since biology has committed us to personal death anyway, with whatever immortality we can hope for residing only in our children and our culture, shouldn't we be happy to see that culture become as capable as possible? In fact, attempting to hobble its growth is an almost certain recipe for long term suicide. The universe is one random event after another. Sooner or later an unstoppable virus deadly to humans will evolve, or a major asteroid will collide with the Earth, or the sun will go nova, or we will be invaded from the stars by a culture that didn't try to slow down its own evolution, or any number of other things. The bigger, more diverse and competent our offspring are, the more capable they will be of detecting and dealing with the problems that arise.

For the egomaniacs among us there is another possibility. The main problem in keeping up with the machines is that we evolve by the old DNA + nucleated cell + sex + personal death method, while our machines evolve by the new improved intelligence + language + culture + science + technology technique, which is so very much faster that our biology seems to stand still in comparison. If we could somehow transfer our evolution to the faster form, we should be able to hold our own.

At first thought genetic engineering might seem to be the key. Successive generations of human beings could be designed by engineering mathematics and on the basis of computer simulations just like airplanes and computers are now. But this is just like building robots out of proteins instead of metal and plastic. Being made of protein is in fact a major drawback. That stuff is stable only in a narrow temperature and pressure range, sensitive to all sorts of high energy disturbances, and so on, and rules out many construction techniques and components. Is there some way to retain our essential humanness, at least temporarily until we think of something better, while transferring ourselves to a more malleable form?

Imagine the following process (meant to suggest a variety of ways such a thing could be done). You are in an operating theater, and a brain surgeon (probably a machine) is in attendance. On a table next to yours is a potentially human equivalent computer, dormant now for lack of a program to run. Your skull, but not your brain, is under the influence of a

local anaesthetic. You are fully conscious. Your brain case is opened, and the surgeon peers inside. Its attention is directed at a small clump of about 100 neurons somewhere near the surface. It examines, nondestructively, the three dimensional structure and chemical makeup of that clump with neutron tomography, phased array radio encephalography, etc., and derives all the relevant parameters. It then writes a program which can simulate the behavior of the clump as a whole, and starts it running on a small portion of the computer next to you. It then carefully runs very fine wires from the computer to the edges of the neuron assembly, to provide the simulation with the same inputs the neurons are getting. You and it both check out the accuracy of the simulation. After you are satisfied, it carefully inserts tiny relays between the edges of the clump and the rest of the brain, and runs another set of wires from the relays to the computer. Initially these simply transmit the clump's signals through to the brain, but on command they can connect the simulation instead. A button which activates the relays when pressed is placed in your hand. You press it, release it and press it again. There should be no difference. As soon as you are satisfied, the simulation connection is established firmly, and the now unconnected clump of neurons is removed.

The process is repeated over and over for adjoining clumps, until the entire brain has been dealt with. Occasionally several clump simulations are combined into a single equivalent but more efficient program. Though you have not lost consciousness, or even your train of thought, your mind has been removed from the brain and transferred to the machine. A final step is the disconnection of your old sensory and motor system, to be replaced by higher quality ones in your new home. This last part is no different than the installation of functioning artificial arms, legs, pacemakers, kidneys, ears and hearts and eyes being done or contemplated now.

Advantages become apparent as soon as the process is complete. Somewhere in your machine is a control labeled "speed." It was initially set to "slow," to enable the simulations to remain synchronized with the rest of your old brain, but now the setting is changed to "fast." You can communicate, react and think at a thousand times your former rate. But this is only a minor first step.

Major possibilities stem from the fact that the machine has a port which enables the changing program that is you to be read out, nondestructively, and also permits new portions of the program to be read in. This allows you to conveniently examine, modify, improve and extend yourself in ways currently completely out of the question. Or, your entire program can be copied into a similar machine, resulting in two thinking, feeling versions of you. Or a thousand, if you want. And your mind can be moved to computers better suited for given environments, or simply technologically improved,

far more conveniently than the difficult first transfer. The program can also be copied to a dormant information storage medium, such as magnetic tape. In case the machine you inhabit it is fatally clobbered, a copy of this kind can be read into an unprogrammed computer, resulting in another you, minus the memories accumulated since the copy was made. By making frequent copies, the concept of personal death could be made virtually meaningless. Another plus is that since the essence of you is an information packet, it can be sent over information channels. Your program can be read out, radioed to the moon, say, and infused there into a waiting computer. This is travel at the speed of light. The copy that is left behind could be shut down until the trip is over, at which time the program representing you with lunar experiences is radioed back, and transferred into the old body. But what if the original were not shut down during the trip? There would then be two separate versions of you, with different memories for the trip interval.

When the organization of the programs making up humans is adequately understood, it should become possible to merge two sets of memories. To avoid confusion, they would be carefully labeled as to which had happened where, just as our current memories are usually labeled with the time of the events they record. This technique opens another vast realm of possibilities. Merging should be possible not only between two versions of the same individual but also between different persons. And there is no particular reason why mergings cannot be selective, involving some of the other person's memories, and not others. This is a very superior form of communication, in which memories, skills, attitudes and personalities can be rapidly and effectively shared.

The amount of memory storage an individual will typically carry will certainly be greater than humans make do with today, but the growth of knowledge will insure the impracticability of everybody lugging around all the world's knowledge. This implies that individuals will have to pick and choose what their minds contain at any one time. There will often be knowledge and skills available from others superior to a person's own. The incentive to substitute those talents for native ones will be overwhelming most of the time. This will result in a gradual erosion of individuality, and formation of an incredibly potent community mind.

A pleasant possibility presents itself. Why should the mind transferral process be limited to human beings? Earthly life contains several species with brains as large as or larger than man's, from dolphins, our cephalic equals, to elephants and the large whales, and perhaps giant squid, with brains up to twenty times as big. If the technical problem of translation can be overcome, and it may be quite difficult for squid, in particular, since their minds are evolved entirely independently, then our culture could be fused

with theirs, with each component used according to its value. In fact, a synthesis of all terrestrial life is desirable with the simpler organisms contributing only the information in their DNA, if that's all they have. In this way all the knowledge generated by terrestrial biological and cultural evolution will be retained in the data banks, available whenever needed. This is a far more secure form of storage than the present one, where genes and ideas are lost as species become extinct and individuals die.

We now have a picture of a superconsciousness, the synthesis of terrestrial life, and perhaps jovian and martian life as well, constantly improving and extending itself, spreading outwards from the solar system, converting nonlife into mind. There may be other such bubbles expanding from elsewhere. What happens when we meet another? Well it's presumptuous of me to say at this tender stage of the evolution, but fusion of us with them is certainly a possibility, requiring only a translation scheme between the data representations. This process, possibly occurring now elsewhere, might convert the entire universe into an extended thinking entity. ■

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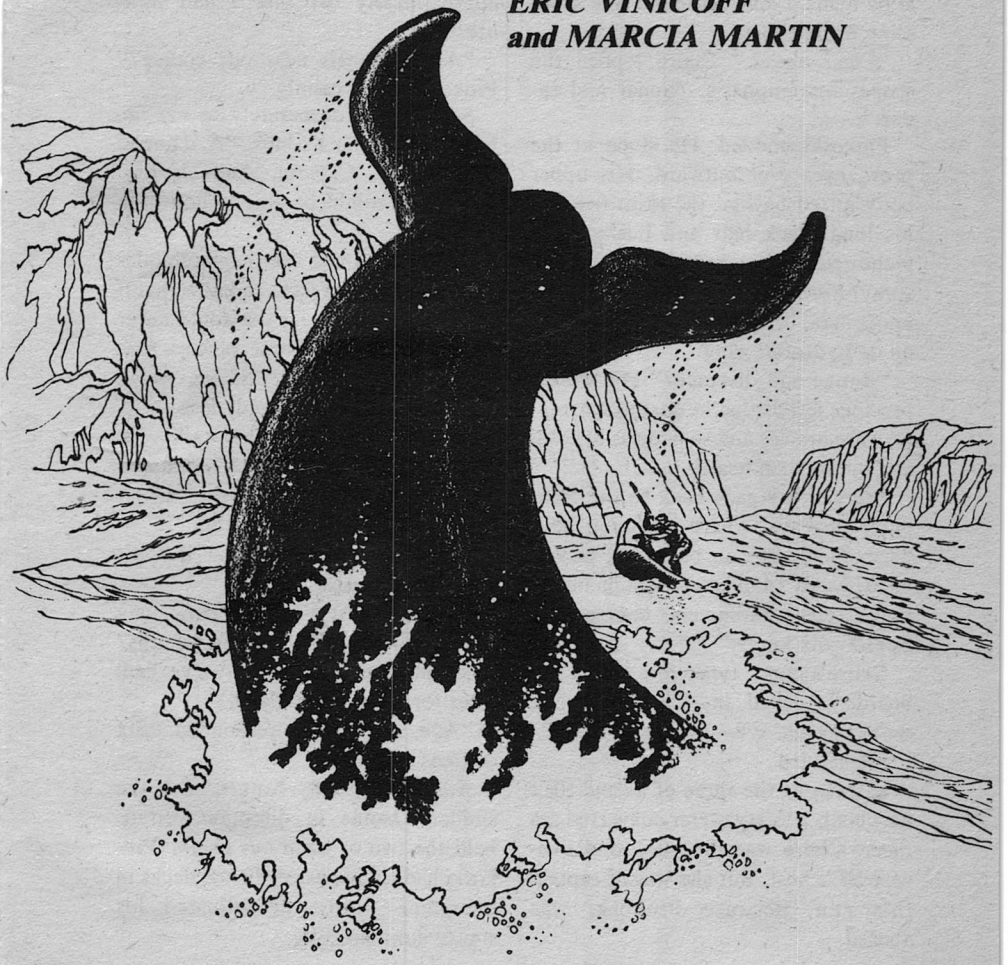
The struggle between Man and Nature is altered by technology— but not abolished.

ERIC VINICOFF and MARCIA MARTIN



Jack Gaughan

It was cold beyond the skim field, starry clear, knifing antarctic cold. Killing cold, and it had claimed its due enough times to earn the name. Large bergs floated near the horizon, black cutouts against the faint 'northern lights'. Water ran freely around the hull, but bergy-bits shattering on the alloy made a musical sound like shoveling broken glass.

"Clear ahead." Claire tapped the scopes for emphasis. "Sonar and radar."

Pinkoski nodded. He stood at the prow, eyes ever outward. His upper body jutted beyond the skim field, so his long black hair and bushy mustache were attacked by wind and spray. *Rorqual* was cruising at its fifty knots max, lifted half out of the water on its hydrofoil wing.

"Range and distance?" His words, precious jewels that he shared sparingly, were precise and so deep as to seem felt rather than heard.

I jerked my gaze back to the computer displays, where it should have been. "Fade out on buoy A6, pickup on B13 and 14. That programs out to range thirty kilometers, course 233. Speed—six knots."

Claire's hands typewrote across her board. "Locked in, Chan. Captain, we're closing. ET—twelve minutes."

He nodded.

It was just the three of us and SE's best boat, a thirty meter converted sea racer. Claire was the pilot, and likewise SE's best. But she wasn't captain this run, because Pinkoski was aboard.

Me? I had been happily monitoring fish tracking buoys at Cal Tech's Hilo station when SE bought my contract. Then I was dropping buoys from a jetcopter in a wide grid of antarctic waters. Finally I ended up here.

"Bergs ahead!" Claire shouted. "Range three kilometers! Intersect in approximately two and a half minutes!"

"Any channels near our course?" Pinkoski asked calmly.

She wanted desperately to say no, but couldn't lie to him. "A damned narrow one, Captain. And shallow, though we might be able to hop it on the wing."

I shivered. I had heard enough tales of antarctic shipwrecks to know that if we went up on the ice we would never get home to spend our hazard pay. "Captain," I cut in, "if we swing around the bergs we'd only lose—"

"Time, and maybe the trail." He turned to look at me briefly, and saw down to my bedrock of terror. "Don't worry, lad. We'll come through it."

I was almost convinced. "But it's not worth the risk."

"Bloody blast it's not! How long have we been out? Five, six months? And this the only strike we've had! Veer for the channel, lass!"

"Aye, aye," Claire responded. "Six degrees to port."

Rorqual actually banked with the sudden change in direction. Straps held the two of us in our chairs. Pinkoski had ridden wave-slicked decks in hurricane winds; he adjusted his stance automatically.

The bergs ahead began to swell. They were flat-topped, indicating that they had but recently broken off from the great ice sheet covering Antarctica. When they aged, they would resemble Norman fortresses with many turrets and spires.

A pencil shaft of night between two of them also grew, but not quickly enough. Claire hyped the turbines to emergency, and *Rorqual* rose even higher. The normal slight bouncing of the hull against wavelets became triphammer pounding that loosened teeth. Yet Pinkoski didn't return to the cockpit.

Claire looked frankly scared. I'm sure I did too.

"Fifteen seconds to intersect!" she shouted.

"Keep a weather eye on your displays," Pinkoski said to me over his shoulder. "I don't want to lose the trail during the passage. It may be a bit rough."

That, from him, was like a pronouncement of doom.

The bergs reached from sea to sky in front of us, and the channel was still microscopic. Ice dark with volcanic ash towered a hundred meters or more. Thunder rolled across the water as it cracked internally, and small flat pieces slid down from the main masses to form growler bergs.

Spray was an all but solid sheet battering the boat and Pinkoski. Even with adhesive deck shoes I couldn't see how he kept from being knocked overboard. But there he stood, vague

in the night, as implacable as the immense shapes he faced.

"Five seconds!" Claire's voice broke. "Brace for possible collision!"

Then we were in the channel, moving so fast that the icy walls were a close rushing presence.

"We're clear below," Claire whispered, "but the cliffs are so irreg—"

CRAAAAANG!

I waited for the world to go away. The sound and feel of ice tearing through metal was a terrible thing that shredded the soul. But seconds later, finding myself still alive, I opened my eyes.

Pinkoski was gone from the prow.

I looked around wildly, unbelievingly. We were beyond the bergs, in open water again, and floating in the silence of stilled turbines. Claire was frantically struggling with her emergency systems board. She had no time for anything else, not even the blood flowing down her cheek from a long scalp wound.

Strange creaking noises were coming from below, and I imagined I could feel the boat settling. I didn't bother her.

"Bloody blast this misbegotten patch of bilgewater!" The faint words drifted up from beyond the deck about five meters back from the prow on the starboard side. I stared, and made out two black-gloved hands hanging onto the railing. As I watched, Pinkoski pulled himself back on board. His black warmsuit dripped profusely, and his face stretched with effort into strange ridges and valleys. The skim field didn't make his task any easier.

I realized with shock that he was *old*.

I wobbled over to help, but he made it up before I reached him. His worn face was sweaty but welded into its usual grim mask. "Jesus," I babbled, "you were almost—"

He pushed by me and jumped down into the cockpit. "How badly are we breached?" he demanded of Claire even as he read the displays over her shoulder.

She wiped blood away from her right eye. "Took a hit starboard, tore us open along three meters of seam. Pumps at full, but losing ground. We're taking water fast."

"How about patching it, lass?"

"Too big for the autopatch system, and welding one on from either inside or outside would take a day in drydock."

"What does that leave?"

She punched a button marked EMERG FLOTATION—STARBOARD BILGE. A dull thud shot through the hull, and *Rorqual* rose and righted itself. She scanned the displays again and began trembling. "We're okay now, I think."

I pulled the med kit from under her chair and did what I could for her cut. Meanwhile Pinkoski went below to make sure the pressurized gasbags were holding against the water and not abrading on torn hull alloy. I could hear plastic foam gurgling into the bags. When it hardened in a few minutes we would be safer.

He quickly rejoined us, but Claire

had managed to get the turbines idling in the interim.

"We'll float," he reported.

"Good," I said. "Just as long as it gets us home."

"All in good time, lad. Get back to your board and find me my whale."

I couldn't believe it. "This isn't a jihad, Captain. We can go home, refit and come back. We'll find another one."

He came over and stared at me. I was *homo urbanis* and had encountered many tough city dudes. But they were civilized tough, artificial and therefore vulnerable. Pinkoski had a different type of toughness; salt and sea, wind and water. Unstoppable. "We're seaworthy. Get back to your board."

I wilted. The computer was still working, sad to say. "It's still out there, Captain. Near the surface. It just came up from a deep dive, so I think it'll play on top a bit. Range three kilometers. Course 059."

Claire set up a course on her board. Her eyes were shining, and there was no question in her. The way she looked at him said it all.

"I want that whale," Pinkoski said to no one in particular. "It's one of the last. The hunt is up, after so many searching years. I'll have it ended. Now."

Rorqual jumped ahead and climbed on its wing, which had somehow come through the crash intact. A small boat in a big, big ocean.

Pinkoski went back to the stern bay and unlatched it. "We've got to close before it dives, lass."

"We will," she promised.

This was all crazy. We didn't belong here, and wouldn't be here but for an old seaman who had given his life to a dream, and another old man who owned Santee Enterprises and could lend substance to any dream he shared.

Out there somewhere in the black water swam their dream. *Balaenoptera musculus*. The great blue whale. Largest living being ever on Earth, at the doorway leading from reality to myth.

The one out there probably wasn't the last. Estimates put the survivors at a few dozen. But this would be the last generation. They wandered individually in vast migratory paths, and mated when males encountered females. With so few left, it wasn't likely any would so meet.

Thus the dream. The last hunt.

"ET one minute!" Claire shouted. "Slowing to stalk!"

Pinkoski began pulling equipment from the bay. He donned a black plastic headlamp and goggles. The jetski was heavy, but he managed to manhandle it to the stern, ready for jump-off.

Finally he drew the harpoon from its nest of electronic gear. It sang of cold silver pain in the reflected cockpit light. It was long and spectrally slender in the shaft, with an icepick tip and a stubby haft. I winced.

Like everything else out here, SE's best. This obsession was costing Mister Santee big bucks. That didn't

bother me, but throwing lives into the pot did.

The turbines slowed until *Rorqual* moved ahead at a mere crawl. "Thar she blows!" Claire shouted. "Ten points to starboard!"

The big prow searchlight flared to life and swung around under sonar slaving. A thin wedge of ocean was dimly illuminated, a stage in the center of the night.

And there it was. A long, low, mottled blue-gray island flippering slowly away from us. It spanned over thirty-five meters from black baleen to flukes. White showed on the undersides of the flippers, and the tiny dorsal fin was barely visible. Spray shot up from its blowhole.

But the main thing was it was *big*. Bigger than any other whale, and I had seen some huge ones up close during my studies. Humpbacks. Right whales, so called because they were the ones the whalers were looking for. Sperm whales.

But this was their king, last and greatest, hunted into oblivion to the shame of humanity. I recognized it from photos, of course—of us only Pinkoski had even seen a living blue whale, fleetingly and far away, from the deck of the *James Bay* just before the accident that focused his life.

"Beautiful," he whispered, and I barely heard him over the lapping of water against the hull. "At last . . . an ending."

He moved the harpoon thoughtfully, staring at it, into the jetski's rack. Then he swung into the saddle.

"Luck, Captain!" Claire waved frantically.

It should have been ludicrously melodramatic. Ahab after his whale. Gary Cooper striding out to his gunfight. Only it wasn't. Loneliness and desperation clotted the air. Why was he here, really? Claire and I couldn't ever know, and that left us on the outside. Alone in an environment that hated us. A part of someone else's destiny. Trapped.

He kicked the jetski and himself over the side, splashing into the water then bobbing back up. He said nothing to us. We were out of it now.

The whale was diving, then rising again several hundred meters further away. Claire moved *Rorqual* slowly to keep up. Wanted or not, we would see what there was to see.

Pinkoski rode the jetski in a wide arc to come up on the whale's port flank. The tiny craft almost disappeared in the broth of wake the flukes kicked up.

A commercial deck gun could have blown a harpoon into the whale from up to two kilometers away. But this harpoon had to be planted in exactly the right place. Which required precision.

Proximity.

Confrontation.

Which might have been a part of the white-heat in Pinkoski.

"He's making his run," Claire said unnecessarily.

I nodded. He was a small figure in the distance, frail and pointless, coming up alongside the great whale. It

ignored him. How could it know the transcendental power of human emotion.

The harpoon came out of its rack, rose high in his right hand while his left remained on the jetski's handlebar. That right hand—and arm—seemingly normal, was a prosthesis, no less artificial than the harpoon. It formed an electromechanical symbiosis between technology and biology, between weapon and wielding flesh.

Two young men had been aboard the *James Bay* during its days of heroism, a seaman and an industrialist, diverse types brought together by ideals. In the midst of the struggle, between trawlers and prey, a lifelong friendship began. One lost an arm when a steel prow sheared through a wooden lifeboat. The other replaced it as best he could.

Pinkoski closed until the side wake of the whale threatened to knock him from the saddle. He came to within meters of the patch of parasite-covered hide that had been selected for the lack of vital organs under it.

Suddenly the whale's broad head dipped beneath the water. Up came the twin-mattress tail. It was about to dive.

Pinkoski stood up on the jetski's footrests. The harpoon cast a last gleam of light back our way. Then he flung it into the whale's flank.

The whale slid under its white wake. Froth slammed the side of the jetski. Before Pinkoski could sit down or regain his balance, it tipped over.

Pinkoski vanished.

The tail came down flat on the jetski. A cracking sound reached us. Then everything was gone from the surface of the ocean.

Claire and I just kept staring.

Something started beeping on my board. Flashing redness caught the corner of my eye.

Pinkoski wasn't there anymore.

Then I noticed the sound and light. I pointed to the board. Claire saw, and dully locked in a new course. We were acting instinctively. Routine was an escape from thought.

Rorqual swung to port and closed on the source of the radio beacon signal.

I took a boathook to the prow and stared down. The big searchlight had targeted the flotation balloon for me. I speared it with the hook.

Pinkoski was gone. The last part of his hunt was left to us.

Claire killed the turbines.

I hauled the balloon aboard, then reeled in the line hanging from it.

Up came the harpoon.

I used my pocket vibraknife to cut it free from the line. I shivered at its cold metallic touch. The ocean had wiped it clean of blood. I looked it over. Everything seemed to have gone perfectly.

Except for one detail.

I detached the tip, and also the haft which was now hollow since the flotation balloon had ejected and pulled the harpoon out of the whale. That left about two meters of glistening silver shaft. I checked a tiny indicator on one end—it was glowing green.

"How does it look?" Claire was

staring over my shoulder.

"The cryo-unit light is green. I think it's a go."

"Great." But she said it with no enthusiasm.

I walked slowly sternward to the equipment bay. The harpoon unit was purely a temporary measure. I slid the shaft back into its electronic auxiliaries, made the necessary connections and nodded when green lights flashed amid the gear. The boat computer had taken over caring for our prize.

"Ahoy there! Did you net it?"

Claire and I whirled. She stifled a scream, then began crying softly. I almost had a heart seizure.

Pinkoski, streaming water but apparently in one piece, was pulling himself over the deck railing. If he had looked old before, he now resembled death resurrected. But he stood rigidly upright. His voice was controlled.

"How—?" I choked. Even a warmsuit couldn't save a person from that much time in 6° centigrade antarctic water. Not to mention the battering he must have taken from the flukes, or the time spent underwater.

Claire rushed him into the cockpit. He refused first aid, but let her make him a cup of coffee.

"You haven't answered my question," he said to us.

"We got it," I replied as I studied my board. "And the whale is about 250 meters below us, alive and well."

"Good."

He took the steaming cup from Claire and put it to his lips. "Then it's time we set a homeward course."

I nodded gratefully. Claire returned to her board and began plotting a safe route back through the bergs. I stared at Pinkoski as he stared out at the dark water. All I could figure was that he gripped life a lot tighter than the rest of us, and therefore was that much harder to kill.

"Fare you well," he said to the deeps. "Live in peace. You won't be the last. Your children will live as long as there are oceans."

So they would. The thousands of its living cells in the cryogenically preserved sample would go to the SE genetic labs. DNA would be subtly altered to produce chromosome chains for both sexes and the many trait differences that made up a genetic pool. Clones would be raised in neoembryonic fluid tanks to young adulthood, then introduced with care into their natural environment. Now that they would face only natural dangers—whaling was a part of the bad old days—they would grow and multiply.

The greatest living beings on Earth would survive.

Rorqual swung around and rose on its wing, rushing northeast, toward home.

I smiled weakly at Pinkoski. "Now what?"

"For me?" He laughed—a deep, rich music I hadn't heard before. "There are other species in danger of being lost. Other whales. Porpoises. Even fish. We'll be back, lad."

If he meant we as in me too, he was crazy. Or was he? ■

A COMPUTER THAT WRITES SCIENCE FICTION

Why shouldn't science fiction writers practice what they preach?

Paul J. Nahin

I write science fiction. I've written, as near as I can figure, at least one hundred short stories and science fact articles over the last ten years. My tens of thousands of words have passed through the hands of editors like Campbell, Bova, White, Pierce, Ferman, Scithers, Baen, Ryan— the list is nearly endless.

What's that, you ask? Who *am* I? You've never heard of me?! Well, maybe that's because I haven't sold a hell of a lot of those efforts so far. But I'm still trying. I may be fat, nearsighted, developing dandruff in my beard, and going bald, but I'll tell you one thing—I don't give up! Now, there *is* a perfectly good reason for why this track record of mine isn't as terrific as it might be. I hate to type. Yep, that's right, the sight of a typewriter makes me feel woozy, even nauseous. Because I know all about the typos, faded ribbons, crooked margins, and other horrible nasties that live in my typewriter. I've met them often. Many a story of mine has been ruined, not because it had a rotten idea, or dumb science, or stupid characterization, or moved along at a pace of a feather through molasses, but because of that damn typewriter. Let me tell you something: Spider Robinson's secret isn't that he's a good writer (and he certainly is), but I suspect he's also a whiz at typing.

On the other hand, I don't want you

to think I'm a *complete* slouch as a storyteller, because then you might just ask yourself, "Why should I bother reading the rest of this—this guy doesn't have any credentials!" An event of epic proportions (hang onto your seat, now) occurred recently when Ben Bova at Analog published my first story in the April 1978 issue. Well, maybe that's a slight overstatement, but *I* thought it was important. I mention this *only* as encouragement (I'm no braggard, nosir) to all hopeful SF writers who have nothing but rejection slips. One recent, bitter New Hampshire winter I warmed my entire house for a week by burning all my slips, with only an occasional log, so don't feel alone. Okay, where was I—oh, yes, the despicable nature of typewriters.

To be honest, I don't even know *how* to type. I hunt and peck with one finger, and Lord is that boring (and painful). I don't spell too well, either. It takes me *hours* to get a page done. For a while there, I had my wife typing my stories, but after a string of five straight rejections, I got a sixth one—from my own wife. So there I was, rejected by the woman who had promised to love, honor, and obey me, with story ideas burbling out of my ears, and no way to get them on paper. Talk about frustration.

And then—a solution! By profession, I'm "normally" a computer engineering professor in a university electrical engineering department. My life is filled with video terminals, magnetic tape transports, line printers and such. One of our computers is a HUGE machine (made by DEC, Digital Equipment Corporation, in Maynard, Massachusetts) called a DEC-system-10/80. This computer is a *time sharing* system, which means that many people, with as many different problems, can be working at separate terminals simultaneously. Each thinks he's receiving individual attention. Actually, the computer is very rapidly giving each terminal a few milliseconds of computational service and then moving on to the next guy. It all happens so fast, everyone thinks *he* is the only one in the system. At my university, we have over one hundred terminals (some are typewriterlike devices called DECwriters, which remind me too much of the monster I have at home, and others are televisionlike video terminals). All of these terminals have keyboards that look just like one on an electric typewriter, plus a few additional keys.

The DECwriters do have the feature of giving you an immediate, permanent copy of everything you type, while, of course, the video terminals don't. For several reasons, however, which I'll elaborate on later, I think the video terminals are the ones to use when writing stories. A video terminal screen fills up from top to bottom, and once filled, new lines of text appear at the bottom, i.e., the screen display scrolls upward.

Let me give you some numbers to show you how big this machine is. The builders of the pioneering computers, like ENIAC, were pleased as punch with

a capacity of one thousand bits of high-speed memory (vacuum tubes). In those days, "high-speed" meant the computer could perform an addition in several milliseconds. "My" DEC-10 has over thirty-six *million* bits of high-speed memory (magnetic cores), and its addition time is measured in *micro*seconds. Not impressed? Well, it has a somewhat slower, second-level memory of magnetic disk (which is still pretty fast) of nearly fifteen *billion* bits! Finally, by using a special form of magnetic tape storage (called DECtape), I can stash away an almost unlimited quantity of data, and later quickly recall any part of it into the main computer memory for processing. *Still* not impressed? You're beyond hope—I'll bet the end of the world would leave you with a yawn!

What's all this got to do with the solution I mentioned? I'm getting there—just hang in for a bit longer.

One day not so long ago, one of my graduate students brought the first draft of his Masters thesis to me. I was astounded. It wasn't a pile of incoherent scribblings on coarse ruled paper (the kind where the ink spreads out along the fibers), but a beautifully typed job, with numbered pages on pure white, smooth paper. As I held this *first draft* in my hands I knew something new had come into my life. I played it subtle (after all, I was the prof and didn't want to look ignorant or stupid to my student). "Holy Cow! This is fantastic, I've never seen such a super looking first draft! Quick, tell me how you did this, please!"

And that's how I learned all about RUNOFF, the DEC computer program that writes all my stories now. Well, actually I still *write* the stories, but only to the point where I have the words down on paper. But no magazine editor will look at what, at that point, is a mess beyond description. What RUNOFF does is take my miserable pile of paper (covered, of course, with golden words, even if they *are* unreadable) and makes it *look* good.

That's how I solved my typing problem. And not only that, using RUNOFF is fun. I get as big a kick out of doing the final, mechanical part of the manuscript preparation as I do from writing the story in the first place.

At all times my stories are in the computer's memory (when I last looked, there were nine roosting on DECtape, and five in disk memory), which means I don't have to put up with piles of paper all over my office (it's *already* a mess). With a single computer command, any time I get the urge, I can get a fresh, "original" printout of any story. This means I eliminate all chance of losing a story in the mail when I send an editor an "original," and I no longer have to spend time dumping dimes into a photocopy machine. But best of all, I can *edit* a story under computer control. Typos, left-out words, last minute changes, or rewrites after an editor turns thumbs-down on a story, are no problem. They're *easy* to do. In fact, I often chuckle with glee when I find a mistake because it's *fun* to make it go

away! Who would believe it!

Of course, I still have to *type* a story—but here we run into an interesting psychological phenomenon. When, in the dim past I used to hunch over my typewriter, I was nervous, irritable, twitchy, and *scared*! My God, what if I made a mistake! I'd have to stop, roll out the paper a bit, erase the mistake (thus creating a sickening smear), and then, finally, roll the paper back in. Naturally the erasing operation caused the paper to slip slightly on the carriage roller, causing the rest of the line to be offset. And the line would then be too close (or too far) with respect to the one above it. But with the computer, there are no permanent commitments. So now I'm relaxed, calm, and collected.

By now I hope I've got you screaming, "All right, already, you outsmarted the typewriter. But *how* does this clever program do its trick?" Okay, I'll tell you. I'm going to show you how a short story evolves from a disgusting looking mess to a beautiful, finished manuscript, ready for the appreciative eye of a grateful editor. The first thing you've got to do is rid yourself of the common idea that computers are just number crunchers. Au contraire! They are *information processors*. And RUNOFF processes *text* information, i.e., it manipulates *words* like you wouldn't believe.

To avoid having this article end up reading like a computer user's manual (they have their place—the computer center—but they're awfully dry), I want you to imagine the following scenario. You have a completed story, written in sloppy longhand, and you have access to a DECsystem-10. You walk down the hall from your office to the comp center, spot an *unused* video terminal (this is the hardest step!), and pull up a chair. A few seconds after you punch the power-on button, the terminal screen lights up and you're now ready to connect the terminal to the computer. To grab the computer's attention, you type Control-C, a two finger operation done by holding down a special key labeled CONTROL, and then hitting the C key.

The only thing visible on the screen at this point (besides all the preliminary system status stuff automatically printed by the computer), is a period at the left-hand side. This is called the "monitor-dot," and it's the symbol prompter to you that a special program called MONITOR is watching your terminal and waiting for you to do something. What you do is type LOGIN and then a carriage return with a line feed (this last double operation is actually done by hitting a key marked NEW LINE, which I will indicate from now on with the notation [NL]). The computer then asks you for your public user number which it checks against a table of numbers it stores in its memory, and also for a secret password which only *you* know (it's easy to change, right on the computer, by yourself, if you ever think it has been compromised). If the computer accepts the fact that you are who you claim you are (i.e., you typed the right password to go with your user num-

ber), it prints a standard message on the screen telling you how long you can stay on the system. Usually, you can stay on for one hour, sometimes two (depending on the level of use)—if you don't sign off the system within this alloted time, another special program, called CHARON, will automatically disconnect your terminal, a process which may result in total destruction of the text information you have painfully typed in. To really appreciate the significance of this program's effect, notice that it is named after the mythological ferryman who transports the dead over the river Styx to the Gates of Hades! The programmer who wrote CHARON must be a lot of fun at a party.

Okay. You are now on the system, looking at another monitor dot, and all set to go—you ask the computer to put you into the *text editor* program. The text editor, itself, does absolutely no computation in the usual sense—no square roots, hyperbolic functions, matrix inversions, or other neat things like that. Its job is to accept text information directly from the video terminal keyboard. It accepts literally *anything*, and it makes no decisions about whether or not your typed input makes "any sense"—that judgment is made later when the text editor passes your input along to whatever follow-up (like RUNOFF) is going to be *doing* something with the text.

One of the most popular text editors around is called SOS, and is the one I use (SOS stands for "Son of STOPGAP," where STOPGAP was an earlier text editor created as a stopgap measure until SOS could be developed in its final form). Two of the best sources of information on SOS are *The SOS User's Guide*, a monstrous thing prepared by the Harvard Business School (121 pages of mind-boggling detail), and a witty little pamphlet called *The Nitwit's Guide to SOS*, available from the University of Oregon's computer center.

You get access to SOS by typing, in response to the monitor dot, R SOS [NL], which tells MONITOR to retrieve SOS from its system program file. After the few seconds that it takes to get SOS operational pass, your terminal is handed off by MONITOR to SOS, which then prints FILE: on the screen. What SOS is doing is asking you for the *name* of your input text file. All text inputs must have a file name, for the obvious reason—the next time you get on the system, it would be impossible to tell the computer which text file you want without a name. As I mentioned earlier, for example, I normally have about a dozen files that I'm working on, at any given time. You can call your file anything you want, but because we're doing a science fiction story, let's call it DINNER (and that's what you type after the colon, followed by [NL]). If that strikes you as a strange name, good—read on, read on! All will be explained. As another example, when I was writing this article its text file was named SFA (for "science fact article").

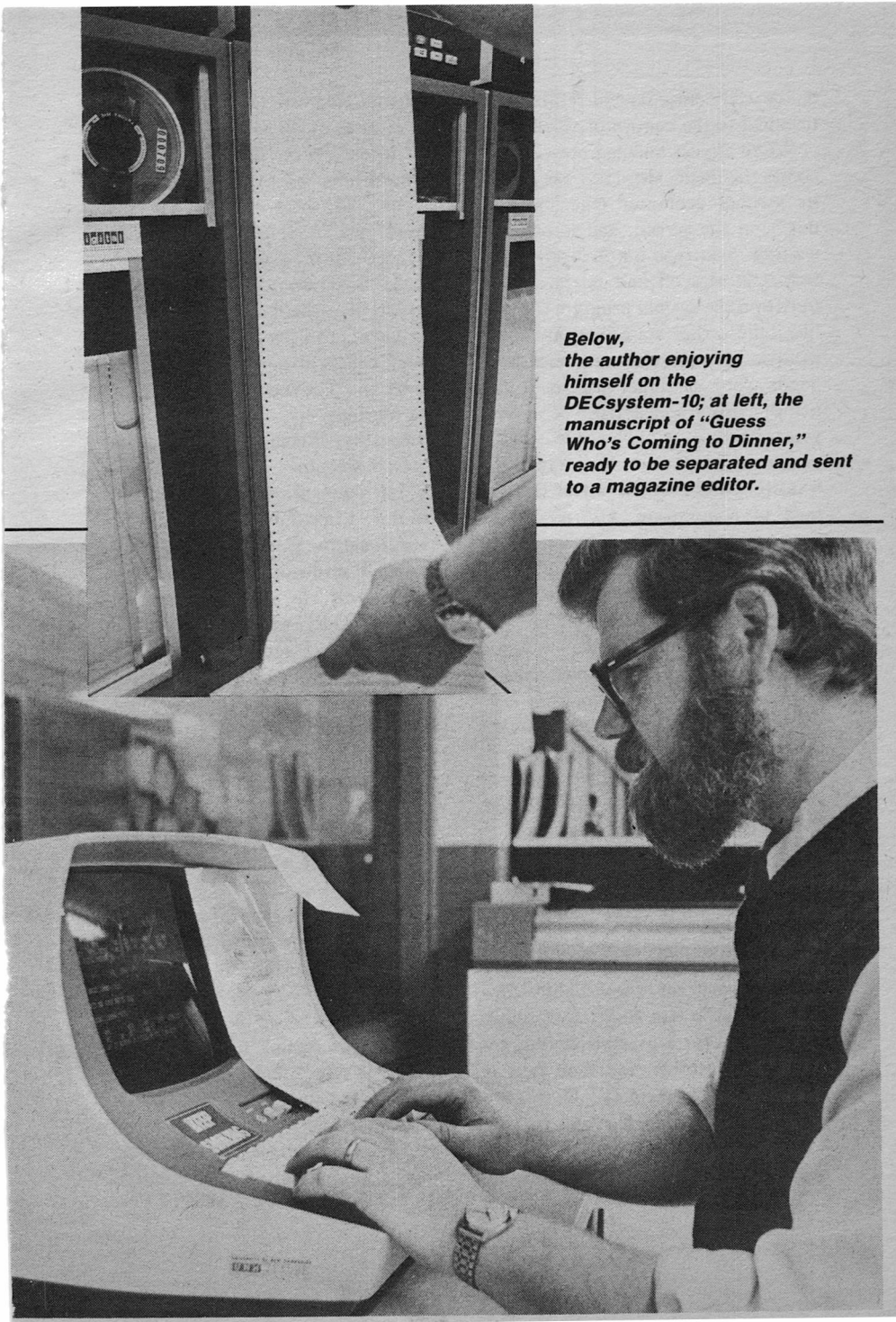
Since DINNER is a brand new file,

SOS begins by printing the first line number of the file, 00100 (all SOS files are line numbered in steps of 00100, starting with 00100), at the left edge of the screen. If DINNER was an old file, and we were retrieving it for more work, SOS would *not* print 00100, but instead would display its prompter symbol, an asterisk, which is similar in intent to the monitor dot—SOS would be telling you it is waiting for you to do something. That something could be, for example, the addition of new text, the deletion or replacement of old text, the creation of a display on the screen of the existing file text, or one of many other options. But, at this point, DINNER is a new file, so you are looking at 00100 on the screen. you begin to type your story. After the first line of text gets over to the right edge of the screen, and you hit the NEW LINE key, SOS prints the next line number, 00200, and waits for you to start typing again.

The line numbers serve a function *within* a text file similar to the file name, i.e., later, when performing computer controlled editing, the line numbers let you tell SOS *where* in the file you want to edit.

Now, this is where you get a real treat. Not only is this a science fact article, but you also get to read a terrific story. If you'll flip your eyes over to page 105, you'll see a hardcopy, line printer listing of the SOS text file called DINNER, which contains the short-short named "Guess Who's Coming to Dinner?" The story itself actually begins at line 01600 and all the stuff before that is to keep the magazine editor happy (and me, too, because without it I don't get paid!)—I'll explain all that in just a bit. Right now, just read the story (and forget all the strange symbols scattered about in the text—I'll explain *them* later, too). As a final comment on the story, while I can't understand how you couldn't like it, that really isn't the point here—what actually counts is the *technical detail* (all the strange symbols) that will eventually produce a manuscript attractive in appearance.

You're all done typing in the story. You've finished line 04400, and hit the NEW LINE key. *But*, SOS doesn't know you're done, so it displays line number 04500 at the left of the screen. To get out of this text input mode, you now hit another special key marked ESC, which stands for "escape." *Now* SOS knows you're done, and responds by printing its symbol prompter (an asterisk, remember?). As I mentioned earlier, this means SOS is now prepared to perform all sorts of editing operations for you. Let's suppose, however, that you have done a super job of writing and typing, and don't need to make any changes. Thus, you're now ready to let RUNOFF gobble up your SOS text file and produce a manuscript. So, in response to the SOS asterisk, you type E (for "exit") and hit the NEW LINE key. This "saves" your text file in disk memory (where it will stay indefinitely, available for future access unless you either save an updated version of DINNER or



Below, the author enjoying himself on the DECsystem-10; at left, the manuscript of "Guess Who's Coming to Dinner," ready to be separated and sent to a magazine editor.

deliberately erase it) and returns your terminal to the control of MONITOR.

We're almost finished now, so here comes the finale. MONITOR has printed its symbol prompter (the "monitor dot") on the screen, and is patiently waiting. You type R RUNOFF[NL], and MONITOR zips off and retrieves RUNOFF from the system program file (just like it did earlier, for SOS). As soon as RUNOFF is operational, MONITOR hands your terminal off to it and RUNOFF prints an asterisk—it's asking you for the name of the SOS text file you want processed. You type DINNER[NL]. And that's it! After the passage of some time, RUNOFF comes back and tells you (by printing another asterisk) that a new file called DINNER.MEM (all files by RUNOFF are named, automatically, by taking your next file name and tacking a.MEM onto it) has been created. DINNER.MEM is your *manuscript* file—it doesn't have all the strange symbols in it that DINNER does. But, of course, it was all those symbols in DINNER that told RUNOFF how to create DINNER.MEM. You exit from RUNOFF and return to the warm, cozy embrace of MONITOR by typing a Control-Z.

There are three things you can do now. First, you can ask for a display of DINNER.MEM on the video screen, and you'll see your story scroll right before your eyes (you can stop the scrolling at any time, for a careful reading, by typing a Control-S, and then start it again with a Control-Q). Or maybe you want to have something to take home with you for a more leisurely contemplation. In this case you ask MONITOR to queue the manuscript file over to an express line printer in the terminal room with you (at my school, it's an old, beat-up monster that sounds just terrible, but it does the job), and out it comes in just seconds. Finally, if you want a polished production job (like you'd send to an editor), you queue DINNER.MEM over to the comp center's super high-quality printer and pick the manuscript up the next morning.

In reality, of course, things don't go quite so smoothly. After you take a look at your first-draft manuscript, you almost invariably find rotten sentence structure, misspellings, and other terrible screw-ups too numerous to mention. Or, in more urbane language, consider what John Kenneth Galbraith wrote recently in *The Atlantic*: "There may be inspired writers for whom the first draft is just right. But anyone who is not certifiably a Milton had better assume that the first draft is a very primitive thing." You have to edit. But cheer up—*this* is the fun part, because it's simple and easy to do. Just get into SOS again, retrieve the story file, and after SOS gives you the high sign by printing its symbol prompter (remember—the story file is now an *old* file), begin editing. How do you do that?

Basically, there are just four operations. P (for "print"), R (for "replace"), D (for "delete"), and I (for "insert"). If you want to just look at line 02600, type P2600[NL]. If you want to look at all lines between 02600

and 03300, inclusively, type P2600:3300[NL]. The requested lines of text scroll up on the screen. If you want to erase a line (say, line 02700), type D2700[NL]. If, instead, the trouble was just a word left out, type R2700[NL], and SOS will print 02700 on the screen and wait for you to type the new, correct line. If you've discovered you need to add a line of text between two existing lines (say, lines 01600 and 01700), type I1650[NL], and again, SOS will print 01650 and wait for the line to be inserted. After each of these operations is terminated (by hitting NEW LINE), SOS prints a new asterisk. You just give the next appropriate editing command and continue to clean up your text.

There are many, many complications, extensions and generalizations on these four fundamental commands, but they are not really essential. They make life easier, but you can work with SOS very nicely with just the basics, as I've outlined them here. Another editing command that I really like, different in nature from these first four, also explains why a video terminal is better than a DECwriter (in addition to being faster and totally noiseless) for story writing—it is the Control H. Imagine you are happily typing a line of text into a story file, and instead of spelling "dog" correctly, you type "dgo." Laugh, if you must, but I've done it! You can *back up* on the video terminal screen, one character at a time, for each Control-H operation. When you get to the beginning of where the text went wrong (you can tell where you are because SOS is always displaying a winking cursor at your current location within a line), you just start typing again. As each new, correct symbol is typed in, the old ones just disappear! On a DECwriter, you can do the same thing, but of course the paper is printed with both versions and after a while, it becomes *very* confusing. On a video terminal, what you see is what you get.

We're ready now to take up the final aspect of computerized story writing. Namely, just what the heck *do* those funny looking symbols in the SOS text file mean? Okay, let's walk through the text file for "Guess Who's Coming to Dinner?" The very first line contains four commands to RUNOFF (all RUNOFF commands start with a period). They say, in order: all manuscript printing is to be done in lower case, except for those particular symbols that are specially tagged to be capitalized; the printing is to produce a ragged right margin (right justification produces a very "mechanical" looking manuscript, and can produce unsightly spaces between words); the size of a page is to be 60 lines per page, with 65 characters per line (this fills a standard 8½ by 11-inch page). RUNOFF allows you to set left and right margins, too, but by not specifying margin commands, you accept the default settings (which are pleasing to most people).

Lines 00200 through 01000 produce the first page header that tells

the editor (of the magazine, not SOS) how much money the story is going to cost him using his particular word rate, and where to send it! Printing automatically begins at the left, so "250 words" appears in the upper left-hand corner of the first manuscript page. Line 00300 moves the start of the next line to be printed (my name, from line 00400) to a position 51 characters from the left margin. This number is used because it just puts the last "n" in my name at the right margin stop. In line 00400 we run into our first example of the capitalization flag, the *circumflex*, "^". This tells RUNOFF to print the very next letter in upper case, but then to return to lower case from then on, until the next flag is encountered. Lines 00500, 00700, and 00900 print my mailing address in just the right place to right justify it with my name (I did this because while I like a ragged right margin for the manuscript itself, I also like the "blocky" look of a justified header).

Up to now we have accepted the default setting in RUNOFF of single spacing between lines. But a manuscript should be double spaced, so line 01100 now commands RUNOFF to go to double spacing. Line 01200 skips *four* lines (2 times 2 is 4), and now we're ready to print the story title. The .CENTER; command tells RUNOFF to take everything after the semicolon and to print it *centered* on the page. This is terrific, as any writer who has had to count the characters in a title, subtract from the page width, and then divide by two to get the left insert value, will testify. Line 01400 skips down from the title another four lines. Line 01500 is a neat little command. What it does is print, at the top of every page *after* the first one, my name in capitals and then a slash, i.e., NAHIN/. The reason the entire name is capitalized is because of the flag "<", which is like the "^" flag, except it *locks* the capitalization. The lock is broken by the second "<" just before the slash. The reason for the long string of spaces before my name is so it will print out at the far *right* of the page, just before where RUNOFF *automatically* prints the page number. So, for example, at the upper right hand corner of page ten we get NAHIN/ Page 10. That's what I call convenience.

Line 01600 is where the story actually starts, and the .P 5,1; tells RUNOFF that this is the start of a paragraph that is to be indented five places, and double (the 1 times the spacing parameter which we have set to 2) spaced down from the last line (since the SKIP command in line 01400 has already moved us down four lines, then the first line of story text is *six* lines below the title).

There are just two more things to tell you, and then you'll be able to read SOS text files for RUNOFF like an expert. Take a look at the exclamation mark at the end of line 01900. What's the underscore doing in front of the mark? Well, it so happens that in some special cases (which are so special I'm not going to bother talking about them here) the exclamation

mark is used as a command symbol to RUNOFF. Putting the underscore in front of the mark tells RUNOFF that, in this case, it is just an exclamation mark, and should be so printed, and is *not* to be interpreted as a command symbol. Finally, look at the word "did" in line 03700. The circumflex followed by the ampersand tells RUNOFF to start underlining, and to continue to underline until it sees a backslash followed by an ampersand. So, in this case, we get "did."

A final technical thought—telling you about the paragraph command for RUNOFF has reminded me of a mess I got myself into while writing this very article. It gives me the opportunity to tell you about one last extremely powerful editing command in SOS—the *substitute* command. This command allows you to replace a specified string of characters with any other string of characters (the two strings do *not* have to be the same length). I used this editor command to change the RUNOFF paragraph settings for a preliminary draft of this article because originally (don't ask me why) I had them at .P 5,2;—this was wrong because once I set the line spacing to double spacing (using .SPACING 2), these settings caused the paragraphs to be *quadruple* spaced! I couldn't correct this by changing the SPACING command because *that* would mess up the correct double spacing between lines of text. What I should have done, of course, was use .P 5,1;. But I didn't want to retype all those settings! So I used the substitute command. Suppose the hitting of the ESC key is represented by [$]. Then, while in the SOS editor prompter mode, I typed S.P 5,2[$].P 5,1[$][NL]. This searched the text file for the first occurrence of the string specified between the "S" and the first [$] operation, and replaced it with the string between the two [$] operations. To continue the search and substitution process, I just typed S[$][NL] and the rest of the text file was similarly processed. For that early draft, with more than two dozen paragraphs, the total command editing time was less than ten seconds.

That completes our discussion of story writing on a computer, except for one last question that may have already occurred to you. "This is all very nice," you might be thinking, "but isn't it nothing more than a lucky stroke for a writer to have access to such a fantastic resource? After all, how many people can get their hands on a multimillion dollar computer?"

The fact of the matter is, however, that you don't have to work for a university to have such access. There are many commercial time-sharing companies that will sell you computer time, right over your telephone. What you need in your home are a video terminal (present purchase price is around $1,000), and an acoustic coupler (about $250). The coupler is hardwired to the terminal, and contains a double plug into which you insert your telephone receiver. You dial the number for your computer firm (data transmission is accomplished by using various audio tones),

and then LOGIN, just like with a DEC-10. In fact, the central computer at the time-sharing firm might *be* a DEC-10. Once a month you'll get a bill based on your actual use of the computer, plus probably some fixed overhead charge (after all, even if you don't use it during the month, the computer firm has to be available for the *possibility* you'll call), and a rental fee for a terminal and coupler if you don't buy your own equipment.

In exchange for your money, the computer firm provides you access to a text editor and a manuscript production program, and they'll even rent you "parking space" on their disk storage units to hold your various files. But there *is* a potential problem—how do you get an actual manuscript into your hands? Well, if you just can't wait, you can buy one of several small line printers that attach to your terminal. Cost? Anything from $250 to $4,000, depending on the speed and quality of printing. Or, if you're willing to wait for the U.S. mail, the computer firm can just pop a manuscript printout into the mail for you.

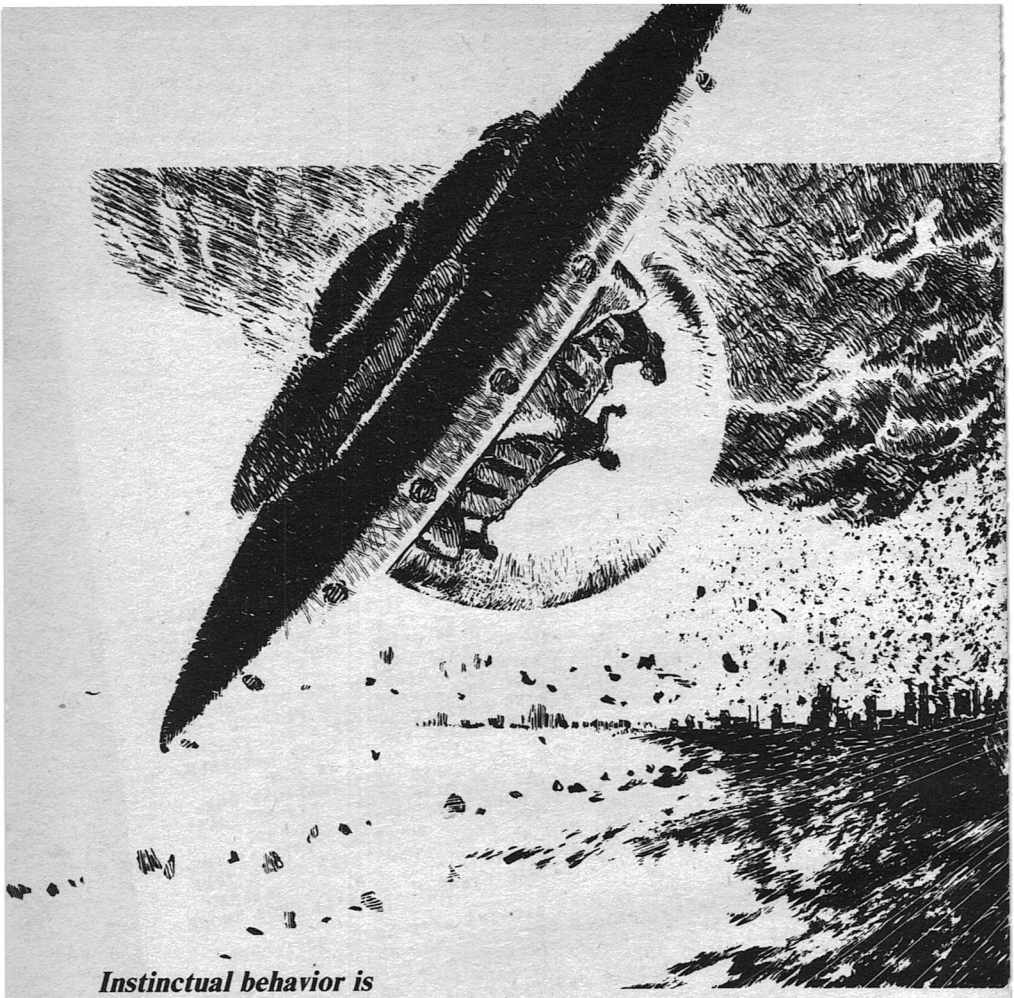
If you're the adventurous type, there is another option. Buy your *own home* computer! This isn't as far out as it might sound. Today, you can buy a factory assembled microcomputer system (for under $600) that exceeds the capabilities of a laboratory research computer of twenty-four years ago, costing more than a million dollars. Again, as part of this system, you'll want to add a line printer. You can also add your own disk system (for about $1,000) that will store text files on small flexible magnetic disks (they look like the cheapo 45 rpm records that are often packed in cereal boxes as promotional gimmicks), costing just a few dollars each. Text editors are already available for some home systems, and while I haven't heard of a RUNOFF type program for them yet, I'm confident they're coming soon.

Sure, I know what you're thinking now—an electric typewriter is a heck of a lot cheaper! You'll get no argument from me on that point. If there is anyone in the world that knows what a stretched budget is, it's a college professor. But computer technology goes through an evolutionary phase or "new generation" about once every five years or so. Each such phase typically increases speed and decreases cost by a factor of three or more. In just ten years, then, we should see a reduction in cost by a factor of at least ten—that's getting competitive with typewriters. And think of the convenience of such a home system (and think of the fun!)

It'll take some effort for writers to learn to use a computer-based home "word processor," but if any group can do it, it ought to be science-fiction writers. Let the writers of mysteries, romances, and pornography continue to pound out their fantasies on typewriters (that might someday be as old-fashioned as using a chisel on stone tablets). But I think it is manifest destiny for SF writers to ride the crest of this new wave into the future. Don't you agree? ■

The SOS text file named DINNER.

```
00100
00200   .LOWER CASE.FLAG CAPITALIZE.NO JUSTIFY.PAGE SIZE 60,65
00300   250 WORDS
00400   .LEFT 51
00500   ^PAUL ^J. ^NAHIN
00600   .LEFT 48
00700   ^KINGSBURY ^HALL/^E^F
00800   .LEFT 38
00900   ^UNIVERSITY OF ^NEW ^HAMPSHIRE
01000   .LEFT 49
01100   ^DURHAM, ^N^H     03824
01200   .SPACING 2
01300   .SKIP 2
01400   .CENTER;"^GUESS ^WHO'S ^COMING TO ^DINNER?"
01500   .SKIP 2
01600   .TITLE                                                  <NAHIN</
01700   .P 5,1;^CACKLING CRAZILY TO HIMSELF, THE DERANGED GENIUS TIGHTENED
01800   THE LAST BOLT ON THE TIME MACHINE. ^NOW HE WOULD SHOW THOSE FOOLS
01900   IN THE ^NATIONAL ^ACADEMY. ^CALL HIM AN IDIOT, WOULD THEY---THOSE
02000   SELF-SERVING, INCOMPETENT, JEALOUS BASTARDS_!
02100   .P 5,1;^HE ROTATED THE TIME PENETRATION DIAL TO TWO HUNDRED YEARS,
02200   SET THE AUTOMATIC RETURN SWITCH TO ONE MINUTE, AND FLIPPED THE
02300   POWER LEVER ON. ^WITH A FLICKERING REMINISCENT OF A FLOURESCENT
02400   LAMP COMING TO LIFE, THE TIME MACHINE AND ITS CREATOR VANISHED.
02500   ^ALAS, THE TIME TRAVELER HAD MADE A SLIGHT ERROR IN HIS
02600   CALCULATIONS. ^WHILE WORKING OUT THE PROPER BIAS VOLTAGES FOR
02700   THE CRYSTAL ROD WARP MODULATOR, HE HAD MISPLACED A FEW DECIMAL
02800   POINTS. ^HE TRAVELED BACK RATHER MORE THAN HE HAD PLANNED.
02900   .P 5,1;^STILL, IT WAS WORTH THE THRILL OF SUCCESS. ^EVEN AS THE
03000   TERRIBLE ^TYRANNOSAURUS REX, THE MOST FEARSOME FLESH EATER THAT
03100   EVER TERRORIZED THE LAND, THUNDERED DOWN UPON HIM, HE SCREAMED
03200   WITH PLEASURE. "^I WAS RIGHT, ^I WAS RIGHT_! ^THIS'LL SHOW THOSE
03300   BASTARDS ^I WAS RIGHT_!"
03400   .P 5,1;^AND THEN HE AND THE TIME MACHINE WERE GONE, SWALLOWED
03500   WHOLE INTO THE STEAMING, RANCID BOWELS OF THE MONSTROUS HORROR.
03600   ^A FEW SECONDS LATER, THE AUTOMATIC RETURN ELECTRONICS ACTIVATED,
03700   AND THE SECOND HALF OF THE TRIP WAS MADE WITHOUT MISHAP (ALTHOUGH
03800   THE CRYSTAL WARP RODS ^&DID\& PARTIALLY MELT FROM THE UNEXPECTED,
03900   ENORMOUS MASS).
04000   .P 5,1;^THE TIME TRAVELER WAS RIGHT. ^OH MY, WAS HE RIGHT. ^AFTER
04100   THE EVENTS OF LATER THAT NIGHT, AND ALL OF THE NEXT DAY, THOSE
04200   INCOMPETENT BASTARDS IN THE ^NATIONAL ^ACADEMY CERTAINLY DID
04300   CHANGE THEIR OPINIONS OF HIS ONCE-REDICULED THEORY ON TIME TRAVEL.
04400   ^YES, INDEED_!
04500   .CENTER;-<END<-
```



Instinctual behavior is the product of many generations of trial-and-error. But when the environment changes abruptly, instinct can become counterproductive.

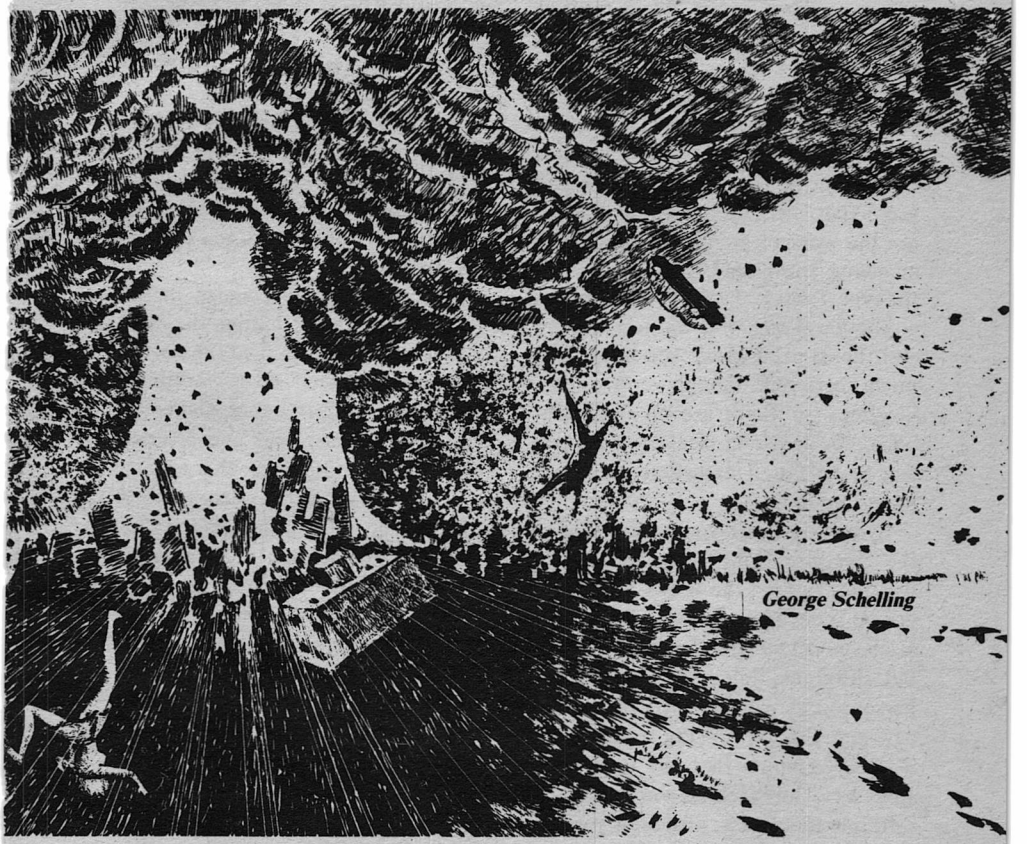
EDMUNDO HAMILTOWNE

Dear Ed,

Hi, Ed!

I felt it would be better this way, though it may surprise you to see a lawyer hand you an 'important document'. You see, if I had mailed it, it could conceivably have gotten lost.

LETTER to ed



If, on the other hand, I had handed it to you directly, you would have been surprised, or perhaps perplexed, or both, at seeing me so haggard and weary; and, besides, you would have asked me questions that I'm not willing to answer.

So, I figured that the best way would be to go to a lawyer and ask him to deliver this letter to you. I shall tell him that it is an 'important document', which indeed it is for me, for you, and even perhaps for the future of mankind.

For I must be sure that you receive it. You *MUST* see, up to a certain extent at least, what lies ahead of you—and of Humanity—and so act accordingly when the time comes.

I didn't write it in longhand to spare you the shock of seeing your own handwriting, so shaky and so weak. But, nevertheless, I had to give you proof that this letter is authentic and not the work of a crank, so I thought of giving you a lead: you'll recognize the type, for it is that of your typewriter (notice the *t*s with the top missing and the *a*s a bit above the line). It is much battered, though, and almost illegible, for there are no fresh ribbons, nor anything else for that matter, to be found anywhere, as you'll learn in due time.

By now I'm sure you have looked at the signature. Sure, it's yours and yet it is not. Funny, the tricks time plays on us! You are now, and I am now also; you and I are the same person, but different times have made two persons of us: you are my living memory, and I'm your living future. And it's the Machine that has made that split. Yes, the Machine you're starting to think about now, although you are still unaware of the crux of it.

The choice is yours: either you plunge ahead and do it—and somehow manage to avoid the horrid tragedy ahead—or else give up the idea, and live through every terrifying moment of what is to come. It's entirely up to you.

As it was up to me at that time. It is the same choice I was facing, but I went ahead and in time I succeeded, so you also will. So please, go ahead and try. You'll have it ready to work just as the hecatomb is about to start.

Please don't be skeptical or idealistic. There is nothing you can do, but to save yourself and your dear ones. Politicians are for the birds, military are mad, and scientists, that brilliant heedless bunch, are only sharpening the weapons of oblivion. Keep clear of them and *work*.

It's now 3 AM. I've landed in the backyard and, after hiding the Machine there, I staggered to the corner drugstore, deserted, and got antibiotics, aspirins, amphetamines, and corticoids, for I'm very weak and feverish and have a splitting headache. I feel a bit better now after loading myself with those chemicals, though I'm dizzy and my stomach hurts and my ears are ringing. After taking those medicines, I entered my home, using the key. I'm confident that nobody will notice the Machine where I hid it: it's too dark and too late; and, besides, everybody is too weary to do anything even if they see it. As I was making the typewriter ready, I heard you roaming downstairs in the basement, busy with the Machine; so busy that I'm sure you won't hear me despite the clatter I'm making while typing this letter, for the ribbon is as dry as a bone. One other leap into the past—but displaced a few miles so as to not to arrive again at home—to hand this letter over to a lawyer who will deliver it to you; and then . . . then I don't know or care. Perhaps I'll go to a

hospital or something of the kind, though I know there is damn little they'll be able to do to help me.

I come from 2326, the year we stopped when finally the radiation counter quit ticking. In 2326 the same river bathes the same valley, but the few remaining ruins are crumbling with every storm. A most strange breed of plants and weeds do exist there, or rather here and then. No beasts are in sight, neither wild nor domestic, and not a single human being. Every night I have given the radio a try, but I've only heard static. I haven't dared to think that there will be no human beings left on Earth then.

Ed, pretty soon you'll have to face a conflict I want to warn you about.

It is so important for you to make the right choice that I've dared, after much thought, to backtrack time, despite the deadly danger of landing a few weeks too late. It is not that I fear being burnt to a cinder, mind you, for at this stage that would mean the end of a long and sad journey for me, and would be welcome. The deadly danger is my possible disappearance and, consequently, your never receiving this letter.

Ed, your loving wife, Ella, won't understand what you're doing. As you'll start to design the Machine and to iron out all the difficulties, as you'll become more and more engrossed with your work, you'll leave her behind. She's only a woman after all, even if you're a rigid moralist who won't understand what's going on before it's too late: she'll gradually drift away from you, to eventually quit and go—she and the kids—to live with . . . no, I won't tell you whom with. What's the point in making you angry toward them? It will happen, that's all, for you won't be able to divide your attention nor, sad as it may sound, your money between the Machine and her. In the last moments, you'll feel the exhilaration of finally having the Machine ready, but also the unbearable humiliation of having everybody know that you are a cuckolded husband. The problem is that the exhilaration will be private, for nobody will care about you or about the Machine; whereas the humiliation will be public, for the scorn and envy common people can feel toward humble and dedicated men can be monumental, as you'll learn soon enough.

But you'll grit your teeth and go on working, and you'll have the Machine ready just before the Blast. The Bomb will explode five miles away from where your home stands now, and you know what happens to life at that distance. Everybody there dies a sudden, horrible death.

Of course, you will neither know nor care by the time you're ready. To hell with all of them! will seethe your wounded pride . . . Oh, Ed, how much I would wish to return to this time, to correct the horrible mistake I've made! But, much as I want to, I can't, for I would bump into you. I might as well accept it: I have lost Ella forever, Ella and the kids; but it will unload my conscience to know that,

albeit vicariously, I have given her a chance.

Once your Machine is ready, you'll start to load it with everything you'll need. And all the time you'll be feeling a queer mixture of elation at your final triumph; plus a gnawing, angry glee at leaving your wife and your neighbors forever. God, how I remember how I felt! . . . I sat at the controls and firmly handled the lever that was going to shoot me into the future, and was I joyous!

And then the sirens started to blare and my hands began to sweat and I couldn't pull that lever at all, for those trumpets of doom wrecked me inside out. You see, Ed, it's one thing to leave people whom you know will continue to lead their lives; but it's quite another to depart, being fully aware that they'll shortly face instant or delayed death. It's worse yet if your own kids are there.

My hand fell from the lever and I was so wracked by my desire to leave and my desire to save them that I started to cry while the sirens went on wailing their deafening call. After a while I sobered up, and started to think about what to do. I had the means to save many, taking a few into the future at a time. I rejected that thought at once, for I didn't know what kind of consequences that many trips could have in the space-time continuum. But one thing I knew for sure: I had to save my kids.

I bolted out of the Machine and ran toward the communal fallout shelter, for I knew I would find them there. A white-helmeted civil-serviceman wearily waved his hands at me as I approached. "Watch your step!" he yelled above the din that rose from the shelter.

I picked my way down carefully among the bloody corpses of those who had been trampled to death. My heart leapt every time I saw a mangled child—and there were several of them strewn like bloody marionettes along the steps, together with oldsters and women—but none of them were my kids, thank Heavens.

Bedlam greeted me in the shelter. It was full of people, some of whom were walking, while others ran, and still others sat immobile, just staring vacantly ahead. Shouts, prayers and curses blended horribly with the odors of sweat and fear. I plunged into the horde desperately seeking my kids, while adding to the general tumult by calling their names at the top of my voice. The maelstrom hurled me hither and thither, toward walls, dishevelled women, children; toward the man who was selling 'fallout pills' at $20 apiece; toward the preacher who was screaming, "Ye sinners, repent!"

I finally saw my kids, crouching pop-eyed in a corner by Ella. I grabbed their hands, yanked them to their feet and started to the door, while Ella tried to jerk them free of me. The civil-serviceman who was closing the shelter's door wouldn't let me out, so I had to knock him cold. With the children sobbing and my wife bellowing and dragging behind, I climbed the stairs with the three of

them in tow, slipping and falling over the gory remains of the unfortunate trampled.

Once in the street I started to run toward home without letting the children go, with my wife alternately threatening and pleading. Without losing momentum, I threw the kids into the Machine and sat in front of the controls. I grabbed the lever and looked at Ella, and something collapsed within me. I simply couldn't leave her there. "Want to join?" I asked her. She stood petrified for a moment, wet her lips and looked around, as if for help. "Okay," she said at last, stepping in.

I pulled the lever, and a few seconds later I was dazzled by a blinding flash of white light, while the radiation counter started to roar like one of those old airplane engines. At the same time we all felt a sudden, but mild, increase in temperature, which the air conditioner dispelled almost immediately. The radiation counter quieted down gradually, and when it stopped ticking I brought back the lever to 'Neutral'. We were in the year 2326. "Just in time," Ella whispered, awed. "Oh, Ed, thank you ever so much!" and she started to cry.

It was wonderful to be alive, and for a few days we were all very happy, exploring, clearing, working; conscious all the time that future Humanity would spring from us.

Then, Ed, radiation sickness emerged. Seems that we had received too much radiation during the trip. First the kids, and then Ella, started to wither rapidly in front of my eyes; and there was nothing I could do to help them. All three of them died in front of my eyes after a horrible agony within hours of each other. After digging their graves I felt exhausted. Didn't pay too much attention to my weakness, though, distracted as I was with my sadness at their loss. But the weakness remained, and I knew that I was falling sick. All three of them had died, and I would be dead in a few days too. I had attempted to save them, but had killed them instead.

The next day I started to run a fever and to feel belly cramps; and it occurred to me that if I could come back and warn you I could perhaps give them another chance.

And that's why I'm here, Ed, banging this typewriter, despite the fact that I'm feeling as sick as a dog and that my fingertips are tender, all bruised and blistered after my writing this letter to you.

Ed, I don't know what to tell you to do on their behalf. It's very difficult to think when your mind is befogged by fever, dizziness and headache and you're weak, while cramps of fire are eating away your guts.

But you're alive now, Ed; alive and sound, and what's more, you have plenty of time to figure out what to do so that they can have this other chance. This other chance that will erase my terrible blunder.

Give them that chance, Ed, please, I beg you. They are all you have. They deserve to live.

ED


Paul Lehr

PART TWO OF FOUR PARTS

TITAN

After birth comes exploration
of one's surroundings.
Of course, some "children"
are more curious than others. . . .

JOHN VARLEY

SYNOPSIS

The year is 2025. DSV Ringmaster *is on the first voyage of exploration in the past eleven years. The destination is Saturn, and the Captain is Cirocco Jones, a thirty-four-year-old veteran astronaut. There are three men and three women under her command:*

First Officer William Rubin, 40. Rubin functions as ship's engineer, and during the trip has become romantically involved with Captain Jones.

Satellite Exploration Module Pilot Eugene Springfield, 29.

Medical Officer Calvin Greene, 26.

Gaby Plauget, 28, astronomer.

April 15/02 and August 3/02 Polo, two of five clones of their Nobel Prize-winning mother, Susan, who handle geology, chemistry, and physics between them.

The monotony of the trip is interrupted by Gaby's discovery, while still some distance from Saturn, of an eleventh moon. She names it Themis, and soon finds it is no ordinary moon. It is almost certainly an artifact: an interstellar spacecraft, or a colony world. But who built it, and where are they now?

Themis is shaped like a wagon wheel. There is a hub with a hole in the center. Radiating from the hub are six spokes, connecting to a vast torus, thirteen hundred kilometers across. Solar heating fins hang beneath the torus, and above it are six square mirrors which channel sunlight down to windows in the "roof." The torus is hollow, and the spin rate would produce one-quarter gravity on the inside.

Ringmaster's *mission profile is quickly scraped, and Cirocco is ordered to orbit Themis. This proves difficult, because of its odd shape, but she manages to station her ship beneath the torus.*

She wonders how she is going to enter it, but Themis makes the decision for her. A gigantic grapple seizes Ringmaster, *destroying it. Smaller grapples gather every piece of debris, including the crew, and they are swallowed up. There follows a period of complete sensory deprivation. Cirocco believes she has been eaten by a giant animal, and in time is expelled from beneath the ground, naked and hairless. Only the metal parts of her suit have survived.*

With the remains of her suit radio Cirocco contacts Gaby, and the two soon get together. Gaby has been changed by her sensory deprivation; she is no longer interested in astronomy, and she believes she is in love with Cirocco. The two women find a stream winding through dense jungle and begin to follow it. They have little sense of time, as any point inside Themis is always in light or darkness, depending on its location. They are in a region of daylight, a perpetual afternoon. The climate is temperate, but they encounter a sudden wind accompanied by a deep moaning sound and followed by a snowfall. The snow melts rapidly on the warm ground.

The stream leads them to a two-kilometer cliff, where they discover they are near one wall of the torus. From their vantage point they can see almost half of the interior curving up on either side of them. Sprouting from the land are huge cables that vanish through the roof.

As they are looking, they hear a voice from overhead. It is Calvin Greene, sitting in a tree.

CHAPTER SIX

Before Cirocco quite had a chance to settle down, they were all sitting in a circle and Calvin was talking.

"I came out not far from the hole where the river disappears," he was saying. "That was seven days ago. I heard you on the second day."

"But why didn't you call us?" Cirocco asked.

Calvin held up the remains of his helmet.

"The mike is missing," he said, extricating the broken end of wire. "I could listen, but not transmit. I waited. I ate fruit. I just couldn't seem to kill any of the animals." He spread his broad hands, and shrugged.

"How did you know this was the right place to wait?" Gaby asked.

"I didn't know, for sure."

"Well," Cirocco said. She slapped her palms on her legs, and then laughed. "Well. Fancy that. Just when we'd about given up hope of finding anybody else, we stumble over you. It's too good to be true. Isn't it, Gaby?"

"Huh? Oh, yeah, it's great."

"It's good to see you folks, too. I've been listening to you for five days now. It's nice to hear a familiar voice."

"Has it really been that long?"

Calvin tapped a device on his wrist. It was a digital watch.

"It's still keeping perfect time," he said. "When we get back, I'm going to write a letter to the manufacturer."

"I'd thank the maker of the watchband," Gaby said. "Yours is steel and mine was leather."

Calvin shrugged. "I remember it. It cost more than I made in a month, as an intern."

"It still seems like too much time. We only slept three times."

"I know. Bill and August are having the same trouble judging time."

Cirocco looked up.

"Bill and August are alive?"

"Yeah, I've been listening to them. They're down there, on the bottom. I can point to the place. Bill has his whole radio, like you two. August only had a receiver. Bill picked out some landmarks and started talking about how we could find him. He sat still for two days, and August found him pretty quick. Now they call out regular. But August only asks for April, and she cries a lot."

"Jesus," Cirocco breathed. "I guess she would. You don't have any idea where April is, or Gene?"

"I thought I heard Gene once. Crying, like Gaby said."

Cirocco thought it over, and frowned.

"Why didn't Bill hear us, then?

He'd be listening in, too."

"It must have been line of sight problems," Calvin said. "The cliff was cutting you off. I was the only one who could listen to both groups, but I couldn't do anything about it."

"Then he'd hear us now, if—"

"Don't get excited. They're asleep now, and they won't hear you. Those earphones are like a gnat buzzing. They ought to wake up in five or six hours." He looked from one of them to the other. "The smart thing for you folks is to get some sleep, too. You've been walking for twenty-five hours, you know."

This time, Cirocco had no trouble believing him. She knew she was existing on the excitement of the moment; her eyelids were drooping. But she couldn't give in yet.

"What about yourself, Calvin? Have you had any trouble?"

He raised one eyebrow. "Trouble?"

"You know what I'm talking about."

He seemed to draw in on himself.

"I'm not talking about that. Not ever."

She was inclined not to push it. He seemed peaceful, as if he had come to terms with something.

Gaby stood up and stretched, yawning hugely.

"I'm for the sack," she said. "Where do you want to stretch out, Rocky?"

Calvin stood up, too. "I've got a place I've been working on," he said. "It's up here in this tree. You two can use it, and I'll stay up and listen for Bill."

It was a bird's nest woven from twigs and vines. Calvin had lined it with a feathery substance. There was plenty of room, but Gaby chose to get close, as they had been doing before. Cirocco wondered if she ought to call a halt to it, but decided it didn't matter.

"Rocky?"

"What is it?"

"I want you to be careful around him."

Cirocco came back from the edge of sleep.

"Mmmph? Calvin?"

"Something's happened to him."

Cirocco looked at Gaby with one bloodshot eye. "Go to sleep, Gaby, okay?" She reached around and patted her leg.

"Just watch out," Gaby muttered.

If only there was some sign to mark the morning, Cirocco thought, yawning. It would make getting up a lot easier. Something like a rooster, or the sun's rays coming in at a different slant.

Gaby was still asleep beside her. She disentangled herself and stood on the broad tree limb.

Calvin was not around. Breakfast was within arm's reach: purple fruit the size of a pineapple. She picked one and ate it, rind and all. She began to climb.

It was easier than it looked. She went up almost as fast as she could have climbed a ladder. There were

definitely things to be said for one-quarter gee, and the tree was ideal for climbing, better than anything she had seen since she was eight years old. The knobby bark provided handholds where limbs were scarce. She picked up a few scratches to add to her collection, but it was a price she was willing to pay.

She felt happy for the first time since her arrival in Themis. She didn't count the meetings with Gaby and Calvin, because those had been so emotional they had verged on hysteria. This was just feeling good.

"Hell, it's been longer than that," she muttered. She had never been a gloomy person. There had been some good times aboard *Ringmaster,* but little out-and-out *fun.* Trying to recall the last time she had felt this good, she decided it was the party when she learned she had her command after seven years of trying. She grinned at the memory; it had been a very good party.

But she soon put all thought from her mind and let her soul flow into the endeavor itself. She was aware of every muscle, every inch of skin. There was an astonishing amount of freedom in climbing a tree with no clothes on. Her nudity, until now, had been a nuisance and a danger. Now she loved it. She felt the rough texture of the tree under her toes, and the supple flex in the tree limbs. She wanted to yodel like Tarzan.

As she approached the top, she heard a sound that had not been there before. It was a repeated crunching, coming from a point she couldn't see through the yellow-green leaves, in front of her and a few meters down.

Proceeding more cautiously, she eased herself onto a horizontal limb and sidled toward the open air.

There was a blue-gray wall in front of her. She had no idea what it might be. The crunching came again, louder, slightly above her. A tuft of broken branches moved in front of her and out of sight. Then, with no warning, the eye appeared.

"Wow!" she yelped, before she could get her mouth shut. Without quite recalling how she got to be there she was three meters back, bouncing with the motion of the tree and staring transfixed at the monstrous eye. It was as wide as her outstretched arms, glistening with moisture, and astonishingly human.

It blinked.

A thin membrane contracted from all sides, like a camera aperture, then snapped open again, literally quick as a wink.

She broke all records getting down, not feeling it when she scraped her knee, yelling all the way. Gaby was awake. She had a thighbone in her hand, and looked ready to use it.

"Down, down!" Cirocco yelled. "There's something up there. It could use this tree for a toothpick." She levitated the last eight meters, hit the ground on all fours, and was on her way down the hill when she collided with Calvin.

"Didn't you hear me? We've got to get out of here. There's this thing—"

"I know, I know," he soothed, putting out his hands, palms toward her. "I know all about it, and it's nothing to worry about. I didn't have time to tell you before you went to sleep."

Cirocco felt deflated, but far from soothed. It was terrible to have that much nervous energy and nothing to do with it. Her feet wanted to run. Instead, she blew up at him.

"Dammit, Calvin! You didn't have *time* to tell me about a thing like *that*? What is it, and what do you know about it?"

"That's our way off this cliff," he said. "His name is—" he pursed his lips and whistled three clear notes with a warble at the end, "—but I see that's awkward to use mixed with English. I call him Whistlestop."

"You call him Whistlestop," Cirocco repeated, numbly.

"That's right. He's a blimp."

"A blimp."

He looked at her oddly and she gritted her teeth.

"He looks more like a dirigible, but he's not, because he doesn't have a rigid skeleton. I'll call him and you can see for yourself." He put two fingers to his lips and whistled a long, complex tune with odd musical intervals.

"He's calling him," Cirocco said.

"So I heard," Gaby said. "Are you okay?"

"Yeah. But my hair's going to come back in gray."

There was an answering series of trills from above, then nothing happened for several minutes.

Whistlestop bulged into view from the left. He was three or four hundred meters from the cliff face, traveling parallel to it, and even that far away they could see only a little of him. He was a solid blue-gray curtain being drawn across their view. Then Cirocco spotted the eye. Calvin whistled again, and the eye swiveled aimlessly, eventually finding them. Calvin looked back over his shoulder.

"He don't see so good," he explained.

"Then I'm for staying out of his way. Like in the next county."

"That wouldn't be far enough," Gaby said, awed. "His ass would *be* in the next county."

The nose disappeared and Whistlestop continued to glide past. And glide past. And glide, and glide, and glide. There seemed to be no end to him.

"Where's he going?" Cirocco asked.

"It takes him a while to stop," Calvin explained. "He'll get squared away pretty soon."

Cirocco and Gaby finally joined Calvin at the edge so they could see the whole operation.

Whistlestop the blimp was a full kilometer from stem to stern. All he needed to look like a bigger-than-life-size replica of the German airship *Hindenberg* was a swastika painted on his tail.

No, Cirocco decided, that was not quite true. She was an airship enthusiast, had been active in the NASA project to build one almost as big as Whistlestop. While working with the

project engineers, she had come to know the design of the LZ-129 quite well.

The shape was the same: an elongated cigar, blunt at the nose, tapering to a point at the stern. There was even some sort of gondola slung beneath, though farther back than in the *Hindenberg*. The color was wrong, and the texture of the skin. No bracing structure was visible; Whistlestop was smooth, like the old Goodyear blimps, and now that she could see him in the light he shone with a mother-of-pearl iridescence and a hint of oiliness over the basic blue-gray.

And *Hindenberg* had not had hair. Whistlestop did, along a transverse ventral ridge, growing thicker and longer amidships, thinning out to a sparse blue down toward the ends. A clutch of delicate tendrils hung beneath the central nodule, or gondola, or whatever it was.

Then there were the eyes, and the tail fins. Cirocco saw one side-looking eye, and thought there were probably more. Instead of four flight surfaces at the tail Whistlestop had only three: two horizontal ones and one rudder. Cirocco could see them flexing as the monstrous thing struggled to turn its nose toward them, at the same time backing up half its length. The fins were thin and transparent, like the wings of a man-powered O'Neill flyer, and supple as a jellyfish.

"You . . . uh, you *talk* to this thing?" she asked Calvin.

"Pretty well." He was smiling at the blimp, happier than Cirocco had ever seen him aboard the *Ringmaster*.

"It's an easy language to learn, then?"

He frowned. "No, I don't think you could say that."

"You've been here—how long? Seven days?"

"I tell you, I know how to talk to it. I know a lot about it."

"Then how did you learn it?"

The question obviously troubled him.

"I woke up knowing it."

"Say again?"

"I just *know* it. When I first saw him, I knew all about him. When he talked, I understood. As simple as that."

It was far from that simple, Cirocco was sure. But he obviously did not want to be pressed on the question.

It took the better part of an hour for Whistlestop to position himself, then to nose in carefully until he nearly touched the side of the cliff. During the operation, Gaby and Cirocco moved well back. They felt better when they saw its mouth. It was a meter-wide slash, ridiculously tiny for a creature of Whistlestop's size, set twenty meters below the forward eye. There was a separate orifice below the mouth: a sphincter muscle that doubled as a pressure-relief valve and whistle.

A long, rigid object protruded from the mouth and extended to the ground.

"C'mon," Calvin said, beckoning to them. "Let's get aboard."

Neither Gaby nor Cirocco could

think of a line to go with that. They just stared at him. He looked exasperated for a moment, then smiled again.

"I guess it's hard for you to believe, but it's true. I do know a lot about these things. I've already been for a ride. He's perfectly willing; he's going our way anyhow. And it's *safe.* He only eats plants, and very little of that. He can't eat too much, or he'd sink." He put a foot on the long gangplank and walked toward the entrance.

"What's that thing you're standing on?" Gaby asked.

"I guess you could call it his tongue."

Gaby started to laugh, but it had a hollow sound, and died in a cough. "Isn't this all just a bit too . . . I mean, Jesus, Calvin! There you stand on the damn thing's tongue, asking me to walk into his *mouth,* dammit. I suppose at the end of . . . shall we call it the throat? At the end of the throat is something that's not really a stomach but just serves the same purpose. And those juices that start flowing over us, you'll have a nice, glib explanation for that, too!"

"Hey, Gaby, I promise you, it's as safe as—"

"No, *thank* you!" Gaby shouted. "I may be mama Plauget's dumbest daughter, but nobody ever said I didn't have the sense to stay out of some monster's *mouth.* Jesus! *Do you know what you're asking?* I've already been eaten alive once on this trip. I'm not going to let it happen again."

She was screaming by now, shaking, and her face was red. Cirocco agreed with everything Gaby said, on an emotional level. She stepped onto the tongue, anyway. It was warm, but dry. She turned, and held out her hand.

"Come on, shipmate. I believe him."

Gaby stopped shaking and looked stunned.

"You wouldn't leave me here?"

"Of course not. You're coming with us. We have to get down there with Bill and August. Come on, where's the courage I know you have?"

"That's not fair," Gaby whined. "I'm not a coward. You just can't ask me to do *that.*"

"I am asking you. The only way to deal with your fear is to face it. Come on in."

Gaby hesitated a long time, then squared her shoulders and marched up as if going to her execution.

"I'll do it for you," she said, "because I love you. I have to be with you, wherever you go, even if it means we die together."

Calvin looked at Gaby strangely, but said nothing. They went into the mouth, found themselves in a narrow, translucent tube with a thin floor over even thinner air. It was a long walk.

Amidships was the large pouch visible from the outside. It was thick, clear material, a hundred meters long by thirty wide, and the bottom was covered in pulverized wood and leaves. There were small animals inside with them: several smilers, a selection of smaller species, and thousands of smooth-skinned creatures smaller

than shrews. Like the other animals they had seen in Themis, these paid no attention to them.

They could see out on all sides, and found they were already some distance from the cliff face.

"If this place isn't Whistlestop's stomach, what is it?" Cirocco asked.

Calvin looked puzzled.

"I never said it wasn't his stomach. This is his food we're standing on."

Gaby moaned and tried to run back the way she had come in. Cirocco grabbed her and held her down. She looked up at Calvin.

"It's all right," he said. "He can only digest with the help of these little animals. He eats their end product. His digestive juices can't hurt you any more than weak tea."

"You hear that, Gaby?" Cirocco whispered in her ear. "We're going to be all right. Calm down, honey."

"I h-hear. Don't be mad at me. I'm frightened."

"I know. Come on, stand up and look out. That'll take your mind off it." She helped her up, and they wallowed over to the clear stomach wall. It was like walking on a trampoline. Gaby pressed her nose and hands to it and spent the rest of the trip sobbing and staring fixedly into space. Cirocco left her alone, and went to Calvin.

"You've got to be more careful of her," she said, quietly. "The time in the darkness has affected her more than us." She narrowed her eyes and searched his face. "Except I don't really know about you."

"I'm all right," he said. "But I don't want to talk about my life before my rebirth. That's over."

"Funny. Gaby said pretty much the same thing. I can't see it that way."

Calvin shrugged, plainly not interested in what either of them thought.

"All right. I'd appreciate it if you told me what you know. I don't care how you learned it if you don't want to tell me."

Calvin thought it over, and nodded.

"I can't teach you their language quickly. It's mostly tone and duration, and I can only speak a pidgen version based on the lower tones I can hear.

"They come in all sizes from about ten meters to slightly larger than Whistlestop. They often travel in schools; this one has some smaller attendants which you didn't see because they stayed on his other side. There's some of them now."

He pointed out the window, where a flight of six twenty-meter blimps jostled for position. They looked like ponderous fish. Cirocco could hear shrill whistles.

"What about all these creatures in here?" Cirocco asked. "Do they need all of them to digest their food?"

"No, just the little yellow ones. Those things can't eat anything but what a blimp prepares for them. You won't find them anywhere but in a blimp's stomach. The rest of these critters are like us. Hitchhikers or passengers."

"I don't get it. Why does the blimp do it?"

"It's symbiosis, combined with the intelligence to make his own choices and do as he pleases. His race gets along with other races in here, the titanides in particular. He does them favors, and they return it by—"

"Titanides?"

He smiled uncertainly, and spread his hands. "It's a word I substitute for a whistle he uses. I only get a hazy idea of what they're like because I can't do too well with complex descriptions. I gather they're six-legged, and they're all females. I call them titanides because that's the name in Greek mythology for female Titans. I've been naming other things, too."

"Such as?"

"The regions and the rivers and the mountain ranges. I named the land areas after the Titans."

"What . . . oh, yeah, I remember now." Calvin had studied mythology as a hobby. "Who were the Titans, again?"

"The sons and daughters of Uranus and Gaea. Gaea appeared from Chaos. She gave birth to Uranus, made him her equal, and they produced the Titans, six men and six women. I named the days and nights here after them, since there's six days and six nights."

"If you named all the nights after women, I'm going to think up names of my own."

He smiled. "No such thing. It's pretty much at random. Look back there at the frozen ocean. That seemed like it ought to be Oceanus, so that's what I called it. The country we're over now is Hyperion, and that night over there in front of us, with the mountains and the irregular sea, is Rhea. When you face Rhea from Hyperion, north is to your left and south to your right. After that, going around the circle—I haven't seen most of these, you understand, but I know they're there—I call them Crius, which you can just see, then around the bend are Phoebe, Tethys, Theo, Metis, Dione, Iapetus, Cronus, and Mnemosyne. You can see Mnemosyne on the other side of Oceanus, behind us. It looks like a desert."

Cirocco tried to string them all together in her head.

"I'll never remember all that."

"The only ones that matter right now are Oceanus, Hyperion, and Rhea."

"Let me guess about the rivers. More mythology?"

"Yeah. I picked the nine largest rivers in Hyperion—which has got a hell of a lot of them, as you can see—and named them after the Muses. The one you came down is a feeder of the Clio, which is just about below us now."

Cirocco looked down and saw a blue ribbon winding through dense green forest, followed it back to the cliff face behind them, and gasped.

"So *that's* where the river went," she said.

It arched from the cliff face, nearly half a kilometer below where they had been standing, looking solid and hard as metal for fifty meters before it began to break up. It fragmented

rapidly from that point, reaching the ground as mist.

There were a dozen more plumes of water issuing from the cliff, none so close or spectacular, the rainbows were lined up like croquet wickets. It was breathtaking, almost too beautiful to be real.

"I'd like to have the postcard concession for this place," she said. Calvin laughed.

"You sell film for the cameras, and I'll sell tickets to the rides. What do you think of this one?"

Cirocco glanced back at Gaby, still frozen to the window.

"Reactions seem mixed. I like it okay. What's the name for the big river? That one that all the others join?"

"Ophion. The great serpent of the north wind. If you'll look closely, you can see that it comes out of a small lake back there at the twilight zone between Mnemosyne and Oceanus. That lake must have a source, and I suspect it's Ophion flowing underground through the desert, but we can't see where it goes under. Other than that, it flows without a break, into seas and out of them on the other side."

Cirocco traced the convoluted path and could see that Calvin was right. "I think a geographer would tell you that it's not the same river going into a sea as it is coming out," she said. "But I know all the rules were made for Earth rivers. Okay, so we'll call it a circular river."

"That's where Bill and August are," Calvin said, pointing. "About halfway down the Clio, where that third tributary—"

"Bill! And August. We were supposed to try and contact them. With all that commotion about getting on the blimp—"

"I borrowed your radio. They're up, and waiting for us. You can call them now, if you like."

Cirocco got her helmet ring and radio from Gaby.

"Bill, can you hear me? This is Cirocco."

"Uh . . . yeah, yeah! I hear you. How are you doing?"

"About as well as you'd expect, riding in the stomach of a blimp. What about you? Did you come through it all right? No injuries?"

"No, I'm fine. Listen, I wish . . . I wish I could say how good it feels to hear your voice."

She felt a tear on her cheek, and brushed it away.

"It's good to hear *you*, Bill. When you fell out that window—oh, damn! You wouldn't remember that, would you."

"There's a lot of things I don't remember," he said. "We can straighten it all out later."

"I'm dying to see you. Do you have any hair?"

"It's growing in all over my body. We'd better let all this wait. We've got lots to talk about, me and you and Calvin and . . ."

"Gaby," she prompted, after what seemed like a very long pause.

"Gaby," he said, without much con-

viction. "You can see I'm a bit confused about some things. But it shouldn't be a problem."

"Are you sure you're all right?" She felt cold suddenly, and rubbed her forearms briskly.

"Sure thing. When will you be here?"

Cirocco asked Calvin, who whistled a short tune. He was answered by another tune from somewhere overhead.

"Blimps don't have much idea of time," he said. "I'd say three or four hours."

"Is that any way to run an airline?"

CHAPTER SEVEN

Cirocco chose the front end of the gondola—it didn't help anything to think of it as a stomach—to be by herself. Gaby was still petrified and Calvin was not much fun to talk to once he'd said everything he knew about Whistlestop. He wouldn't discuss the things Cirocco wanted to know.

A handrail would have been nice. The gondola wall was clear as glass right down to her feet, and would have been clear there too but for the carpet of half-digested leaves and branches. It made a dizzying view.

They were passing over thick jungle, much like the country higher up on the cliff. The land was dotted with lakes. The river Clio—broad, yellow, and sluggish—wound through it all: a rope of water thrown to the ground to coil where it wished.

She was astonished at the clarity of the air. There were clouds over Rhea that built to thunderheads on the north shore of the sea, but she could see over them. She could see to the limits of the curve of Themis in both directions.

A school of big blimps hovered at various heights around the suspension cable nearest Whistlestop. She couldn't tell what they were doing there, but thought they might be feeding. The cable was massive enough that trees could very well grow on it.

Looking straight down, she could see the huge shadow Whistlestop cast. The lower they went, the larger the shadow became. After four hours it was tremendous, and they were still above the treetops. Cirocco wondered how Whistlestop proposed to set them on the ground. There was no clear area remotely large enough to accommodate him.

She was startled to see two figures standing at a bend in the river, on the west shore, waving at her. She waved back, unsure if she could be seen.

"So how do we get down?" she asked Calvin.

He grimaced. "I didn't think you'd like this, so I didn't bring it up. No sense in having you worry. We parachute."

Cirocco did not react, and he seemed relieved.

"It's a cinch, really. Nothing to it. Safe as can be."

"Uh-huh. Calvin, I love parachuting. I think it's loads of fun. But I like to inspect and pack my own chute. I

like to know who made it, and if it's a good one." She looked around her. "Correct me if I'm wrong, but I didn't see you carrying any aboard."

"Whistlestop has 'em," he said. "It never fails."

Again Cirocco said nothing.

"I'll go first," he said, persuasively. "So you can see."

"Uh-huh. Calvin, do I understand this is the only way down?"

"Short of going about a hundred kilometers east to the plains. Whistlestop will take you there, but you'll have to walk back through a swamp."

Cirocco looked at the ground, not really seeing it. She breathed in deeply, then exhaled.

"Right. Let's see these chutes." She went to Gaby and touched her shoulders, pulled her gently away from the side wall, and guided her toward the back of the gondola. She was docile as a child. Her shoulders were stiff, and she was shaking.

"I can't really show them to you," Calvin said. "Not until I jump. They're produced when you bail out. Like this."

He reached up and grasped a handful of dangling, white tendrils. They stretched. He began separating them until he had a loose netting. The stuff was like taffy, but held its shape when it wasn't pulled.

He forced one leg through a gap in the netting, then the other. He pulled it up around his hips and it formed a tight basket. He pushed his arms through more holes until his body was wrapped in a cocoon.

"You've jumped before; you know the drill. Are you a good swimmer?"

"Very good, if my life is at stake. Gaby? You swim well?"

It took her a few moments to become aware of them, then a flickering interest grew in her eyes.

"Swim? Sure. Like a fish."

"Okay," Calvin said. "Watch me, and do what I do." He whistled, and a hole irised into being on the floor in front of him. He waved, stepped over the lip, and fell like a stone. Which was not all that fast in one-quarter gravity, but fast enough, Cirocco felt, with an untested chute.

The shrouds spun out behind him like spider silk. Then came a solid, pale blue sheet, tightly bunched together and gone in a second. They looked down in time to see and hear the flutter and crack as the chute opened and grabbed air. Calvin floated down, waving to them.

She gestured to Gaby, who donned the harness. She was so eager to be out that she jumped before Cirocco could check the arrangement.

That's two out of three, she thought, and put her foot through the third set of webs. They were warm and elastic, and comfortable when she had them in place.

The jump was routine, if anything inside Themis could be so. The chute made a blue circle against the yellow sky over her. It seemed smaller than it should be, but apparently it was enough in the low gravity and high pressure. Grabbing a handful of shrouds, she guided herself carefully

toward the river's edge.

She hit standing up and got out of the harness quickly. The chute collapsed on the muddy bank, almost covering Gaby. She stood in knee-deep water and watched Bill coming toward her. It was hard not to laugh. He looked like a pale, plucked chicken with short stubble growing on his chest, his legs, arms, face, and scalp.

She put both hands on her forehead and rubbed them back over her fuzzy scalp, grinning wider as he got closer.

"Am I like you remember me?" she said.

"Even better." He splashed through the last few steps between them. He put his arms around her and they kissed. She did not cry, did not feel the need to, though she was brimming over with happiness.

Bill and August had done wonders in only six days, working with just the sharp edges of their suit rings. They had built two shacks; a third had two sides and half a roof. They were made from branches tied together and caked with mud. The roofs were slanted and thatched.

"The best we could do," Bill said, as he showed them around. "I was thinking in terms of adobe, but the sun won't dry the mud fast enough. They keep out wind, and most of the rain."

Inside, the huts were two by two meters, covered with a thick layer of dry straw. Cirocco could not stand erect, but didn't think of objecting. Being able to sleep inside was nothing to laugh at.

"We didn't have time to finish the other one before you got here," he went on. "One more day, with the three of you helping. Gaby, this one is for you and Calvin. Me and Cirocco will move into the one over there that August used to have. She says she wants the new one." Neither Calvin nor Gaby said anything, but Gaby was sticking close to Cirocco.

August looked like hell. She had aged five years since Cirocco last saw her. She was a thin, hollow-eyed ghost with hands that shook constantly. She looked incomplete, as if half of her had been hacked away.

"We didn't have time to make a fresh kill today," Bill was saying. "We were too busy on the new house. August, is there enough left over from yesterday?"

"I think so," she said.

"Would you get it?"

She turned away. Bill caught Cirocco's eye, pursed his lips, and shook his head slowly.

"Nothing at all from April, huh?" he said, softly.

"Not a word. Gene, either."

"I don't know what's going to happen to her."

After the meal Bill put them to work finishing the third hut. With two for practice, he had it down to a routine. It was tedious, but not physically difficult; they could move large logs readily, but had a terrible time cutting even the smallest ones. As a result, the fruit of their labors was not pretty to look at.

When it was done, Calvin went into the hut he had been assigned while August moved into another. Gaby seemed at a loss, but finally managed to stammer that she was going to look around the area, and would not be back for several hours. She wandered off, looking forlorn.

Bill and Cirocco looked at each other. Bill shrugged, and gestured toward the remaining hut.

Cirocco sat awkwardly. There were many things she wanted to ask, but she was hesitant to start.

"How was it for you?" she asked, finally.

"If you mean the time between the collision and waking up in here, I'm going to have to disappoint you. I don't remember any of it."

She reached over and probed gently at his forehead.

"No headaches? Dizziness? Calvin should take a look at you."

He frowned. "Was I hurt?"

"Pretty bad. Your face was bloody and you were out cold. That's all I could see in the few seconds I had. But I thought your skull might be broken."

He felt his forehead, ran his fingers around to the sides and back of his head.

"I can't find any tender places. There weren't any bruises, either. Cirocco, I—"

She put her hand on his knee. "Call me Rocky, Bill. You know you're the only one I didn't mind it from."

He scowled, and looked away from her.

"All right, Rocky. That's what I need to talk to you about. It isn't just the . . . the dark period, August called it. It isn't just what I can't remember. I'm pretty hazy about a lot of things."

"Just how many things?"

"Like where I was born, how old I am, or where I grew up or went to school. I can see my mother's face, but I can't remember her name, or if she's dead or alive." He rubbed his forehead.

"She's alive and very well in Denver, where you grew up," Cirocco said, quietly. "Or she was when she called us on your fortieth birthday. Her name's Betty. We all liked her."

He seemed relieved, then downcast again.

"I guess that means something," he said. "I *did* remember her because she's important to me. I remembered you, too."

Cirocco looked into his eyes. "But not my name. Is that what you're having trouble telling me?"

"Yeah." He looked miserable. "Isn't that a hell of a thing? August told me your name, but she didn't tell me I called you Rocky. That's kind of cute, by the way. I like that."

Cirocco laughed. "I've been trying to kill that name most of my adult life, but I always weaken when somebody whispers it in my ear." She took his hand. "What else do you remember about me? You recall I was the Captain?"

"Oh, sure. I remember you were the first female Captain I'd ever served under."

"Bill, in free fall, it doesn't matter who's on top."

"That's not what I—" He smiled when he realized he was being kidded. "I wasn't sure about that, either."

They kissed, and he looked up at her and smiled.

"I wanted to tell you that I love you."

"You never said that before. Maybe you shouldn't commit yourself until you get your memory back."

"I think I might not have known I loved you before. Then . . . all I was left with was your face and a feeling. I'll trust that. And I meant what I said."

Gaby chose that moment to walk in the door.

"Pardon me, Rocky, but I was wondering if we should do something about the parachutes. One of them already floated down the river."

Cirocco sat up quickly. "Do what with them?"

"Save them. They might be useful."

"You . . . sure, Gaby. You might be right."

"I just thought it would be a good idea." She looked at the floor and shuffled her feet, glanced at Bill for the first time. "Uh . . . okay. I thought maybe I . . . could make something nice for you." She hurried from the hut.

Bill sat up and put his elbows on his knees.

"Was I reading too much into that?"

Cirocco sighed. "I'm afraid not. Gaby's going to be a big problem. She thinks she's in love with me, too."

CHAPTER EIGHT

"What do you mean, good-bye? Where are you going?"

"I've been thinking it over," Calvin said quietly. He removed his wristwatch and handed it to Cirocco. "You people can use this better than I can."

Cirocco was about to burst with frustration.

"And that's all the explanation we get? 'I've thought it over.' Calvin, we've got to stick together. We're still an exploration party, and I'm still your Captain. We've got to work together toward getting rescued."

He smiled faintly. "And just how are we going to do that?"

She wished he hadn't asked that question.

"I haven't had time to work out a plan on that," she said vaguely. "There's bound to be something we can do."

"You let me know when you think of something."

"I'm ordering you to stay with the rest of us."

"How are you going to stop me from leaving if I want to go? Knock me out and tie me up? How much energy is it going to take to guard me all the time? Keeping me here makes me a liability. If I go, I can be an asset."

"What do you mean, an asset?"

"Just that. The blimps can talk around the whole curve of Themis. They're great with news; everybody here listens to them. If you ever need me for anything, I'd come back. All I'd have to do is teach you a few simple calls. Can you whistle?"

"Never mind that," Cirocco said, with an annoyed wave of her hand. She rubbed her forehead, and allowed her body to relax. If she was to make him stay, she had to talk him out of it, not restrain him.

"I still don't see why you want to go. Don't you like it here with us?"

"I . . . no, not all that much. I was happier when I was alone. There's too much tension. Too much bad feeling."

"We've all been through a lot. It ought to get better when we get some things straightened out."

He shrugged. "Then you can call me, and I'll try it again. But I don't care for the company of my own kind anymore. The blimps are freer, and wiser. I've never been happier than during that ride."

He was showing more enthusiasm than Cirocco had seen since the meeting on the cliff.

"The blimps are old, Captain. Both as individuals and as a race. Whistlestop is maybe three thousand years old."

"How do you know that? How does *he* know?"

"There are times of cold, and times of warmth. I figure they must be because Themis always stays pointed in the same direction. The axis points close to the sun right now, but every fifteen years the rim blocks the sunlight until Saturn moves and brings the other pole back toward the sun. There's years in here, but each of them is fifteen years long. Whistlestop has seen two hundred of them."

"Okay, okay," Cirocco said. "That's what we need you for, Calvin. Somehow you're able to talk to these things. You've been learning from them. Some of it might be important to us. Like these six-legged things, what did you call them . . . ?"

"Titanides. That's all I know about them."

"Well, you might learn more."

"Captain, there's too much to know. But you've landed in the most hospitable part of Themis. Stay put, and you'll be all right. Don't go into

Oceanus, or even Rhea. Those places are dangerous."

"See? How could we have known that? We *need* you."

"You don't understand. I can't learn about this place without going to *see* it. Whistlestop's language is mostly out of my range."

Cirocco could feel the bitterness of defeat welling up inside her. Damn it, John Wayne would have keelhauled the bastard. Charles Laughton would have clapped him in irons.

She knew it would make her feel a lot better just to take a swing at the obstinate son of a bitch, but that would wear off quickly. She had never commanded like that. She had won and kept the respect of her crew through showing responsibility and using the best wisdom she could bring to bear on any situation. She could face facts, and knew Calvin was going to leave them, but it just didn't feel right.

And why not? she wondered. Because it lessened her authority?

That had to be part of it, and part of it was her responsibility for his welfare. But it came back to the problem she had faced from the beginning of her command: the lack of enough role models for a female ship's captain. She had determined to examine all assumptions and use only those that felt right to her. Just because it was right to Admiral Nelson in the British Navy did not mean it was right for her.

There had to be discipline, surely, and there had to be authority. Naval captains had been demanding one and enforcing the other for thousands of years, and she did not intend to throw away all that accumulated experience. Where a captain's authority was questioned, disaster usually followed.

But space was not the same, generations of science fiction writers to the contrary. The people who explored it were highly intelligent, individualistic geniuses, the very best the Earth had to offer. There had to be flexibility, and the NASA legal code for deep-space voyages acknowledged it.

Then there was the other factor she could never forget. She no longer had a ship. The worst thing that could ever happen to a Captain had happened to her. She had lost her command. It would be a bitter taste in her mouth for the rest of her life.

"All right," she said, quietly. "You're right. I can't spare the time and energy to guard you, and I don't feel like killing you, except in a figurative sense." She made herself stop when she realized she was gritting her teeth, and deliberately relaxed her jaw. "I'm telling you now that if we get back, I'm bringing you up on charges of insubordination. If you go, it will be against my wishes, and against the interests of the mission."

"I accept that," he said, without emotion. "You'll come to see that the last part is not true. I'll be more use where I'm going than I would be here. But we're not going back to Earth."

"We'll see. Now, why don't you teach somebody how to call blimps? I find I'd rather not be around you."

In the end, Cirocco had to learn the

whistle code, because she had the most musical ability. Her sense of pitch was near-perfect, and it was critical to the blimp speech.

There were only three phrases to learn, the longest being seven notes and a trill. The first translated as "good lifting," and was nothing but a polite greeting. The second was "I want Calvin," and the third was "Help!"

"Remember, *don't* call a blimp if you've got a fire going."

"How optimistic you are."

"You'll make a fire soon enough. Uh, I was wondering . . . do you want me to take August off your hands? She might feel better if she was with me. We can cover more ground looking for April."

"We can take care of our own casualties," Cirocco said, coldly.

"Whatever you think is best."

"She's barely aware that you're leaving anyway. Just get out of my sight, will you?"

August proved to be not as comatose as Cirocco had thought. When she heard Calvin was leaving, she insisted on joining him. After a brief battle, Cirocco gave in, though with even more misgivings than before.

Whistlestop came in low and began spinning a cable. They watched it whip and twist in the air.

"Why is he willing to do this?" Bill asked. "What does he get out of it?"

"He likes me," Calvin said, simply. "Also, he's used to carrying passengers. The sentient species pay for their rides by moving food from his first stomach into the second. He doesn't have the muscles for it. He has to save on weight."

"Does everything here get along so well?" Gaby asked. "We haven't seen anything like a carnivorous animal so far."

"There are carnivores, but not many. Symbiosis is the basic fact of life. That, and worship. Whistlestop says all the higher life forms owe allegiance to a godhead, and the seat of divinity is in the hub. I've been thinking of a goddess that rules the whole circle of the land. I call her Gaea, for the Greek mother."

Cirocco was interested, in spite of herself. "What is Gaea, Calvin? Some sort of primitive legend, or maybe the control room of this thing?"

"I don't know. Themis is a lot older than Whistlestop, and a lot of it is unknown to him, too."

"But who runs it? You said there were many races in here. Which one? Or do they cooperate?"

"Again, I don't know. You've read the stories of generation ships where something went wrong and everybody slipped back to savagery? I think something like that might be going on here. I know something's working somewhere. Maybe machines, or a race that stays in the hub. That may be the source of the worship. But Whistlestop is sure there's a hand on the wheel."

Cirocco scowled. How could she let him go, with all that information in his head? It was spotty and they had no

way of knowing how much of it was true, but it was all they had.

But it was too late for second thoughts. His foot was in the stirrup at the end of the long line. August joined him and the blimp reeled them in.

"Captain," he shouted, just before they disappeared. "Gaby shouldn't have called this place Themis. Call it Gaea."

"I'm sorry, Bill, I know you put a lot of work into this place. But when they come to get us, I want to be working as hard as I can toward getting ourselves out."

"I agree with you, basically. What's your idea?"

She explained her thinking about the hub, the fact that if there was a central technological control for this vast construct, it would be up there.

"I don't know what we'd find. Maybe nothing but cobwebs and dust, and everything down here is still going by sheer inertia. Or maybe the captain and a crew waiting to blow us to pieces for invading their ship. But we have to look."

"How do you propose to get up there?"

"I don't know for sure. I'm assuming the blimps can't do it or they would know more about this goddess they talk about. There may not even be any air in the spokes."

"That would make it a bit tough," Gaby pointed out.

"We won't know until we look. The way to get up the spokes is the support cables. They should go all the way up the insides, right to the top."

"My god," Gaby muttered. "Even the slanted ones are a hundred kilometers high. And that just brings you to the roof. From there it's another five hundred kilometers to the hub."

"My aching back," Bill groaned.

"What's the matter with you?" Cirocco demanded. "I didn't say we'd climb them. We'll decide that when we get a good look. What I'm trying to tell you is that we're *ignorant* of this place. For all I know, there's an express elevator sitting in the swamp that would take us all the way to the top. Or a little man selling helicopter tickets, or magic carpets. We'll never know unless we start looking around."

"Don't get excited," Bill said. "I'm with you."

"What about you, Gaby?"

"I go where you go," she said, matter-of-factly. "You know that."

"All right. Here's my thinking. There's a slanted cable to the west, toward Oceanus. But the river flows the other way, and we could use that for transportation. We might even get to the next row of cables faster that way than beating through the jungle. I think we should head east, toward Rhea."

"Calvin said we should stay out of Rhea," Bill reminded.

"I didn't say we'd go into it. If there's anything that would be harder to take than this perpetual afternoon, it would have to be perpetual night, so I'm not anxious to go there anyway. But there's a lot of country between

here and there. We could take a look at it."

"Admit it, Rocky. You're a tourist at heart."

She had to smile. "Guilty. I thought a while ago, here we are in this incredible place. We know there are a dozen intelligent races in here. What do we do? Sit around and fish. Well, not me. I feel like nosing around. It's what they were paying us for, and hell, it's what I like. Maybe I want some adventure."

"My god," Gaby said again, with a hint of a chuckle. "What more could you ask? Hasn't enough happened?"

"Advantages have a way of turning around and biting you," Bill said.

"Don't I know it. But we're heading down that river, anyway."

CHAPTER NINE

The seeds grew from the tops of the tallest trees in the forest. Each tree produced only one seed at a time, and when it reached maturity it exploded like a cannon shot. They had heard them going off at long intervals. What was left after the explosion was something like a walnut shell, evenly and smoothly divided.

When they saw a large one float by, they swam out and pulled it to shore. It rode high in the water when empty. Loaded, it still had plenty of freeboard.

They took two days outfitting it and trying to rig a rudder. They fashioned a long pole with a broad blade on the end, and hoped that would be enough. There was a primitive oar for each of them in case they ran into rough water.

Gaby cast off the line. Cirocco put her back into poling them out to the middle of the river, then took her post at the stern, one hand lightly on the tiller. A breeze came up, and she wished once again for her hair. What a fine thing, to have hair whipping in the wind. It's the simple things we miss, she thought.

Gaby and Bill were excited, forgetting their animosity for the time being as they sat on opposite sides of the boat, watching the river ahead and calling out hazards to Cirocco.

"Sing us a sea chantey, Captain," Gaby yelled back.

"You've got it mixed up, stupid," Cirocco laughed. "It's you low-life types in the fo'c'sle who pump the bilge and sing the songs. Haven't you ever seen *The Sea Witch*?"

"I don't know. Has it been on the treedie?"

"It's a flat movie starring good ol' John Wayne. The *Sea Witch* was his ship."

"I thought it might be the Captain. You've just picked yourself a nickname."

"What about a name for *this* boat, Rocky?" Bill asked.

"Hey, it should have a name, shouldn't it? I was so busy trying to scrounge up champagne for the launching I forgot all about it."

"Don't mention champagne to me," Gaby groaned.

"Any suggestions? Here's your chance for a promotion."

"I know what Calvin would have named it," Bill said, suddenly.

"Don't talk to me about Calvin."

"Nevertheless, we've committed ourselves to Greek mythology. This ship should be named the *Argo*."

Cirocco looked doubtful. "Wasn't that tied up with the search for the golden fleece? Oh, yeah, I remember the movie now."

"We're not searching for anything," Gaby pointed out. "We know where we want to go."

"Then how about . . . " Bill paused, then looked thoughtful. "I'm thinking of Odysseus. Did his ship have a name?"

"I don't know. We lost our mythologist to that overgrown tire advertisement. But even if it did, I wouldn't want to use it. Odysseus had nothing but trouble."

Bill grinned. "Superstitious, Captain? I never would have believed it."

"It's the sea, lad. It does strange things to a body."

"Don't give me your late show dialogue. I vote to call the boat *Titanic*. There was a ship for you."

"A bucket of rust. Don't tempt the fates, matey."

"I like *Titanic*, too," Gaby laughed. "Who'd believe it, on a boat made out of a glorified peanut?"

Cirocco looked up, thoughtfully. "Let it be on your heads, then. *Titanic*, it is. Long may she sail. You may whoop, and otherwise make merry."

The crew cheered three times, and Cirocco grinned and took a bow.

"Long live the Captain," Gaby shouted, raising a fist in the air.

"Say," Cirocco said. "Shouldn't we be painting the name on the fender, or whatever the hell it is?"

"On the *what*?" Gaby looked horrified.

Cirocco grinned. "This is a fine time to be telling you, but I don't know anything about boats. Who's done some sailing?"

"I've done a little," Gaby said.

"Then you're ship's pilot. Change places with me." She released the tiller and walked forward carefully. She reclined on her back, stretched, and folded her arms under her head. "I'll be making important command decisions," she said, with a big yawn. "Don't disturb me for anything less than a hurricane." She closed her eyes to a chorus of hoots.

Life settled into a routine. Soon they were working flawlessly as a team, seldom needing to talk. Most of the time there was little to do but stay alert for sand bars. Gaby and Bill spent a lot of time making clothing from the parachute cloth. They both got to be handy with thorn needles.

Cirocco spent most of her time daydreaming, watching the clouds drift by. She considered ways and means of reaching the hub, trying to anticipate problems, but it was a futile occupation. The possibilities were too varied to allow reasonable planning. She much preferred woolgathering.

She eventually did sing to them, and surprised them both. She had taken voice and piano lessons for ten years as

a child, had considered a career as a singer before the lure of space grew too strong. No one knew about it until the trip in the *Titanic*; she had thought it not in keeping with her image to entertain the crew with songs. Now she didn't care, and the singing brought them closer together. She had a rich, clear alto that worked best with old folk music, ballads, and Judy Garland songs.

After thirty-four days of slow drifting, the crew of *Titanic* found themselves leaving the tropical forest. The land had never been hilly; now it turned flat as a billiard table and Ophion sprawled for kilometers in every direction. There was no longer a shoreline as such. The only things to mark the end of the river and the beginning of the marshlands were stands of tall grass rooted in the bottom and the occasional meter-high mud bank. A sheet of water stretched over everything, seldom more than ten centimeters deep except in the winding mazes of sloughs, bayous, inlets, and backwaters. There were kept clear and gouged deeper by big eels and one-eyed mudfish the size of hippos.

The trees in the region came in three varieties, growing in widely-scattered clumps. The kind that appealed to Cirocco looked like glass sculpture, with straight, transparent trunks and regular branches in a crystalline arrangement. The smallest branches were filaments that could have been used in fiber optics. When the wind blew, the weakest branches broke off. Recovered and wrapped with chute cloth on one end, they made excellent knives. From the flashing effect when the filaments moved, Gaby named them xmas trees, pronouncing it "exmas."

The other major vegetation was not so much to Cirocco's liking. One plant—it seemed wrong to call it a tree, though it was large enough—resembled a pile of what can be seen on the ground at any cattle ranch. Bill named them dung trees. On their closest approach to one they could see that there was an internal structure, but no one wanted to get too near because they smelled all too much like what they appeared to be.

Then there were trees that did a better job of looking the part. They had something of the cypress and a little of the willow in them, growing in untidy tangles festooned with creepers that struggled to pull them down.

The marshlands were alien in a much more unpleasant way than the highlands had been. The jungle they had left behind was not too different from the Amazon or the Congo. Here, nothing looked familiar, everything was misshapen and threatening.

Camping was impossible. They began tying the boat to trees and sleeping in it. It rained every ten to twelve hours. They rigged chutecloth tents over the bow, but water always leaked in and pooled in the bottom. The weather was hot but the humidity was so high that nothing ever dried out.

With the mud, the heat and dampness and sweat, they grew irritable. They were short on sleep, often man-

aging no more than a fitful doze while off duty, doing even worse when all three tried to sleep and ended up competing for the limited space on *Titanic*'s sloping bottom.

Cirocco awoke from a nightmare of being unable to breathe. She sat up, feeling the cloth of her robe peel away from her skin. She felt sticky between her fingers and toes, under her neck, and in her lap.

Gaby nodded to her as she stood up, then turned her attention back to the river.

"Rocky," Bill said. "There's something you'll want to—"

"No," she said, holding her hands up. "Dammit, I want coffee. I'd *kill* for coffee."

Gaby smiled dutifully, but it looked like an effort. They knew by now that Cirocco was a slow starter.

"Not funny. Right." She stared bleakly out at the land that looked as decayed and rotten as she felt. "Just give me a minute before you start asking me things," she said. She struggled out of her clinging clothes and jumped in the river.

It was better, but not much.

She bobbed, treading water and holding the side of the boat and thinking about soap until her foot touched something slippery. She didn't wait to find out what it was, but pulled herself over the edge and stood with water pooling at her feet.

"Now. What is it you wanted?"

Bill pointed toward the north shore.

"We've been seeing smoke over that way. You can see some of it now, just to the left of that bunch of trees."

Cirocco leaned over the edge of the boat and saw it: a thin line of gray sketched against the backdrop of the distant north wall.

"Let's beach this thing and take a look."

It was a long, grueling slog through knee-deep mud and stagnant water. Bill led the way. They began to get excited as they came around the big dung tree that had obscured their vision. Cirocco caught a whiff of smoke over the stronger stench of the tree, and hurried over the slippery ground.

It began to rain just as they arrived at the fire. It was not a hard rain, but it wasn't much of a fire, either. It looked as if all they would get out of it would be black soot on their legs.

The fire was an irregular smudge covering a square hektometer, smoldering fitfully at the edges. As they watched, the gray smoke began to turn white as the rain fell. Then a tongue of flame licked the bottom of a bush a few meters away.

"Get something that's dry," Cirocco ordered. "Anything at all. Some of that marsh grass, and some sticks. Hurry, we're losing it." Bill and Gaby ran off in different directions as Cirocco knelt by the bush and blew on it. She ignored the smoke in her eyes and kept blowing until she felt dizzy.

Soon she was piling on reasonably dry wood. Finally she could sit back and feel sure it would keep burning.

Gaby shouted and threw a stick so high it was nearly invisible before it started to come down. Cirocco grinned when Bill slapped her on the back. It was a small victory, but it could be an important one. She felt great.

When the rain stopped, the fire was still going.

The problem was how to keep it going.

They discussed it for hours, tried and discarded several solutions.

It took the rest of the day and most of the next to make their plan work. They made two bowls from the swamp clay, fired them carefully, then dried a large quantity of the wood which burned most slowly. When that was done, they made small fires in both of the bowls. It seemed wise to have a spare. The scheme would require someone to tend the fire at all times, but they were willing to do that until they found a better solution.

When they were through, it was nearing time for a sleep period. Cirocco wanted to see if they could make it to dry ground, not really trusting their arrangements for the fire, but Bill suggested they make a kill first.

"I'm getting pretty tired of those melons," he said. "The last one I had tasted rancid."

"Yeah, but there's no smilers. I haven't seen one in days."

"Then we'll knock over something else. We need some meat."

It was true they had not been eating well. The marsh had nothing like the profusion of fruit-bearing plants they had found in the forest. The one native plant they had tried tasted like a mango and gave them diarrhea. On the boat that was comparable to an inner circle of hell. Since then they had relied on stored provisions.

They decided the big mudfish were the most obvious prey. Like all the other animals they had encountered, the fish took little notice of them. Everything else was too small and quick, or, like the giant eels, too big.

The mudfish liked to sit in the ooze with their snouts buried, moving by flipping their tails.

She and Gaby and Bill soon had one surrounded. It was their first close look at one. Cirocco had never seen a creature so ugly. It was three meters long, flat on the bottom, and bulged in the middle from its blunt snout to a wicked-looking horizontal tail fluke. There was a long gray ridge along its back, soft and loose like a rooster's comb, but slimy. It swelled and deflated rhythmically.

"Are you sure you want to eat that?"

"If it'll hold still long enough."

Cirocco was stationed four meters in front of the mudfish while Gaby and Bill approached from the sides. All three carried swords made from broken xmas tree branches.

The mudfish had one eye the size of a pie plate. One edge of the eye elevated until it was looking at Bill. He froze. The fish made a snuffling sound.

"Bill, I don't like this."

"Don't worry. It's blinking, see?" A stream of liquid spurted from a hole above the eye, producing the snuffling sound. "It's keeping its eye wet. No eyelids."

"If you say so." Cirocco flapped her arms, and the fish obligingly looked away from Bill and toward her. She wasn't sure that was an improvement, but took a step forward on the balls of her feet. The fish looked away, bored by it all.

Bill moved in, braced himself, and put his sword through the flesh just behind the eye, leaning on it. The fish jerked as Bill released the sword and danced back.

Nothing happened. The eye did not move, and the organs on its back no longer swelled in and out. Cirocco relaxed, and saw Bill grinning.

"Too easy," he said. "When is this place going to give us a challenge?" He took the hilt of his sword and pulled it out. Dark blood spurted over his hand. The fish bent, touching its snout with its tail, then swung the tail sideways and down on Bill's head. It scooped deftly under his motionless body and hurled him into the air.

Cirocco did not even see where he came down. The fish arched again, this time balancing on its belly with both snout and tail in the air. She saw its mouth for the first time. It was round, lampreylike, with a double row of teeth that counter-rotated and clattered. The tail hit the mud and the fish jumped at her.

She dived flat to the ground, ploughing up a wake of mud with her chin. The fish plopped behind her, arched, and flipped fifty kilos of mud into the air as it lashed madly with its tail. The sharp fin sliced the ground in front of her face, then rose for another try. She scurried on her hands and knees, slipping every time she tried to stand.

"Rocky! Jump!"

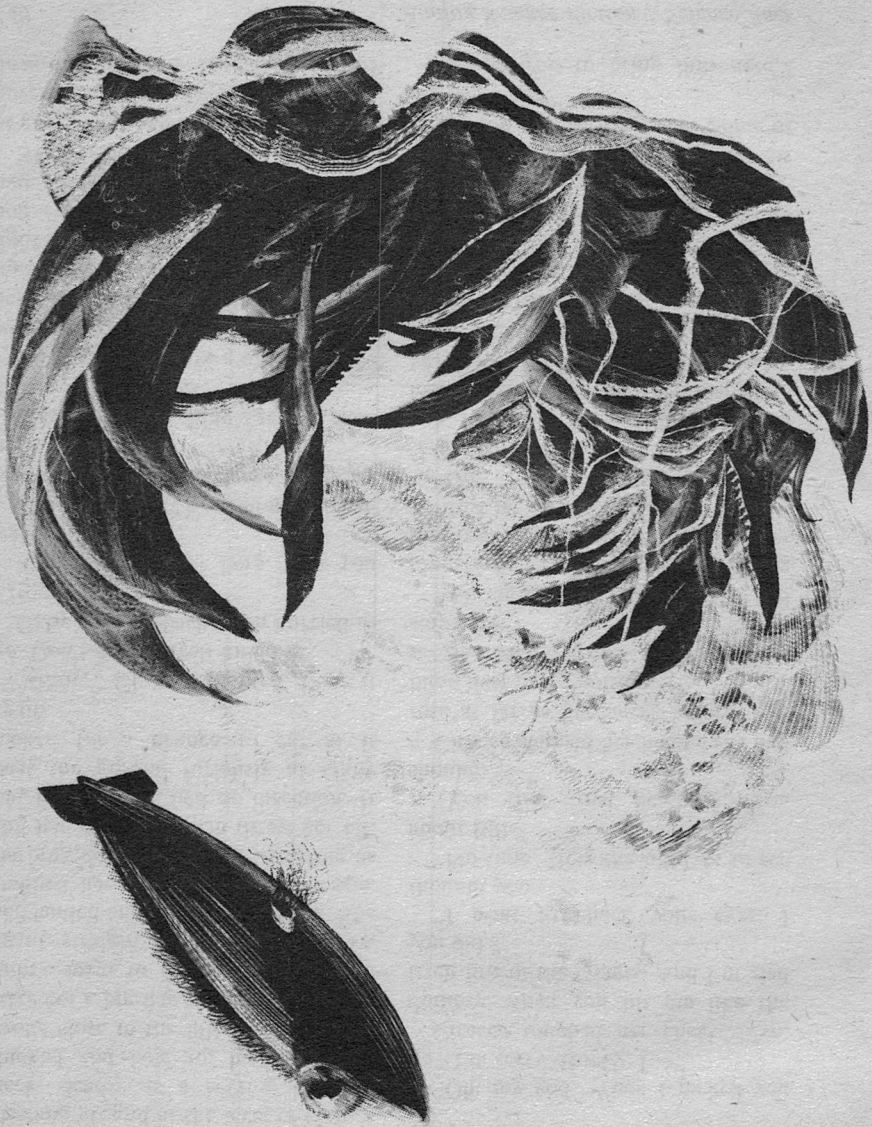
She did, and narrowly missed having her arm taken off as the fish's tail hit the ground again.

"Go, go! It's coming after you!"

A glance behind showed only rotating teeth. All she could hear was their terrible buzz. It meant to eat her.

She was in mire up to her knees and heading toward deeper water, which did not seem like a good idea, but every time she tried to turn the tail flashed out of the mud. Soon she was blind from the constant barrage of filthy water. She slipped, and before she could get up the tail hit the side of her head. She was conscious but her ears were ringing as she turned over and groped for her sword. The mud had swallowed it. The fish was a meter away, curling for a leap that would crush her, when Gaby came running past it. Her feet scarcely touched the ground. She hit Cirocco with a flying tackle hard enough to loosen teeth, the fish leaped, and all three of them skidded three meters through the mud.

Cirocco was dimly aware of a slimy wet wall under one foot. She kicked. The fish lashed at them again as Gaby pulled Cirocco along, swimming through the mud. Then she let go, and



Cirocco lifted her head out of the water, gasping.

She saw Gaby's back as she stood facing the creature. The tail came slashing around at the level of Gaby's neck, deadly as a scythe, but she ducked and held up her sword. It broke close to the hilt, but the sharp edge cut a big flap in the fin. The fish didn't seem to like it. Gaby leaped again, straight for the hideous jaws, and landed on the creature's back. She stabbed her sword hilt into the eye, slashing down instead of thrusting as Bill had done. The fish threw her off, but now the tail had no direction. It beat the ground furiously as Gaby looked for a chance to cut at it again.

"*Gaby*," Cirocco shouted. "Let it go. Don't get yourself killed."

Gaby glanced back, then hurried to Cirocco.

"Let's get out of here. Can you walk?"

"Sure, I . . ." The ground whirled. She clutched Gaby's sleeve to steady herself.

"Hang on. That thing's getting closer."

Cirocco didn't have a chance to see what she meant, because Gaby lifted her before she knew what was happening. She was too weak and confused to fight it as Gaby brought her out of the bog, slung over her shoulder in a fireman's carry.

She was put down gently on a patch of grass, and then she saw Gaby's face hovering over her. Tears were running down her cheeks as she gently probed Cirocco's head, then moved down to her chest.

"Ow!" Cirocco winced and curled around the pain. "I think you broke a rib."

"Oh, my god. When I picked you up? I'm sorry, Rocky, I—"

Cirocco touched her cheek. "No, dummy, when you hit me like the front line of the Giants. And I'm glad you did."

"I want to check your eyes. I thought you—"

"No time. Help me up. Got to see about Bill."

"You first. Just lie back. You shouldn't—"

Cirocco slapped her hand away and rose as far as her knees before doubling over and vomiting.

"See what I mean? You've got to stay here."

"All right," she choked. "Go find him, Gaby. Take care of him. Bring him back here, alive."

"Just let me check your—"

"*Go*!"

Gaby bit her lip, glanced at the fish still thrashing in the distance, and looked tortured. Then she leaped to her feet and ran in what Cirocco hoped was the right direction.

She sat there holding her belly and cursing softly until Gaby returned.

"He's alive," she said. "Out cold, and I think he's hurt."

"How bad?"

"There's blood on his leg and his hands and all over his front. Some of it's fish blood."

"I told you to bring him here,"

Cirocco growled, trying to hold back another fit of nausea.

"Ssssh," Gaby soothed, rubbing her hand lightly over Cirocco's forehead. "I can't move him until I can make a litter. First, I'm going to get you back to the boat and bedded down. Hush! If I have to fight you, I will. You wouldn't want a punch in the jaw, would you?"

Cirocco felt like throwing a punch herself, but the nausea overcame the urge. She settled to the ground and Gaby scooped her up.

She remembered thinking how ridiculous they must look: Gaby was one hundred fifty centimeters tall while Cirocco was one hundred eighty-five. In the low gravity Gaby had to move cautiously, but the weight was no problem.

Things didn't spin so badly when she closed her eyes. She put her head on Gaby's shoulder.

"Thanks for saving my life," she said, and passed out.

She woke to the sound of a man screaming. It was not a sound she ever cared to hear again.

Bill was semiconscious. Cirocco sat up and cautiously touched the side of her head. It hurt, but the dizziness was gone.

"Come here and give me a hand," Gaby said. "We've got to hold him down or he'll hurt himself."

She hurried to Gaby's side. "How bad is he?"

"Real bad. His leg's broken. Probably some ribs, too, but he hasn't coughed up any blood."

"Where's the break?"

"Tibia or fibula. I don't know which is which. I thought it was a laceration until I put him on the litter. He started fighting and the bone stuck out."

"Jesus."

"At least he's not losing much blood."

Cirocco felt another quiver in her stomach as she examined the ragged gash in Bill's leg. Gaby was washing it with boiled chutecloth rags. Every time she touched it, he screamed hoarsely.

"What are you going to do?" Cirocco asked, vaguely aware that she should be telling her what to do, not asking.

Gaby looked agonized. "I think you should call Calvin."

"What's the use of that? Oh, yeah, I'll call him, but it'll take him a while to get here. If Bill's dead, I'll kill him."

"Then we have to set it."

"You know how to do it?"

"I saw it done, once," said Gaby. "With anesthetic."

"What we've got is a lot of rags that I hope are clean. I'll hold his arms. Wait a minute." She moved to Bill's side and looked down at him. He stared at nothing, and his forehead was hot when she touched it.

"Bill? Listen to me. You're hurt, Bill."

"Rocky?"

"It's me. It's going to be all right,

but your leg is broken. Do you understand?"

"I understand," he whispered, and closed his eyes.

"Bill, wake up. I'll need your help. You can't fight us. Can you hear me?"

He lifted his head and looked down at his leg. "Yeah," he said, wiping his face with a dirty hand. "I'll be good. Get it over with, will you?"

Cirocco nodded to Gaby, who grimaced and pulled.

It took three tries, and left both women shaken. On the second pull the bone end protruded with a wet sound that made Cirocco throw up again. Bill bore it well, his breath whistling and his neck muscles standing out like cords, but he no longer screamed.

"I wish I knew how good a job that is," Gaby said. Then she began to cry. Cirocco let her alone and worked on binding the splint to Bill's leg. He was unconscious by the time she was through. She stood up and held her bloody hands up in front of her.

"We'll have to move on," she said. "It's no good here. We have to find a place where it's dry and set up a camp and wait for him to get better."

"He probably shouldn't be moved."

"No," she sighed. "But he has to be. Another day ought to bring us to that high country we saw earlier. Let's go."

CHAPTER TEN

It took two days instead of one, and they were terrible days.

They stopped frequently to sterilize Bill's bandages. The bowl they used to heat the water was nothing so fine as a ceramic pot; it flaked and wanted to melt, and left the water clouded. The water took the better part of an hour to boil because the pressure in Gaea was higher than one atmosphere.

Gaby and Cirocco snatched a few hours sleep, one at a time, when the river was quiet and wide. But when they came to a hazardous stretch it took both of them to keep the boat from going aground. It continued to rain regularly.

Bill slept, and woke after the first twenty-four hours looking five years older. His face was gray. When Gaby changed the bandage his wound did not look good. The lower leg and most of his foot were nearly twice their normal size.

By the time they left the swamp he was delirious. He sweated profusely, and ran a high fever.

Cirocco contacted a passing blimp early on the second day, getting back the high, rising whistle that Calvin had told her meant "Okay, I'll tell them," but she was already starting to fear it was too late. She watched the blimp sail serenely toward the frozen sea, and asked herself why she had insisted they leave the forest. And if they must, why not go on Whistlestop, sailing over it all, far from terrible things like mudfish that refused to die?

Her reasons were as valid now as they had been then, but it didn't stop her from blaming herself. Gaby could

not ride in the blimps, and they had to find a way out. But she thought there must be easier, more satisfying things than taking the responsibility for other lives, and she was sick of her own life. She wanted out, she wanted someone else to take the burden. How had she ever thought she could be a captain? What had she done right since taking command of *Ringmaster*?

What she really wanted was simple, but so hard to find. She wanted love, just like anyone else. Bill had said he loved her; why couldn't she say it back to him? She had thought she might be able to say it, someday, but now it looked like he was going to die, and he was her responsibility.

She also wanted adventure. It had driven her all through her life, from the first comic book she opened, the first space documentary she had watched as a wide-eyed child, the first old black and white flat-screen swashbucklers and full-color westerns she saw. The thirst to do something outrageous and heroic had never left her. It had pushed her away from the singing career her mother wanted, and the housewife role everyone else thrust at her. She wanted to swoop down on the base of the space pirates, lasers blazing, to slink through the jungle with a band of fierce revolutionaries for a night raid on the enemy stronghold, to search for the Holy Grail or destroy the Death Star. She had found other reasons, as an adult, to slog her way through college and train herself to be the best there was so that when the chance came, they could choose no other for the Saturn mission. Beneath it all, nevertheless, it was the itch to travel and see strange places and do things no one else had done that landed her on the decks of *Ringmaster*.

Now she had her adventure. She was floating down a river in a cockleshell boat inside the most titanic structure ever seen by a human eye, and a man who loved her was dying.

East Hyperion was a land of gently rolling hills and long stretches of plains, dotted with wind-blown trees like an African savanna. Ophion grew narrower and began to rush along, at the same time becoming mysteriously cooler.

They drifted for five or six kilometers at the mercy of the river, past low cliffs that dropped abruptly at the water's edge. *Titanic* was unsteerable when she moved fast. Cirocco watched for a widening in the river and a place to land.

She saw it, and they spent two hours fighting the current with poles and paddles to bring the boat to the rocky shore. Both of them were on their last reserves of strength. More ominously, there was no food in the boat and East Hyperion did not look fertile.

They dragged *Titanic* up the shore, feet sliding over rocks tumbled smooth by the water, until they were sure it was out of danger. Bill was not aware of the movement. He had not spoken in a long time.

Cirocco sat up with Bill while Gaby fell into a deathlike sleep. She kept herself awake by exploring the area

within a hundred meters of the campsite.

There was a low bank twenty meters from the river's edge. She scrambled to the top.

East Hyperion looked like a great place for a farmer. Wide stretches of the land looked like a yellow Kansas wheat field. That illusion was spoiled by other areas that were rust red, and still others of a pale blue mixed with orange. It all rippled in the wind like tall grass. Dark shadows drifted by, some of the clouds so low they formed fogbanks in the creek beds, even in sunlight.

To the east, hills marched to the twilight zone of west Rhea, gradually gaining a green coloring that must have been forest, then losing it in the darkness to become stark rocky mountains. In the west the land flattened out, with the shallow lakes and bogs of the mudfish marsh glittering as they caught the sunlight. Beyond that was the darker green of the tropical forest, and higher up the curve were more plains that vanished into the twilight of Oceanus, with its frozen sea.

Scanning the distant hills, she saw a group of animals: black dots against the yellow background. Perhaps two or three of the dots were larger than the others.

She was about to return to the tent when she heard the music. It was so faint and distant that she realized she had been hearing it for some time without recognizing it for what it was. There would be a rapid cluster of tones, then a sustained note, wrenchingly sweet and clear. It spoke of quiet places and an ease she thought she might never see again, and was as familiar as a song heard in the cradle.

She found herself crying quietly, being as still as she could, willing the wind to be still with her. But the song was gone.

The titanide found them while they were taking down the tent prior to moving Bill. It stood on the top of the bluff where Cirocco had been the day before. Cirocco waited for it to make the first move, but it seemed to have the same idea.

The most obvious word for the thing was centaur. It had a lower part shaped like a horse, and an upper half so human it was frightening. Cirocco was not quite sure she believed in it.

It was not as Disney had envisioned centaurs, nor did it have much to do with the classical Greek model. It had a lot of hair, yet its dominant feature was pale naked skin. There were great multicolored cascades of hair on the head and tail, on the lower parts of all four legs, and on the creature's forearms. Oddest of all, there was hair between the two front legs, in the place where a decent horse—which Cirocco's mind kept trying to see—had nothing but smooth hide. It carried a shepherd's crook, and but for a few small ornaments, wore no clothing.

Cirocco was sure this was one of the titanides Calvin had mentioned, though he had made a mistake in translation. It—*she*, Calvin had said

they were all female—she was not six-legged, but six-limbed.

Cirocco took a step forward, and the titanide put a hand to her mouth, then held it out in a quick gesture.

"Look out!" she called. "Please be cautious."

For a split second Cirocco wondered what the titanide was talking about, but that was quickly buried in astonishment. The titanide had not spoken English, Russian, or French, which until that moment had been the only languages Cirocco knew.

"What's the . . ." She stopped, clearing her throat. Some of the words were pitched quite high. "What's the matter? Are we in danger?" Questions were hard, requiring a complex appoggiatura.

"I perceived you to be," the titanide sang. "I felt you must surely fall. But you must know best what is right for your own kind."

Gaby was looking at Cirocco strangely.

"What the hell's going on?" she asked.

"I can understand," Cirocco said, not wanting to get into it any deeper. "She told us to be careful."

"Careful of . . . *how*?"

"How did Calvin understand the blimp? Something's been messing with our minds, honey. It's coming in handy right now, so shut up." She hurried on before other questions could be voiced, because she knew none of the answers.

"Are you the people of the marshes?" the titanide asked. "Or do you come from the frozen sea?"

"Neither," Cirocco trilled. "We have traveled through the marsh on our way to the . . . to the sea of evil, but one of us is hurt. We mean you no harm."

"You will do me little harm if you go to the sea of evil, for you will be dead. You are too large to be angels who have lost their wings, and too fair for creatures of the sea. I confess I have not seen your like before."

"We . . . could you join us on the beach? My song is weak; the wind does not lift it."

"I'll be there in two shakes of your tail."

"Rocky!" Gaby hissed. "Look out, she's going to come down!" She moved in front of Cirocco and stood with her glass sword held ready.

"I *know* she is," Cirocco said, grappling with Gaby's sword arm. "I asked her to. Put that away before she gets the wrong idea, and stay back. I'll yell if there's trouble."

The titanide came down the cliff forelegs-first, her arms out for balance. She danced nimbly, riding the small avalanche she had created, then she was trotting toward them. Her feet made a familiar clopping sound on the rocks.

She was thirty centimeters taller than Cirocco, who found herself taking a step back as the titanide drew closer. Seldom in her life had she met a taller woman, but this female creature would have towered over anyone but a professional basketball player. Seen close, she was more alien than

ever, precisely because parts of her were so human.

A series of red, orange, and blue stripes that Cirocco had thought were natural markings turned out to be paint. They were arranged in patterns, confined mostly to her face and chest. Four chevron stripes adorned her belly, just above where her navel would have been if she had possessed one.

Her face was wide enough to make the broad nose and mouth look appropriate. Her eyes were huge, with a lot of space between them. The irises were brilliant yellow, with radial streaks of green surrounding wide pupils.

The eyes were so astonishing that Cirocco almost failed to notice the most nonhuman feature of her face. She had thought they were an odd kind of flower tucked behind each ear, but they turned out to be the ears themselves. The pointed tips reached over the crown of her head.

"I am called (C# . . .)" she sang. It was a series of musical notes in the key of C sharp.

"What did she say?" Gaby whispered.

"She said her name was . . ." She sang the name, and the titanide's ears perked up.

"I can't call her that," Gaby protested.

"Call her C sharp. Will you shut up and let me do the talking?" She turned back to the titanide.

"My name is Cirocco, or Captain Jones," she sang. "This is my friend, Gaby."

The ears drooped to her shoulders, and Cirocco nearly laughed. Her expression had not changed, but the ears had spoken volumes.

"Just 'sheer-ah-ko-or-cap-ten-jonz'?" she chanted in an imitation of Cirocco's monotone. When she sighed her nostrils flared with the force of it, but her chest did not move. "It is a long name, but not a windy one, begging your pardon. Do you folk feel no joy, to name yourselves so dourly?"

"Our names are chosen for us," Cirocco sang, feeling unaccountably embarrassed. It was a dull moniker to give the titanide after she had handed Cirocco such a sprightly air. "Our speech is not as yours, nor our pipes so deep."

C# laughed, and it was an entirely human laugh.

"You speak with the voice of a thin reed, indeed, but I like you. I would take you home to my hindmother for a feast, if you were agreeable."

"We would accept your invitation, but one of us is badly injured. We need help."

"Which of you is it?" she sang, ears flapping in consternation.

"It is neither of us, but another. He has broken the bone in one of his legs." She noted in passing that the titanide language included pronoun constructions for male and female. Song fragments meaning male-mother and female-mother and even less likely constructions flitted through her head.

"A bone in his leg," C# sang, her

ears doing a complicated semaphore. "Unless I miss my guess, this is quite serious for folk such as you, who cannot spare one. I will call the healer at once." She raised her staff and sang briefly into a small green lump at the end.

Gaby's eyes widened.

"They have radio? Rocky, tell me what's going on."

"She said she'd call a doctor. And that I have a dull name."

"Bill could use the doctor, but he ain't gonna be a member of the AMA."

"Don't you think I know that?" she hissed, angry. "Bill's looking very bad, dammit. Even if this doctor has nothing but horse pills and juju, it won't hurt for him to take a look."

"Was that your speech?" C# asked. "Or are you in respiratory distress?"

"It's the way we talk. I—"

"Please forgive me. My hindmother says I must learn tact. I am merely—" she sang the number twenty-seven and a time word that Cirocco could not convert, "—and have much to be taught beyond womb knowledge."

"I understand," sang Cirocco, who did not. "We must be strange to you. You certainly are to us."

"Am I?" The key of her song betrayed that it was a new thought to C#.

"To one who has never seen your kind."

"It must be as you say. But if you have never seen a titanide, from whence do you come in the great wheel of the world?"

Cirocco had been puzzled by the way her mind translated C#'s song. It was when she heard the notes "whence" that she realized, by calling to mind alternate interpretations of the two-note word, that C# was speaking in polite, formal modality, using the microtone flattening of pitch reserved for the young speaking to elders. She switched to the chromatic tone rows of instructional mode.

"Not from the wheel at all. Beyond the walls of the world is a bigger place that you can't see—"

"Oh! You're from *Earth*!"

She had not said Earth, any more than she had called herself a titanide. But the impact of the word for the third planet from the sun surprised Cirocco as much as if she had. C# went on, her attitude and posture having shifted with her switch—following Cirocco's lead—to teaching speech. She became animated, and if her ears had been the tiniest bit wider she would have flapped into the air.

"I'm confused," she sang. "I thought Earth was a fable for the young, spun out around campfires. And I thought Earth beings to be like titanides."

Cirocco's newly-tuned ear strained at the last word, wondering if it should be translated as people. As in "we people, you barbarians." But the chauvinistic overtones were not there. She spoke of her species as one among many in Gaea.

"We are the first to come," Cirocco sang. "I'm surprised you know of us,

as we knew nothing of you until this moment."

"You don't sing of our great deeds, as we sing of yours?"

"I'm afraid not."

C# glanced over her shoulder. Another titanide stood atop the bluff now. She looked much like C#, but with a disturbing difference.

"That's (B♭ . . .)" she sang, then, looking guilty, shifted back to formal mode.

"Before his arrival, there is a question I would ask that has been burning my soul since first I saw you."

"You don't have to treat me as an elder," Cirocco sang. "You might be older than I am."

"Oh, no. I am three by the reckoning of Earth. What I wish to know, hoping the inquiry is not an impudent one, is how you stand for so very long without toppling over?"

CHAPTER ELEVEN

When the other titanide joined them, the disturbing difference Cirocco noted earlier was abundantly clear, and even more disturbing. Between the front legs, where C# had a patch of hair, B♭ had a completely human penis.

"Holy God," Gaby whispered, nudging Cirocco's elbow.

"Will you be quiet?" Cirocco said. "This makes me very nervous."

"You, nervous? What about me? I can't understand a note you're singing. But it's pretty, Rocky. You sing real nice."

Other than the male genitals in front, B♭ was almost identical to C#. Both had high, conical breasts and hairless, pale skin. Their faces were both vaguely feminine, wide-mouthed and beardless. B♭ had more paint on his body, more flowers in his hair. Aside from that and the penis the two would have been hard to tell apart.

One end of a wooden flute protruded from a fold of skin at the level of his missing navel. Apparently it was a pouch.

B♭ stepped forward and extended his hand. Cirocco stepped back and B♭ moved swiftly, putting a hand on each of her shoulders. She was frightened for only a moment, then realized he shared C#'s apprehension. He had thought she was falling backwards, and meant only to steady her.

"I'm fine," she sang, nervously. "I can stand on my own." His hands were large, but perfectly human. It felt very strange to be touching him. Seeing an impossible creature was quite different from feeling its body heat. It brought home forcefully the fact that she was making humanity's first contact with an intelligent alien. He smelled of cinnamon and apples.

"The healer will arrive soon." He sang the song of equals with her, though scored in a formal mode. "In the meantime, have you eaten?"

"We would offer you food ourselves," Cirocco sang, "but in truth, we have run out of provisions."

"And my foresister offered you none?" B♭ gave C# a reproving look, and she hung her head. "She is curious and impulsive, but not thoughtful.

Please forgive her." The words he used to describe his relationship to C# were complex. Cirocco had the vocabulary, but not all the referents.

"She has been most kind."

"Her hindmother will be pleased to hear it. Will you join us? I do not know what manner of food you prefer, but if we have anything to your liking, it is yours."

He reached into his pouch—a leather one strapped around his waist, not the one that was part of his body—and came up with something large and reddish-brown, like a smoked ham. He handled it like a turkey drumstick. The titanides sat, folding their legs neatly and easily, so Cirocco and Gaby sat, too, an operation the titanides watched with frank interest.

The joint of meat was passed around. C# brought out several dozen green apples. The titanides simply put them into their mouths whole. A crunch, and they were gone.

Gaby was frowning at the fruit. She raised an eyebrow as Cirocco took a bite of one. It tasted like a green apple. It was white and juicy inside, and had small brown seeds.

"Maybe we'll figure all this out later," Cirocco said.

"I wouldn't mind a few answers right *now*," Gaby retorted. "Nobody's going to believe we sat around eating goddam green pippin *apples* with flesh-colored *centaurs*."

C# laughed. "The one named Ga*bee* sings a rousing song."

"Is she talking to me?"

"She likes your song."

Gaby smiled sheepishly. "It was nothing like the Wagner that's been coming from your direction. How do you understand them? What about the way they look? I've heard of parallel evolution, but from *the waist up*? Humanoids I could believe. I was ready for anything from big blobs of Jello to giant spiders. But they look *too* much like us."

"Yet most of them look nothing like us."

"Right," Gaby said, shouting again. "But look at that face. Take away the donkey ears. The mouth is wide and the eyes are big and the nose looks like he got hit in the face with a shovel, but it's in the range of what you can find on Earth. Look lower, if you dare." She shuddered. "Look *only* at that, and I defy you to tell me it's not a human penis."

"Ask her if we can join in," B♭ sang, heartily. "We don't know the words, but can improvise an accompaniment."

Cirocco sang that she had to speak to her friend a little longer, and would translate later. He nodded, but followed the conversation attentively.

"Gaby, please don't shout at me."

"I'm sorry." She looked at her lap and made an effort to calm down. "I like things to make sense. A human penis on an alien creature doesn't. Did you see their hands? They have fingerprints, I saw them. The FBI would file them with no questions asked."

"I saw that."

"If you could tell me how you talk to them . . ."

Cirocco spread her hands. "I don't know. It's as if the language was always in my mind. Singing is harder than listening, but only because my throat's not up to it. It scared me at first, but now it doesn't. I trust them."

"Just like Calvin trusts the blimps."

"It's clear that something toyed with us while we were asleep. Somebody gave me the language—I don't know how or why—and that somebody gave me something else. It's a feeling that the purpose behind the gift was not evil. And the more I talk to the titanides, the more I like them."

"Calvin said pretty much the same things about the goddam blimps," Gaby said, darkly. "You nearly arrested him."

"I think I understand him a little better now."

The titanide healer—a female whose name was also in the key of B♭—entered their tent and spent some time examining Bill's leg under Cirocco's watchful eye. The edges of the wound were yellow and blue-black. Fluid bubbled out when the healer pressed around it.

The healer was aware of Cirocco's concern. She twisted her human torso and rummaged in a leather satchel held to her equine back by a cinch strap, came up with a clear round flask filled with brown fluid.

"A strong disinfectant," she sang, and waited.

"What is his condition, healer?"

"Very grave. Without treatment, he will be with Gaea in a few tens of revolutions." Cirocco translated it that way at first, but there had been one word used for the time period. Applying metric prefixes, she thought of it as a decarev. One revolution of Gaea took nearly one hour.

The meaning of "be with Gaea" was clear, though she did not use the word Gaea. She referred at once to her world, to the Goddess who was the world, and to the concept of returning to the soil. There was no connotation of immortality.

"Perhaps you would prefer to await the arrival of a healer of your own kind," the titanide sang.

"Bill may never see him."

"This is so. My remedies should remove the infestations of small parasites. I don't know if they will inhibit the workings of his metabolism. I could not promise you, for instance, that my treatment would not harm the pump which propels his vital fluids, as I don't know where this pump is located in your kind."

"It's right here," Cirocco sang, thumping her chest.

The titanide's ears jumped up and down. She pressed one ear to Bill's chest.

"No fooling," she sang. "Well, Gaea is wise, and says not why she spins."

Cirocco was in an agony of indecision. The concepts of metabolism and of germs were not things a witch doctor would know about. Those

A Calendar of Upcoming Events

29 January-1 February
General Meeting of the American Physical Society at New York, NY. Info: American Physical Society, 335 East 45 St., New York NY 10017.

9-11 February
ROC*KON*3 (Arkansas area SF conference) at Little Rock, AR. Guest of Honor—Frank Kelly Freas; Fan Guest of Honor—Shelby Bush III. Registration $8 in advance, $10 at the door. Info: Roc*kon*3, P.O. Box 9911, Little Rock, AR 77219.

9-11 February
FORT CON (Colorado area SF conference) at CSU, Ft. Collins, CO. Guest of Honor—James Gunn. Registration $6. Info: Fort Con, c/o CSU Anti-Martian Society, CSU Student Center, Box 407, Ft. Collins, CO 80523.

16-18 February
BOSKONE 16 (New England area SF conference) at the Sheraton Boston, Boston, MA. Guest of Honor—Frank Herbert; Science Speaker—Mark Chartrand; Official Artist—Mike Symes. Registration $8 until 15 January 1979, $10 at the door (Boskone life membership $80.00). Art show, hucksters. Info: NESFA, Box G, M.I.T. Branch PO, Cambridge, MA 02139.

16-18 February
QUAKECON I (San Francisco area SF conference) at Golden Gateway Holiday Inn, San Francisco, CA. Guests of Honor—Robert Anton Wilson, Bill Breiding, and Elmer Perdue. Toastmaster—Gary Farber. Registration $6 until 15 February, $7 at the door. Info: Quakecon, Box 9990, 537 Jones St, San Francisco, CA 94102.

26 February-2 March
CompCon 79 (IEEE Computer Society) at San Francisco, CA. Info: Compcon 79 Spring, P.O. Box 639, Silver Spring, MD 20901.

23-27 August 1979
SEACON 79 (37th World Science Fiction Convention) at Metropole Hotel, Brighton, U.K. American Guest of Honor—Fritz Leiber; British Guest of Honor—Brian Aldiss; Fan Guest of Honor—Harry Bell; Toastmaster—Bob Shaw. Registration $7.50 (supporting) to 31 December 1978, $15 (attending) to 31 December 1978. Info: Seacon '79, 14 Henrietta St., London WC2E 8QJ, U. K. This is the science fiction world's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition, banquet, the works. Join now and get to nominate and vote for the Hugo awards and the John W. Campbell Award for Best New Writer.

ANTHONY R. LEWIS

Items for the Calendar should be sent to the Editorial Offices, ***four months*** *in advance of the issue in which you want the item to appear.*

words had translated exactly that way. Yet even the healer was aware that her medicine might harm a human body.

But Calvin was gone, and Bill was dying.

"Pray, what are these used for?" the healer sang. She was holding Bill's foot. Her fingers gently bent the toes.

"Uh, they're . . ." she groped, but could not find the words for atrophied evolutionary vestiges. There was a word for evolution, but not as applied to living things. "They're useful in keeping one's balance, but not indispensible. They are oversights, or imperfections of design."

"Ah," the healer crooned. "Gaea makes mistakes, it is well known. Take, for instance, the one with whom I was first hindsexed, many myriarevs ago." Cirocco wanted to translate the object of the last sentence as "my husband," but that didn't fit; it could as easily have been "my wife," though that was off the mark, too. There was not an English equivalent, she realized, then remembered her problem.

"Do what you can for my friend," she sang. "I commend him into your hands."

The healer nodded, and got to work.

She first bathed the wound with the brown liquid. She packed it with a yellow jelly and put a large leaf next to the skin, "to lure out the small eaters of his flesh." Cirocco's hopes rose and fell as she watched. She didn't care for the leaf, nor for the reference to luring. It looked too primitive. But when the healer dressed the wound, she used bandages taken from sealed packets that she said had been "cleansed of parasites."

As she worked, she examined Bill's body with great interest, sometimes humming a little ditty of astonishment.

"Now who would have thought of that . . .? . . . a muscle *here*? Attached *so*? Like walking on broken feet . . . no, I don't believe it." She described Gaea variously as wise, endlessly inventive, needlessly elaborate, and a silly fool. She also observed that Gaea enjoyed the occasional joke as well as the next deity—this while staring at Bill's buttocks.

Cirocco was covered in sweat when the healer was through. At least she had not produced rattles or voodoo dolls, nor drawn magical marks in the sand. When she had tied the last knot in the bandages, she began to sing a song of healing. Cirocco couldn't see that it would hurt anything.

The healer bent over Bill and put her arms around and under him, lifted him gently from the waist and held him close to her body. She placed his head on her shoulder and bent her own head down until her lips were close to his ear. She rocked back and forth, crooning a lullaby without words.

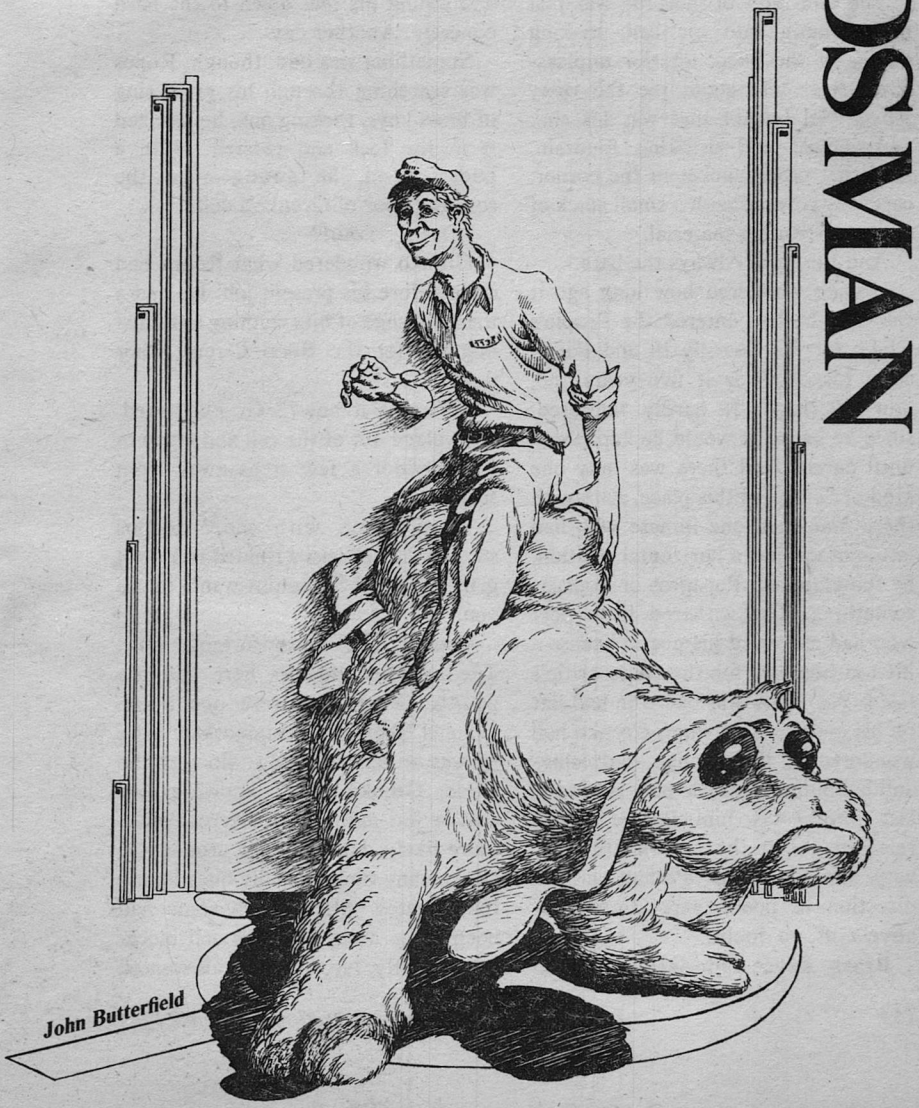
Bill gradually stopped shivering. Color began to return to his face, which became more peaceful than it had been since the injury.

In a few minutes, Cirocco would have sworn he was smiling.

TO BE CONTINUED

the ODDS MAN

A good gambler can see opportunity in any situation.
GARY ALAN RUSE



John Butterfield

Grenko raised his head up a bit, listening, then dropped it gently back into the recessed spot on the dusty gray mattress. The scuff-scuff of worn-heeled boots was coming down the corridor, a bit earlier than usual, he thought.

The dim light of morning was just now coming into his cell, making details of the bleak interior unpleasantly clear. He could see the rusty faucet and bucket that was his sink and shower and drinking fountain. And that other bucket in the corner, carefully covered with a small stack of approved reading material.

And the bars. Always the bars.

Grenko wondered how long ago it was that he had entered the People's Clinic for the Socially Ill and Politically Insane. Was it five years ago, now? Perhaps. It hardly mattered, since he knew he would be kept there until cured. And there was only one kind of "cure" in this place. Although there *had* been one inmate who had left in other than a horizontal position, he remembered. Popagros or Popagas something. The withered little poet who had exercised his poetic license a bit too liberally for the State critic's taste. Yes, *there* was one who had left on his own feet, although Grenko had wondered at the strange mutterings and babblings the little poet made the last time he saw him. Before he was released. After the treatments. Yes, very strange words. Perhaps a new direction in poetic expression. Creative stuff, no doubt.

Brass keys suddenly smacked against his cell bars in a raucous racket. The guard, Ropos, was there. Fat Ropos.

"Up! Up! Get up!" he grated.

Grenko hesitated as long as he thought he could without arousing the guard's temper. Then he slowly sat up and swung his feet down to the hard concrete. Another day . . .

Something was odd, though. Ropos was searching through his great ring of brass keys. Picking one, he inserted it in the lock and twisted. With a pudgy hand, he swung open the squeaky door of Grenko's cell.

"Out . . . *out*!"

Grenko wondered what Ropos had done before his present job. He had a mental image of him running a trained dog act for the Borzi Circus. Poor dogs . . .

"What is it now?" Grenko asked. He walked out of the cell and stood in the corridor a few steps away from Ropos.

"Just come with me," Ropos snarled. His cheeks wrinkled in an evil grin. "Colonel Skorznios wants to see you."

Grenko felt uncomfortable now. The so-called doctors here and the guards like Ropos were one thing. Colonel Skorznios was another. Who he was or what he had to do with the clinic, Grenko didn't know, except that he was military. Or Secret Police, more likely. He had been around the clinic many times, usually questioning the inmates. After which some had been taken away from his cell block, permanently. No, if Skorznios wanted

to see him, it was not good. Not good at all.

Ropos led him down the corridor, past the double doors with their double locks and past the guards of the outer section of the clinic. Around the corner and to the left, there was a room. Grenko had seen it before, when he had been in the admissions office five years ago. Or was it six?

Skorznios was there, standing cool and arrogant, leaning against the big wooden desk in the center of the room. It was real wood, too. Not the crummy plastic office junk the modern factories were turning out. It was old and worn, but still polished and beautiful.

The clinic director sat behind it, unmoving, expressionless. He was a small, wormish, bespectacled man—the complete opposite of Skorznios in every way.

The Colonel was trim and hard. No, not just hard . . . brittle. His features were brittle too, lean and hard and brittle like shards of glass. His moustache was a neat wire bristle brush.

"Grenko? Yes, you're the one." The voice was almost friendly, like the gentle hiss of a pit viper. Skorznios looked back down at a file-folder in his hands. "Why were you sent here, Grenko?"

He paused. "I don't really remember."

Skorznios's eyes flashed. "Don't lie to me, Grenko!"

"I'm not sure, then. It was years ago. I'm not sure how many. And there were a variety of charges. Don't you have it all in that file?"

Skorznios glared at him. He looked back at the file. "It seems that you were a gambler, Grenko. That among other talents which the State does not consider compatible with the ideals of good citizenship."

Grenko shrugged.

"And we have records which state that you engaged in an illegal bet. A bet on the outcome of our first manned Mars probe." The Colonel stood erect. "A bet *against* its success!"

Grenko scratched his chin. "Did it ever make it, by the way?"

Skorznios fumed. "No."

"Then I won."

"Too bad you can't collect!" Colonel Skorznios threw the file down on the director's desk with a loud smack that made the small, wormish man jump. "How could you make a bet like that, Grenko? Didn't you realize that by doing so, you were casting doubts on the skills of our technicians and scientists? That you were disparaging our heroic cosmonauts, and even our beloved nation? Those are sick thoughts, Grenko. Very sick, indeed. Fortunately, a good citizen reported your behavior and you were sent here to correct your dangerous ways."

"You wouldn't happen to know which good citizen . . .?"

"Never mind! Now as I was saying, you were sent here to be treated for your antisocial tendencies. And I can't say from your behavior that you've made any improvement!"

Grenko slid his hands into his pockets and watched Skorznios's mustache

twitch uncomfortably. "Is that why you wanted to see me, Colonel?"

"No . . ." Skorznios replied, his eyes narrowing. "As I said, your gambling activities were only part of your abundant list of counter-revolutionary actions. But . . . these things are in the past. We might be willing to forgive these old indiscretions of yours. We sometimes forget past errors of judgment . . . when it suits our purpose."

Grenko was silent for a while, wondering what it was they wanted of him. They were not threatening, at least not yet, so they must be after something they thought they could best get by persuasion. But what could he have they wanted?

The Colonel smiled, showing a row of perfect teeth, lined up like little soldiers on parade. "How would you like to leave here, Grenko?"

"Walking, I think . . ." replied Grenko, remembering the others. "No . . . make that running."

The Colonel's smile faded. "What I mean to say is, we are considering giving you your freedom . . . in exchange, that is, for something you can help us with. A project of sorts. You help us—we help you."

"What kind of project?"

"You might call it a scientific experiment. Very important. You might even become famous. And think of the service you'd be doing for our beloved—no, I can see that is not the argument to encourage the likes of you. Suffice it to say that if you participate in this project, you will be able to leave the clinic, and even return to your old job."

Grenko shivered involuntarily, remembering the eighty-hour work weeks, driving transports through snow-laden miles of poor roads. Still, it was better than the clinic. "You said . . . *experiment*? Anything like the old malaria cure experiments?"

"Oh, nothing so dangerous! Not at all. This is not a medical project, rest assured. We just want you to do a little exploring for us."

Grenko had a vision of himself locked inside a deep-space probe, bleeping his way to infinity. "Not in a rocket, I hope."

Colonel Skorznios straightened a few stray fibers of his wire bristle moustache. "No. This is in no way connected with our space program. I can't go into details here and now, for security reasons, of course. But if you agree to help us, we will transport you immediately to the laboratory where you will be further briefed. So—what do you say, Grenko? It is not such a bad deal, is it? Your freedom, for a little work . . .?"

He considered. Every voice of reason within him screamed "no" to the offer. Some offer—he could not even guess what it might turn out to be, and yet . . . and yet . . . almost anything would be better than slowly rotting away in the clinic. At least it would be something different to do.

"I guess I'll take a chance, Colonel," Grenko replied. "After all, as you said, I am something of a gambler."

A blast of cold air squeezed past the canvas flap that covered the rear of the old army truck and chilled the interior even more. Grenko pulled his newly acquired coat closer around him. It was old and taken from a storeroom in the clinic, but at least it was warm. He wondered who it had belonged to before. Grenko examined the coat, absentmindedly poking a finger through one of several holes in the front that happened by coincidence to have a matching set in the back. No need wondering what fate had befallen the previous owner.

The rear flap was pushed momentarily aside as a guard climbed into the truck with him. This one was military, but reminded him of Ropos, only not so fat. The guard said nothing, taking a seat on the opposite side of the truck.

An instant later, the motor roared and the truck was moving. There was a brief pause as the truck waited for the gate to open, then it was through and leaving the clinic grounds. Grenko could scarcely believe it. For at least five years, and possibly six, he had not seen the outside world. Not that there was much to see now through the small opening in the side flap through which he peered. Just gray houses clustered along black roads and squares, liberally sprinkled with white snow. He wondered if it only seemed beautiful after five years in the clinic, or if—

A warning grunt from the guard made him turn around. The soldier was shaking his head, frowning. "No looking, please!" The "please" came out a vague threat. "You do not need to see where we are going. It is a matter of—"

"Security—yes, I know," Grenko responded, and pulled the coat a bit closer. "Security."

The truck had been rumbling who-knows-where for hours, along who-knows-what route. Grenko did not even bother trying to determine direction or mileage. That was a game for spies and soldiers behind enemy lines, and maybe kidnap victims in capitalist countries where people had enough money to tempt criminals. It would not make him feel any better to know where he was going. He would find out soon enough anyway.

Minutes later, Grenko had the distinct impression that night had fallen, which was perfectly ridiculous since it was not quite noon yet. Still, it was dark. Judging from the sudden, amplified roaring of the motor, he realized that the truck had gone into a tunnel. But it seemed to be a tunnel without end. More miles rolled by, and then abruptly the truck halted. The sound of a large, heavy gate closing behind it was the first indication they had passed through some sort of checkpoint.

The guard got to his feet and moved to the rear of the truck, shoving the canvas flap aside. He climbed down, then looked back at the still-sitting figure. "Out!" he said. "We are here."

Grenko rose and followed the guard out of the truck, wondering if the man had been taking speech lessons from Ropos. Besides, he knew he was "here." He just didn't know where "here" was.

"Here" turned out to be the interior of a very large and only partially illuminated hangarlike building, which from its position at the end of a tunnel might mean it was underground. No doubt due to the everpresent need for security.

Colonel Skorznios appeared from the cab of the army truck, his unbuttoned, knee-length overcoat fluttering behind him like the cloak of some misbegotten Czarist general. It was an image he would have detested, had he been aware of it.

Skorznios and the guard flanked Grenko and escorted him to a partitioned-off section of the hangar, sort of a building-within-a-building. More guards stood near the entrance, brandishing the latest automatic weapons. A brief walk through equally well guarded halls within the section brought them to a laboratory.

There was a kind of orderly clutter about the place that made Grenko, with his mechanical background, feel at home. The equipment, like everything else, it seemed, had been designed with purely functional qualities in mind and had little in the way of aesthetic appeal. As a result, despite the lab's modern capabilities, it ended up looking like something Louis Pasteur would have rejected as hopelessly obsolete. But it would yield results, and results, ultimately, are all any scientist desires.

The scientist in this particular instance was standing near a large console to the left. White-frocked and graying, he came reasonably close to fitting the stereotyped image Grenko had expected. He turned now and smiled evenly at sight of the men.

"Ah, Colonel, I see you've brought our . . . assistant," the man greeted them. His brief hesitation was scarcely noticeable, except to Grenko, who suddenly felt ill at ease once again.

"Yes, I've told him of the great importance of this project," Skorznios replied. "But of course the details I have left for you to explain."

"To begin with, I am Dr. Padellin," the scientist said, stopping directly in front of Grenko. He turned briefly to Skorznios. "You did mention, I trust, that this project involves a little exploration? Yes—well, good. Now then . . . Grenko, is it?" he said, reading the name stitched to the clinic uniform. "Do you think you would be willing to do a little exploring for us?"

Grenko looked around the laboratory. "In here?"

"Well . . ." Dr. Padellin paused thoughtfully. "In a way, yes, you might say that." He smiled oddly. "Here, let me show you something. It's really quite amazing."

Grenko followed the scientist over to a rather large sheet of metal which was suspended within an odd system of insulated supports. From the slight flowing hum it seemed to generate,

Grenko could tell that it was energized in some manner. But how or why escaped him.

Dr. Padellin patted the supporting structure lovingly. "I worked on this for years before I finally perfected it . . . in my spare time, of course. And once my superiors realized its great mil—ah, scientific potential, I had no difficulty in obtaining the necessary funds to build this full scale operational model."

"Doctor—" Colonel Skorznios cautioned, his eyes narrowing, "—I don't think the past history of this device will interest our friend . . ."

"Oh? I suppose not. Pity . . ." He seemed not to perceive Skorznios's unspoken warning. "Here, Grenko, touch the panel . . . go ahead, touch it!"

Reluctantly, Grenko reached out a hand, hesitated a moment, then touched the panel. Or rather, he tried to touch it. His fingertips were where they should be to contact the energized sheet of metal, but he could not feel it. It seemed not to be there. Pushing forward suddenly, his entire hand disappeared.

Panic.

Stifling a gasp, Grenko jerked his arm back away from the device and examined his hand, which fortunately was still intact. He squeezed his fingers, checking to see if blood still flowed through them. It did.

Dr. Padellin grinned at him with almost childlike glee. He seemed highly amused at Grenko's startling discovery. "You see—I told you it was amazing! I'm really quite proud of it."

"Yes, but . . ." Grenko looked away from his fingers. "What is it?"

"Why, it's a gateway, of course—an electronic door to some other universe," Dr. Padellin explained. "Or perhaps some other dimension of Earth. Maybe an entirely different world altogether!"

"You don't seem very sure," Grenko commented.

"Well, how could I be sure? We haven't even begun to find out where this gateway leads to yet. We haven't begun to explore at all. But that, *that*, is precisely why you are here."

"You want *me* to go through *there*? And explore?"

The scientist nodded.

"Why can't you do it yourself?" Grenko asked, then hastily added, "I mean, as a scientist, you know more about these things than *I* would."

"Well, I . . . I would, but . . ." Padellin seemed nervous. "But I must stay here and tend the equipment, naturally."

"Naturally." Grenko smiled faintly. "I won't ask if it's safe." He looked toward Colonel Skorznios. "Since obviously if it was, you would not be asking me to share in the honor."

"Oh, but it's not really dangerous," Dr. Padellin said encouragingly. "Just unknown. Why, only last week I put one of our laboratory dogs through the gateway and it didn't hurt him in the least. I still hear him barking every once in a while." The doctor paused reflectively. "Only trouble is, I can't

seem to persuade him to come back."

Grenko considered a moment. "Why can't you use one of those fancy remote-controlled gadgets, like on the moon?"

Padellin looked aghast. "Do you have any idea of what they cost? Why, it's in the millions!"

"Besides," Colonel Skorznios suddenly interjected. "You just can't avoid the human factor. There are so many things that can only be done by people." He seemed to smile at some secret joke. "So, will you do it, Grenko? Remember—you help us, we help you."

Grenko considered it another moment. He shrugged.

"Why not?"

Grenko looked down at the odd assortment of gadgets that now were affixed to his form. Telemetry equipment, film and television cameras, sound equipment, medical sensors, those and other things, all mostly on the front of the special harness to balance the weight of the transceiver and batteries on his back. He bounced up and down twice to check the distribution of the bulky equipment. As long as he did not lean over too far. . . .

"Well, everything's ready!" Dr. Padellin said, very much pleased with himself. "We can begin at once."

Grenko wished he shared the man's enthusiasm. Perhaps the good doctor would be less enthusiastic if *he* were wearing the equipment.

"Now what?" Grenko asked.

"Just . . . walk through," Padellin replied. "Look around, pick up things—we'll see what you see, hear what you hear, everything! You'll be in constant contact with us."

Grenko walked, or more accurately, waddled over to the energized metal sheet and touched it tremulously. Then he put one foot through.

"One other thing . . ." Colonel Skorznios said casually. "There is a small explosive charge contained within the equipment you're wearing, solely to prevent the equipment from falling into the wrong hands, of course. In case you should run into some form of people . . . out there. We can activate the charge from here by radio transmission. So keep in mind that it would be ill-advised to try anything foolish! Not that you would . . ."

Grenko's mouth twitched slightly. That was what he had been waiting for—the everpresent hold. The element of control. The leash. He stood there for a moment, half in and half out of existence, then he turned and plunged through the gateway.

The guard next to Colonel Skorznios shook his head contemptuously. "Why send a criminal—an enemy of the State—on such a mission?"

Skorznios smiled calmly. "There will be soldiers later . . . when we know more about what is out there. But for now, why send our own men, when we have the likes of Grenko?"

"If he succeeds in this, you will let him go?" the guard asked. "With what he knows about this project, you will let him live?"

"What do you think?" Skorznios carefully smoothed his moustache.

The guard grinned wickedly. "I see."

Dr. Padellin and an assistant were fussing with the controls of the large console. As a built-in television screen began to glow, Padellin stepped back to admire the image.

"It's working beautifully! Look, Colonel—the television camera is functioning. We are seeing the first pictures of the other side of the gateway!"

Skorznios watched with a kind of detached fascination as the image bumped and jounced along with each step Grenko took. If the color television equipment was operating true to life, then the other world was mostly blue sky and faintly reddish sand. They had already known the atmosphere was breathable since Padellin had tested it with a measuring device strapped to the end of a long pole. More than that had been guesswork until now.

"Can you hear me all right?" Grenko's voice came strongly through the sound receiving equipment. The lab assistant had to turn down the volume.

"Yes . . . yes, perfectly!" Dr. Padellin responded. "Keep going. See if you can find anything interesting or unusual. Collect some samples of the soil, and plants if there are any. Oh, and by the way—see if you can locate my dog."

"Forget the dog," Skorznios snapped. "See if you can locate any traces of civilization. And keep your eye on the radiation indicator—see if there are signs of fissionable deposits we can mine!"

"What? Oh, you mean like uranium." Grenko plodded on. "Look, what shall I do if I *do* find people . . . or what amounts to people?"

Padellin started to reply, but was stilled by the Colonel's hand upon his shoulder. The Colonel hesitated a moment.

"If you do . . . find out what you can about them. How they live, what kind of armies they have . . . that sort of thing." Skorznios smiled wryly. "If you can find a way to communicate, tell them of the wonders of our Republic. And tell them we are friendly."

Grenko made a sound that almost was a laugh, then quickly fell silent again. He kept walking, enjoying the fact that he could turn his head to view the strange world about him without turning the camera so that the others could also see. It was a small degree of freedom, of control. Very small, but enjoyable.

Still, he was not happy with events so far. Perhaps he should not complain, all things considered. But the knowledge that he was wired to detonate should he displease his masters created in him an uneasiness that was hard to shake.

"There's quite an unusual rock down here," he said suddenly. "I'll collect it for you."

Padellin and Skorznios watched as the ground tilted toward them and a

strange disembodied hand reached into the picture. The fingers stretched forward to close around the rock, and the ground loomed closer. And closer and . . .

"Don't lean so far!" Padellin shrieked. "Watch it, Grenko—LOOK OUT!"

A crashing thud came over the sound equipment, and in an instant, the television screen went blank. Padellin and his assistant frantically adjusted the controls, trying to regain the picture. The screen remained blank.

"*Idiot*!" Skorznios screamed. "You have ruined the television camera. We can't see a thing now!"

There was a brief moment of silence, oddly punctuated with a grunt as Grenko apparently righted himself. "Do you want me to try to fix it?"

"No, you fool!" the Colonel bellowed. "Just because you can fix a truck does not mean that you could repair that camera. You could not even begin to—oh, forget it! We will just have to rely on the sound equipment. And be careful that you do not fall again! Remember what we can do if it becomes necessary . . . "

"I will be careful, Colonel. *Very* careful."

Grenko continued exploring, making periodic checks by radio to report his findings, which so far included little more than more blue sky and faintly red sand. After about an hour, he informed them of an oasis he had sighted at which he hoped to replenish his water supply. Padellin gave him the go-ahead, adding a reminder concerning the collection of alien plant samples. He drew near the oasis.

"There's plenty of material for samples," he told them. "Many trees and bushes, plants of all kinds, some bearing fruit. And . . . there's something . . . something like buildings."

Colonel Skorznios abruptly leaped up from the chair in which he had been sitting passively for the last hour. "What! Buildings! Then there must be—"

"People!" Grenko was shouting, his voice strained. "There are people here . . . and they're coming toward me!" he cried out. Then he made an exclamation strongly disapproved of by the State. "Good Lord!"

And that was the last thing he said. Although there was no absence of voices. Strange voices they were, alien and high-pitched, of a language unknown. Then the voices faded, seeming to draw away from the sound pickup on Grenko's equipment.

"Dr. Padellin—" the lab assistant called out, pointing to a glowing light on the console. "Look, he is no longer wearing the equipment harness—we have no readings on him!"

"They have taken him prisoner," Skorznios said coolly.

Padellin turned white as his coat. "But . . . we must save him! Colonel—send your men to rescue him—"

The guard next to Skorznios blanched at the suggestion. He looked to the colonel, fearing he might agree.

"No, I think not," Skorznios re-

plied calmly. "The equipment is still working, sending back sound. We will see what else happens, if anything. And as to Grenko's fate . . . be glad that it was not you, Dr. Padellin."

They waited.

Another hour passed, without the slightest sound from the equipment pack except for the wind blowing across the sand. It was a sound that normally would have induced sleep, but in this instance it seemed to have the opposite effect. Padellin and Skorznios paced about the laboratory in frequently intersecting patterns. Their irritation with each other was becoming more and more pronounced.

"Grenko's finished, undoubtedly," Skorznios was saying. "We'll just have to get another subject for the project." He looked suddenly, meaningfully at Padellin.

The doctor turned pale again. "I have to tend the equipment!" he said feebly. "Besides, I have—"

"Quiet—!" Skorznios stood immobile, listening. From the audio equipment behind him came a sound. Like feet hurrying through sand. Running, falling, then running again. Louder, until they halted abruptly.

"Is it Grenko?" Padellin asked.

His assistant raised an eyebrow and shrugged. "I can't tell. Wouldn't he say something?"

A new sound came now. A slight crunch of sand as the equipment pack was shifted to another position. Then the faint metallic squawkiness of bolts being unscrewed. A clunk, and then the footsteps again, receding into the distance.

Silence.

Colonel Skorznios stared rigidly, looking very much like a cat bewildered by the presence of a bird it could hear but not see. The strain was too much. "*What in Siberia is going on*!"

But no answer came immediately. More minutes dragged on, and finally, Skorznios was about ready to seize the guard's rifle and himself plunge through the gateway. *About* ready, but not quite . . .

Turning to the guard, he grabbed his arm. The man flinched. "Go through there—" Skorznios directed, pointing to the energized screen. "See what happened—locate the equipment pack and report back by radio!"

"Yes, sir, of course . . . ah . . . ah . . . " stammered the guard, stalling for time. "Wouldn't you like me to take along a squad of men? Perhaps a small tank or two?"

"There's no need for that!" Skorznios growled. "*Go*!"

The guard found himself being propelled toward the shimmering screen, his heels skidding along the floor. He had almost reached it when Padellin cried out suddenly.

Finger to lips, signaling for silence, the good doctor seemed to be listening. Skorznios stopped, cocked an ear toward the screen. The guard held his breath.

They could all hear it now. An odd sound, a sort of ca-lumph ca-lumph through the sand. Someone or some-

thing was approaching the gateway. Skorznios and the guard backed away with small, quick steps, as silently as they could. The strange sound was growing quite loud now, and whatever its source, it could not be more than a few feet from the gateway.

Suddenly, something emerged partway through the screen. The men in the laboratory found themselves staring into the homely face of a sad-eyed beast, the likes of which they had never before seen. With only the scruffy head and neck protruding through the gateway, the thing looked for a minute like some hunter's trophy on the wall. It hung there, perplexed by what it saw. Then, as if prodded from behind, it lurched into the laboratory.

Skorznios screamed a garbled command and the guard dropped his rifle. As the man scrambled to pick it up, a voice came from near the top of the creature.

"Hello again—"

Grenko ducked under the top edge of the energized screen and rode the strange beast into the center of the laboratory. The thing could be seen in its entirety now, and resembled nothing else so much as a squat camel with long floppy ears. The ears reached down almost to the level of its knees, and its tail dragged behind it, narrow at first, then broadening into a wide spoonlike structure at the end.

Colonel Skorznios was a man about to burst. "Grenko! What is this!"

Grenko patted the beast. "This is a Kneeb, Colonel."

"A ca-neeb . . . ?" Skorznios didn't like the taste of the word. "I mean—what are you doing riding it! How did you get such a thing trained so fast!"

"Oh, it was already tamed." Grenko climbed down. "I got it from the people at the oasis. They've quite a big settlement there. You'll have to see it."

"I intend to!" Skorznios boiled. "But this beast . . . why did they give it to you?"

"They didn't *give* it to me. It was sort of a business deal. They like trading things. Regular businessmen."

Skorznios sneered. "Capitalists, huh. We'll have to see about that. What did you give them? You had nothing valuable."

"I traded them the camera."

"The television camera? But it's broken. It won't work!"

"No, but I doubt if they'll notice. They have no television sets."

Skorznios snorted. "Well, then at least we know they're not Americans!"

"Grenko—" Doctor Padellin probed, "these people—"

"Frenonians," Grenko interrupted. "They call themselves Frenonians."

"All right, these . . . Frenonians," Padellin continued. "How did you communicate with them?"

Grenko hesitated a moment, his face oddly rigid. "Sign language, mostly. The rest we sort of worked out. They're very clever. And they're very interested in establishing trade relations."

"Trade!" Colonel Skorznios bellowed. "What do they have to trade, other than these . . . these . . . Kneebs!"

Grenko scratched his head. "Well, not much. But they do have something that we don't have much of here—fresh fruits and vegetables. They've got more fruits and vegetables than they know what to do with!" He reached inside his shirt and pulled out a small yellowish pod. Breaking it in two, he held out a half to Skorznios and one to Padellin. "Try it."

Padellin, as always a scientist, examined the piece of fruit with great interest. Skorznios on the other hand took his with a certain reluctance, sniffing it gingerly as if he expected it to explode. They tasted.

"All right, so it's good," Skorznios grumbled. "So what?"

"So think a minute," Grenko replied. "Trade would be good for us, good for them. Everybody will be happy. Think how easy it will be to build on that—to expand from matters of trade to matters of mutual assistance. Military assistance. *Our* bases on *their* side of the gateway. First. Before the Americans. Think about it. I've already made arrangements for negotiations. Told them I was a diplomat. You don't mind, do you . . . ?"

"You *what*?!" The Colonel exploded. "How dare you act as our representative . . . as . . . " His rage suddenly faded. It weakened and changed into an amused look. The amusement became a smile and Skorznios suddenly roared with laughter, coarse and brittle. Padellin looked at him as if he thought the Colonel had gone quite mad.

"Amazing," Skorznios said at last, his laughter subsiding. "It is fascinating to see how fast a counter-revolutionary can be turned into a self-serving bureaucrat once exposed to a little power. Excellent, Grenko. You're on the road to recovery."

Grenko smiled faintly.

"And I do like your ideas," Skorznios added, his features regaining their hardness. "But do not think that you can leap from criminal to diplomat all at once. You may be useful to us, purely as liaison, since you seem to have a way with these . . . Frenonians, did you say? But the decisions in this matter are not yours to make. Remember that—always." Skorznios smiled again—his usual predatory smile. "But I am a generous man, Grenko. I stand to do well from this project. I may even make General. You also could benefit, if you help us . . . and do as we say."

"You mean . . . " replied Grenko casually, "if I play my cards right?"

Colonel Skorznios frowned at the analogy. "Yes, well, enough of this discussion. I must make my report to headquarters. They will be very interested to know the results. Do you have any more of those yellow fruit I can take to show them?"

Grenko hesitated a moment, then reached into his shirt and produced a second pod. He tossed it to the Colonel.

"Good." Skorznios reached toward the Kneeb, then paused, looking for something. "Don't these beasts have reins? How do you control them?"

"Knee movements, I think," Grenko said smoothly. "But I don't think you'll have any trouble. They're very responsive."

Skorznios considered it a moment, then shrugged. With a pat on its rump, he directed the Kneeb toward the door. Upon reaching it, he paused and turned again to Grenko. "My superiors will find this beast excellent evidence of our discovery. I may even make a personal gift of it to the Premier for his zoo. I'm sure you can get another if you wish, from your friends out there. I'll be back eventually, Grenko, so stay out of mischief."

"Of course, Colonel." He bowed slightly. "I wouldn't think of causing trouble."

Grenko stood on a high dune of reddish sand not far from the gateway, surveying his new domain. The guard from the lab stood nearby, a bit nervous, but enjoying the warm sun and invigorating breeze. Grenko watched a number of the wild Kneebs a short distance away. They were digging in the sand with the broad, flat ends of their tails, then dropping mouthfuls of seeds into the holes. Having a great appetite for the yellow pod-fruit that grew in the region, the beasts had evolved a means of cultivating the plants. If anything, they were oversuccessful. The profusely growing plants were spreading out from the oasis, along canals being dug by the Frenonians.

They were working even now, these friendly people Grenko had encountered. He could see them in the distance. Soon they would be meeting others, but Grenko had no fears about their becoming the losers in any negotiations. They were hardly fools. On the contrary, they had clever minds.

Fine and extremely sensitive minds. Sensitive to many things, not the least of which were other people's thoughts. That had been the *real* reason Grenko had no difficulty communicating with them. What was that word again—? Oh yes, *telepathic*!

Grenko had neglected to tell Colonel Skorznios about that little matter. That, and the fact that their extraordinary mental acuity had been brought about by the unusual chemical properties of certain of their fruits and vegetables. Notably the yellow pod-fruits.

But Grenko had cautioned them against revealing this fact to anyone else, or displaying their all-too-clear understanding. For now, it would be a secret, and since the Frenonians enjoyed a good game, they would go along. After all, Grenko wouldn't want anything to spoil their trade agreements. He imagined all those lovely fruits and vegetables being transported back to his homeland. Everybody would love them, and there were plenty for everyone. It might take a year or two for the change to become noticeable. A stray thought at first, then another. Then everyone

would become as skillful as the Frenonians, and it would be too late to do anything about it.

If the people began to hear other thoughts and ideas, different from those cultivated by the men in charge, perhaps they would begin to wonder . . . and to doubt. And that could prove very interesting. Very interesting indeed. All people are governed by consent, whether that consent is given through fear or understanding. Or in some cases, misunderstanding.

Maybe knowing would not solve all their problems. Maybe it would not solve any. But it was a chance, a beginning. There would still be the leaders to contend with, and the military. But could the leaders cope with a populace that couldn't help but know the truth? Would a soldier take orders when he knew what an officer was *really* thinking? Grenko wondered. Cooperation could become a necessity.

Maybe it would work. Maybe not. But it at least seemed worth the risk.

Grenko turned to the lone guard. "Friend, you look like a wagering man. Tell me, what would you be willing to bet that we'll have free elections within five years?"

The guard smirked, and shook his head. "You never learn, do you!"

Grenko smiled.

It was a gamble, of course. The whole thing was a gamble. But the odds were looking better all the time. . . . ■

Lester del Rey

the reference library

EX UNO PLURIMUM:

I have no idea who invented the serial; probably it goes back to the very beginning of fiction magazine publishing. Its advantages were obvious: it was the only way very long stories could be issued in magazine form; and it kept the readers coming back regularly to complete the story. It was sound business.

Of course, publishing a novel in serial form wasn't ideal for the reader. (This was also abused by many writers and editors who carefully contrived cliff-hanger endings for each installment to be sure of snaring the reader.) Waiting between installments was a nuisance. But in many cases, the older magazines were weeklies, which meant that the wait wasn't very long. By the time the wait grew to two months in some cases, the situation was difficult for many readers.

Recently, writers and publishers in the book field seem to be discovering the serial all over again. No, not the series of novels, in which each story has some kind of an ending. That's rather in the good American tradition, as exemplified by our national motto: one out of many. In a good series, the many books combine to form one larger literary form, as in the Lensman series of E. E. Smith. I mean a serial—a single story published in several books. That's a matter of turning one into many, making each book only an installment of the whole.

That strikes me as being completely unfair to the reader, who purchases a book in the expectation that he's getting a story—only to find out that he must wait a year or two before he can discover what happens—and then may have to wait that long again. It's like selling the customer one trouser leg of a suit and having him wait a year for half the jacket.

It's also unfair to the writer, as well as unfair of him. No normal reader can carry the details of a complex novel in his head for a year or more and be ready to pick up where he left off. (And such long novels, when complete, must be rather complex to justify the wordage.) Most readers won't sit down and reread the first book (or books) before starting the new one; some don't even save copies of books for a year. The resulting loss of detail and confusion must inevitably reduce the impact of the total novel on the reader. That's hardly the effect an honest writer who cares for what he writes should want.

It also seems to be rather shoddy publishing practice. The publisher is buying the beginning of a book without knowing whether the further books will be good ones. And suppose the writer dies before finishing? That hasn't happened so far in the field—but it remains a possibility.

The case in point is the five-part serial of Roger Zelazny that began back in 1970 with the publication of *The Nine Princes of Amber*. Now finally in 1978 the fifth and final (?) installment has just been issued—THE COURTS OF CHAOS (Doubleday, 183 pp., $7.95). In this series, an average of two years passed between install-

ments. There were at least eighteen major characters to be remembered, most of them highly complex and interwoven even more complexly. (Nine princes, four princesses, five other major characters—one playing a dual role.) And there was nothing resembling a conclusion to any of the first four.

The basic situation and indicated plot were fascinating. Earth and countless other (somewhat parallel) worlds existed in a vague space-time matrix where almost any world that could be imagined would exist. But none of these worlds was quite real. The reality, lying at the core of everything, was the Kingdom of Amber, apparently created out of chaos by Oberon. Now King Oberon was either dead or missing.

Oberon had nine living sons to contend for the throne. Most of them hated the others, and were engaged in every conceivable plot and dirty trick, forming alliances against first one and then another. As told in the first book, Corwin, the viewpoint hero, had been exiled and robbed of his memory long before. He had existed on our Earth for several centuries. Now, as a result of the power struggle going on, he is made aware of a few facts. One of the other princes takes him on a hell-ride through the shadows of reality. This ability to shape the shadows and thus travel through them to Amber or any other place is one of the powers of all Oberon's children.

Back in Amber, Corwin walks a Pattern which seems to create or symbolize Amber, thus regaining his memory and powers. He gets caught up in the plot to overcome the efforts of brother Eric to take the throne, and all hell breaks loose.

Fine—who could ask for anything more in an original fantasy idea? Well, I could. I wanted some kind of an ending, and there was none. Corwin, having suffered because of one effort to defeat Eric, simply was about to try another, with none of the complexities untangled, none of the motivations straightened out, and even more confusion at the end than at the beginning. Aside from the lack of a resolution, however, it was a marvelous book.

By the time each of the next three volumes appeared, I'd lost a lot of the clues and threads and couldn't possibly remember the relationships of all the characters that interacted on each other. There were vague recaps planted on what had gone before, but they were quite inadequate. Characters that were supposedly dead in one book popped up in another. Characters that seemed to be major enough to remember just disappeared in the next book. And I didn't go back and reread the whole set each time; if I'd done so, I'd probably have grown tired of the first one by the fourth time I read it, anyhow. So the following books impressed me a lot less than the first, though each added a great deal to the complexity of the whole.

Well, the books have to be read from first to last. They form a single novel, not a series of novels. When the final one came, I went back to the beginning. And this time, volumes two, three and four stood up very well, on the whole, and everything tied together and kept the suspense going very well. The five volumes *must* be read as a whole.

The only real fault I found in going

back continuously through the first four volumes was some repetitiveness that wouldn't have been there, probably, if the books had been written as one. How often can the hell-ride through the shadows seem fresh? Yet there it is in full detail, time after time.

Surprisingly, Zelazny kept his inventiveness and the rich feeling of the story fresh and vigorous from the first volume in 1970 to the fourth in 1976—and that's a long stretch for a writer to continue without flagging, particularly since he was writing other novels in between.

Finally, the fifth volume does tie up almost all of the threads and does complete the novel; however, it leaves all sorts of possibilities for further developments, since it offers a whole new pattern of shadowlands. The novel that was serialized over eight years is now complete—and if Zelazny has a sequel in mind, he hasn't said so yet.

Unfortunately, *The Courts of Chaos* seems to have lost something. Some of the inventiveness, potential, and freshness of the other books has been lost. Much of the book seems tired, somehow. There's a long trip to the Courts of Chaos, a strange region partly described in the third book, which seems flat. And the final scene at the Courts of Chaos doesn't come off effectively; Chaos was a region of strangeness and strange beings, but now the figures from it seem little different from any figures in any battle. The marvel of Oberon's fate came to its culmination in the fourth book, and Oberon now is just another tired old man, trying the best he can. What he does should have been emotionally stirring—but isn't. The body of the story is there, but some of the spirit is missing. (And the feeling while reading was quite strong, even though this was fresh and the story I enjoyed in the other books was familiar.)

This shouldn't be surprising, perhaps. It's difficult for a writer to hold the mood of a story year after year—and Zelazny did better than most could have done.

I wish Doubleday and Zelazny had shared the responsibility of treating this as the one book it is, with enough advance for Zelazny to write the whole as one effort and the chance to do it as one long story, complete in a single book. Had that been done, this could well have been a genuinely superb piece of fantasy. As it is, it's a good story—no more.

Two years is too long to wait between installments of a serial, both for the reader and the writer. And if books must be published in serial form, simple honesty requires that the publisher warn the reader at once that the story isn't complete until the final book.

In some degree, C. J. Cherryh has also been doing a serial in three parts in her books about the *mri* and Duncan, who learned to live with those strange aliens. But at least the wait between books isn't so long (two books have appeared in 1978) and each book seems to conclude one major phase of the story.

Her second book in the story is **THE FADED SUN: SHON'JIR** (SF Book Club, 243 pp., $1.98—to be published by DAW Books).

The *mri* were strange, proud aliens who served as mercenary warriors against the forces of Earth. They lost.

And those who still existed were betrayed. Now only two remain—Niun, trained as a warrior but never in battle, and Melein, the priestess-mother-queen who must be obeyed. They are held captive by Earthmen. But Duncan, who lived with them as their somewhat willing captive, manages to free them and get them on a ship, guided by their ancient records toward what may be their home world, incredibly far away.

But no *tsi'mri* (non-mri) may go with the mri. Duncan must accept the rule of Melein and become effectively mri. And during the long voyage, he is forced into the harsh and unyielding discipline and ethic of a *kel*—a warrior of the mri. Somehow he must achieve what no other tsi'mri has ever accomplished, must learn what has taken Niun all his life to master. And if he succeeds—well, he may be almost accepted as mri.

Their only hope is to find other mri on the planet toward which the ship heads. What will they find there? Millennia have passed since they left. And ahead and behind them lie nothing but blasted, lifeless planets where once the mri stopped on their outward drive. Something very wrong has happened, again and yet again.

And behind come the forces of Earth and the alien regul, ready to seize or destroy whatever may be found on the home planet of the mri.

This is a powerful story, bitter and yet somehow inspiring in its determination and feeling of strange loyalties and stranger courage. It sticks in the mind, long after the last page is finished. And there is a resolution to the shaping of Duncan, though much remains to be told.

For books like these first two in the story, I'm even willing to accept serial publication—provided the third book appears as quickly as this second one.

(And before I leave serial books, I must plead guilty to bringing out a three-part serial in the novels I edit. My only excuse is that it began in hard covers, where I had no control, and the story was too good not to issue in paperback form. But at least the readers were clearly notified in both editions that the books were not complete novels.)

Ace Books has begun publishing large-format illustrated books. The first one I've seen is **THE MAGIC GOES AWAY** by Larry Niven (213 pp., $4.95). This is really a long novelette, a little over 30,000 words, with another 4000-word critical article on the story by Sandra Miesel. The story is a final one in the Warlock Series that began with Niven's "Not Long Before the End" in 1969. The basic assumption—a fine, fresh idea—is that at one time magic filled the world; but like any natural resource, once it is used up, is gone. And magicians have been using it up rapidly, until magic is almost exhausted.

In this, Orolandes escapes the destruction of Atlantis and seeks a wizard to remove his guilt at his part in the event. He falls in with the Warlock and other magicians, including the animated skull of Wavyhill. They are seeking more magic—and they plan to bring the moon down to Earth, since it must contain great amounts of unused magic. To accomplish this, they must find the last living god, Roze-Katee. Orolandes is taken along for his strength and fighting skill.

Niven handles this type of story with considerable feeling and wit, and with a deft ability to take the clichés of sword-and-sorcery fiction and make them work so they no longer are clichés.

The illustrations, by Esteban Maroto, fill out the book. There are sixty-odd of them, some of which are used more than once. They are generally in the style of the adventure comic illustrations, though clearer and cleaner in execution than most of such. They fit the conventions of such comic books pretty much—women must be almost naked, etc.—but generally also fit the story. Maroto seems to think a roc is a dragon, rather than a bird, however.

Whether the text and illustrations justify the price for a novelette depends on how picture-oriented one is. A quick glance through the book should answer that question.

Normally, I dislike reviewing anthologies; they depend on the included stories, and evaluating all of those takes up too much space. But I'm happy to make an exception for **CLASSIC SCIENCE FICTION, THE FIRST GOLDEN AGE**, edited by Terry Carr (Harper & Row, 445 pp., $14.95). The twelve stories are mostly novelettes, most of them from *Astounding*, and were published between 1940 and 1942—part of the golden age by nearly anyone's reckoning. Van Vogt, Russell, Heinlein, Sturgeon, Brackett, Asimov and Kuttner are represented, among others. And with a few necessary exceptions, Carr has managed to find stories which are not the ones most commonly reprinted, though they are excellent examples of the writers and the period.

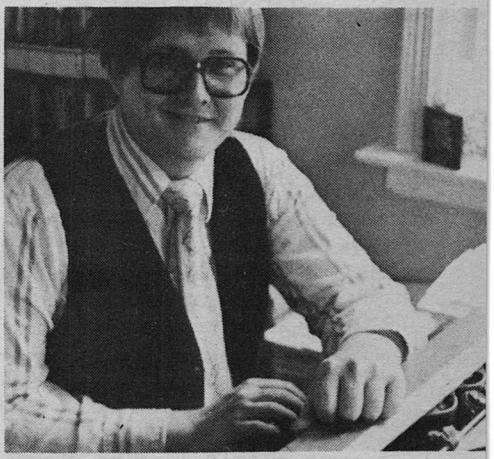
Furthermore, in a long introduction and in the blurbs before the stories, Carr shows clearly that he has done his homework on the period with thoroughness and understanding. I doubt that he was reading when these stories first appeared, but he has managed to give one of the clearest and fairest summaries of the period and what it meant that I've read for some time. It's a really excellent example of what can be done by an anthologist who cares.

THE SECOND BOOK OF VIRGIL FINLAY is now available (Gerry de la Ree, 7 Cedarwood Lane, Saddle River, N.J. 07458, $15.00) and it's every bit as good as the first portfolio by de la Ree. This covers the period from 1942 through 1955 (with a hiatus while the artist was at war) and shows some of Finlay's best work. On the whole, the illustrations in this portfolio are less well known than those in the previous one, though I find them even better, if anything. It's a large book, and the reproduction is gorgeous. For anyone who likes good fantasy art, this book is a must.

And finally, for the readers who like fantasies of barbarian kingdoms and of Atlantis myths, there's something different. **THE SERPENT** by Jane Gaskell (Pocket Books, 307 pp., $1.95) is the first of three volumes which form a single work—but which can be read separately, since each has ending enough. These give a picture of a world that existed when Atlantis existed—though hardly of the standard fictional Atlantean world. They deal with Cija, a girl of noble birth whose country is conquered by Zerd's ar-

BIOLOG

Orson Scott Card



Most of the more recent science fiction writers have had long acquaintance with science fiction, and generally fandom, as well as a strong interest in science. Orson Scott Card is perhaps a one-of-a-kind exception. Scott teaches Sunday school for adults in Salt Lake City, where he lives with his wife and infant son, was a Mormon missionary in Brazil for two years, and never heard of science fiction fandom until he'd sold seven stories.

He was born in Washington state and raised in California, along with several years in Arizona. He has been an editor at Brigham Young University Press, the impresario of a theater company, and a playwright with a dozen productions to his credit.

Scott's first science fiction story idea hit him in 1970, but he was too involved in school to follow through. The story first saw manuscript in 1975. It was accepted by Analog, published in the August 1977 issue (title: "Ender's Game"), and helped win Scott the 1977 John W. Campbell Award for Best New Writer. Since that first story sale, Scott has sold a dozen more to Analog.

A first novel, HOT SLEEP: THE WORTHING CHRONICLE, is coming out this year under the Analog Books imprint. Another novel, A PLANET CALLED TREASON will be coming out from St. Martin's Press; and yet another, based on the story "Mikal's Songbird," (which appeared in Analog) will be forthcoming from Dell. A story collection, CAPITOL: THE WORTHING CHRONICLE will be brought out by Analog Books; stories will be appearing in Analog, Omni, F&SF, The Last Dangerous Visions, New Dimensions, and Destinies. He is also writing a short-fiction review column for Richard Geis's Science Fiction Review. Orson Scott Card is one of our busiest and best new talents.

by Jay Kay Klein

mies. Rather than marry him, she travels with his army in various ways, going from hostage to slave, fighting the attraction she feels developing for Zerd, and taking part in the wars of the time. Sex and adventure mix together. The picture of the mythical times is well developed.

I found the book interesting enough to finish, though not really exciting. But English readers seem to have been totally caught up in Cija's exploits. I suggest that anyone who likes this type of fiction try this first volume. At least you won't be compelled to read all three in order to get a full story! ■

For several months to come our Brass Tacks letters will be addressed to Ben Bova, although at the time you read the column Stanley Schmidt will be the editor. It's going to take some time for us to catch up with ourselves! Please bear with us.

Dear Mr. Bova,

Your editorial about the current boom in science fiction films prompts me to write. I really enjoy having my pulse-rate raised.

Speaking as someone who has reread every issue of your venerable publication released since my birth year (1950) and also as Animation and Rotoscope Designer on STAR WARS (the man who animated the electricity on little R2D2), I find your attitude disappointing. I believe I detect one, maybe two, "sour grapes." (I have always mistrusted people who capitalize common nouns not heading sentences!) Particularly so in light of the fact that I generally like your handling of the magazine (the remake of *Microcosmic God* with Japanese instead of mutants, for example).

You are hoist by your own petard when you say, "It is like watching your very first Christmas Tree . . ." Exactly! Or my first microscope or chemistry set. STAR WARS shares a characteristic with many Disney films, namely: it is a film intended primarily for children that is also of interest to their parents.

Anyone who states that George Lucas "totally ignored" the fundaments of drama, or compares his film to Nazi propaganda, is simply ignorant or misinformed (and unperceptive, if they saw the film). The primary characteristic of the project was extremely intelligent decision making, (and some clever recognition of obvious but heretofore unnoticed ways of doing show business), the most relevant characteristic of the filmmaker (from personal observation) is an uncommonly high sense of ethics and morals (with a somewhat libertarian political outlook, I guess).

But the worst arrogance I find in your article is towards the end where you take upon yourself the power to delineate exactly what is and is not good "science fiction." STAR WARS is the story of an individual who has a rather large effect on his "world." It is also chock full of nuts, as well as many of my favorite "science fiction" characteristics. It has much of the flavor, for me, of the better so-called Heinlein Juveniles (*especially* the dialog).

I really like your magazine, but do not predict much of a future for you in the visual media. By the way, the loss of the Deathstar represents the destruction of a large capital investment on the part of the otherwise intact Empire, it is not a simple total victory. Also, neither Luke nor the "Force" made that torpedo go in that hole, it was me! *You*, I submit, like James E. Carter, are out of touch with your

constituency. So There!

ADAM K. BECKETT
INFINITE ANIMATION Ltd.
PO Box 55068
Valencia, CA 91355

Ah-hah! So it wasn't "the Force" that won the day, after all. Seriously, the Editorial's aim was to point out the pernicious anti-intellectualism of many Hollywood productions, including "Star Wars." This "heart-over-head" attitude is a danger to our society, and is the antithesis of science fiction's long-standing support of rationality.

Dear Mr. Bova:

"Backstage Lensman" is the first story in Analog in quite a few years that knocked me out of my chair laughing. Randy Garrett hasn't forgotten that science fiction can still have a funnybone. Shades of the "Mark Clifton" days. More!

Perhaps a long-memoried reader can help me in my search for a chocolate Maltese falcon. It appeared in a pastiche in the late '50s or early '60s with our hero-detective finding it and eating it to keep it from the bad guys only to discover that the falcon was the secret explosive that would destroy the galaxy (starting with his stomach). Many people I've spoken and written to remember it vaguely but no one has come up with an author, title or copy. Help!

SID WASHER
245 W. 107th St.
NYC 10025

How about it, readers? Anyone remember that story?

Dear Mr. Bova,

I have to share this with you. In a few weeks I'll be moving to another city to enter a school of ministry. The church in which I'll be working is very strong on its science subjects, and I've never had a formal science course in my life—49 years, so far. But I've been a regular reader of Analog for several of those years. This includes the science fact articles as well as the excellent science fiction your magazine carries.

At any rate, a couple weeks ago I took my entrance exam, a 300 question test, much of which included science subjects. In short, I made a higher score on the test than some who have already had all the schooling, and my highest score was in the section on science.

I was pleased, but the dean was astounded. He asked where I got my knowledge of science, and wasn't sure but what I was pulling his leg when I told him it came from Analog. He'd never heard of the magazine before, but I have a feeling he's about to become a subscriber. I thank all the authors who have adhered to the truth in all they've written, science and fiction. And I thank you, Ben Bova, for Analog.

HAL SWIFT
905 Oxford Ave
Sparks, NV 89431

On behalf of Analog's writers, artists, editors, and art director . . . you're very welcome. And good luck!

Dear Ben,

Could I use your letter column to thank Patrice Swadey for her letter in your June issue? My story "Legal Rights for Germs?" appeared over six months ago and filled three pages only

because one of those pages was an illustration and a blurb. Yet thanks to Ms. Swadey, attention has once again been called to it, and I got my name in Analog four more times! (Spelled right, too!) What more could a neopro ask?

Let's see: "Legal Rights" got three letters-of-comment a couple of issues after it appeared, the *National Enquirer* ran a survey-article based on it, I've been told that it will probably be picked up for an anthology of short-shorts, you printed a sequel to it, and now Ms. Swadey helps keep its small life going. I find the whole thing astounding!

I might add that I did not *intend* the story to be a *reductio ad absurdum* of the Right-to-Life movement. For me, it was little more than a story idea. (I'm reminded of Larry Niven's term for people who identify the positions of characters with the positions of their authors, and who think that if a person writes a story with a murderer in it, that writer is therefore a murderer; Niven calls such people "idiots.") If anything, I identify with Felix Gardener. The miracle is that *any* matter *ever* becomes sentient. The "lowest" creature exemplifies that miracle as much as you or I or Ms. Swadey. That a fly is sentient overwhelms me with awe. As Lloyd Biggle put it, "On life's scale of values, the smallest is no less precious . . . than the largest. Every life is a monument to all life." And that's exactly what "Legal Rights" was about (he pontificated). I guess reading so much SF has made me less homocentric than some would have me.

By the way, besides being grateful to Ms. Swadey for helping keep the story alive, I must also thank her for the vigor of her attack. That I could "outrage and astonish" someone! That my innocent little story could be "low, cheap and vicious"! That I could be "massively ignorant" (however ignorance can have mass)! What glorious fun! Harlan, I understand you better.

JOE PATROUCH

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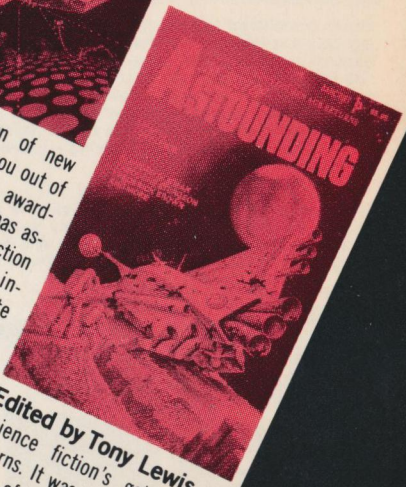

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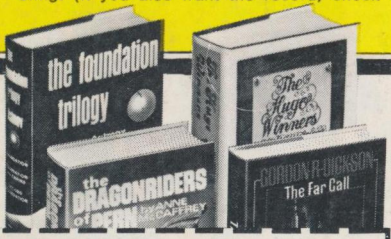

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