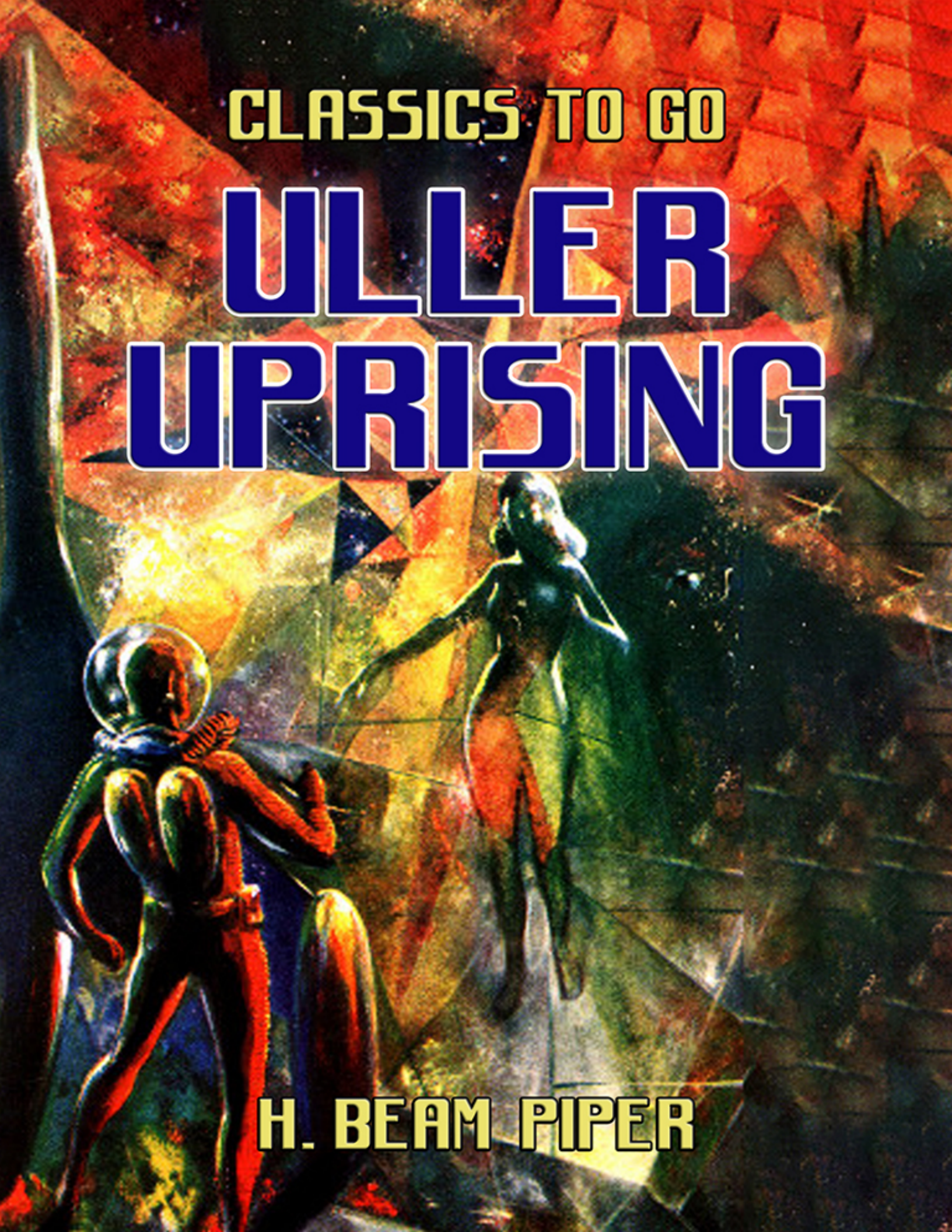
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Introduction

Dr. John D. Clark

THE SILICONE WORLD

1. THE STAR AND ITS MOST IMPORTANT PLANET

The planet is named Uller (it seems that when interstellar travel was developed, the names of Greek Gods had been used up, so those of Norse gods were used). It is the second planet of the star Beta Hydri, right angle 0:23, declension -77:32, G-0 (solar) type star, of approximately the same size as Sol; distance from Earth, 21 light years.

Uller revolves around it in a nearly circular orbit, at a distance of 100,000,000 miles, making it a little colder than Earth. A year is of the approximate length of that on Earth. A day lasts 26 hours.

The axis of Uller is in the same plane as the orbit, so that at a certain time of the year the north pole is pointed directly at the sun, while at the opposite end of the orbit it points directly away. The result is highly exaggerated seasons. At the poles the temperature runs from 120°C to a low of -80°C. At the equator it remains not far from 10°C all year round. Strong winds blow during the summer and winter, from the hot to the cold pole; few winds during the spring and fall. The appearance of the poles varies during the year from baked deserts to glaciers covered with solid CO_2. Free water exists in the equatorial regions all year round.

2. SOLAR MOVEMENT AS SEEN FROM ULLER

As seen from the north pole—no sun is visible on Jan. 1. On April 1, it bisects the horizon all day, swinging completely around. April 1 to July 1, it continues swinging around, gradually rising in the sky, the spiral converging to its center at the zenith, which it reaches July 1. From July 1 to October 1 the spiral starts again, spreading out from the center until on October 1 it bisects the horizon again. On October 1 night arrives to stay until April 1.

At the equator, the sun is visible bisecting the southern horizon for all 26 hours of the day on January 1. From January 1 to April 1, the sun starts to dip below the horizon at night, to rise higher above it during the day. During all this time it rises and sets at the same hours, but rises in the southeast and sets in the southwest. At noon it is higher each day in the southern sky until April 1, when it rises due east, passes through the zenith and sets due west. From April 1 to July 1, its noon position drops down to the north, until on July 1, it is visible all day, bisected by the northern horizon.

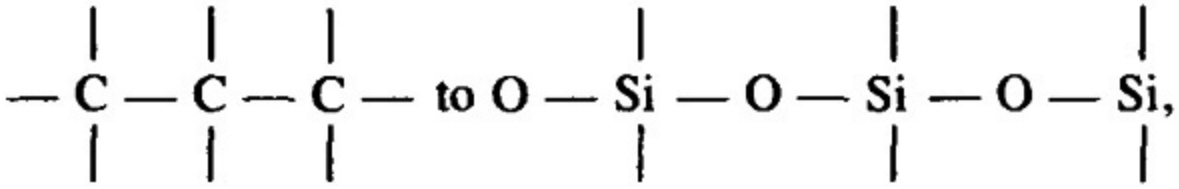
3. CHEMISTRY AND GEOLOGY OF ULLER

Calcium and chlorine are rarer than on earth, sodium is somewhat commoner. As a result of the shortage of calcium there is a higher ration of silicates to carbonates than exists on earth. The water is slightly alkaline and resembles a very dilute solution of sodium silicate (water glass). It would have a pH of 8.5 and tastes slightly soapy. Also, when it dries out it leaves a sticky, and then a glassy, crackly film. Rocks look fairly earthlike, but the absence or scarcity of anything like limestone is noticeable. Practically all the sedimentary rocks are of the sandstone type.

All rivers are seasonal, running from the polar regions to the central seas in the spring only, or until the polar cap is completely dried out.

4. ANIMAL LIFE

As on Earth life arose in the primitive waters and with a carbon base, but because of the abundance of silicone, there was a strong tendency for the microscopic organisms to develop silicate exoskeletons, like diatoms. The present invertebrate animal life of the planet is of this type and is confined to the equatorial seas. They run from amoeba-like objects to things like crayfish, with silicate skeletons. Later, some species of them started taking silicone into their soft tissues, and eventually their carbon-chain compounds were converted to silicone type chains, from



with organic radicals on the side links. These organisms were a transitional type, with silicone tissues and water body fluids, resembling the earthly amphibians, and are now practically extinct. There are a few species, something like segmented worms, still to be seen in the backwaters of the central seas.

A further development occurred when the silicone chain animals began to get short-chain silicones into their circulatory systems, held in solution by OH or NH_2 groups on the ends and branches of the chains. The proportion of these compounds gradually increased until the water was a minor and then a missing constituent. The larger mobile species were, then, practically anhydrous. Their blood

consists of short-chain silicones, with quartz reinforcing for the soft parts and their armor, teeth, etc., of pure amorphous quartz (opal). Most of these parts are of the milky variety, variously tinted with metallic impurities, as are the varieties of sapphires.

These pure silicone animals, due to their practical indestructibility, annihilated all but the smaller of the carbon animals, and drove the compromise types into odd corners as relics. They developed into a fish-like animal with a very large swim-bladder to compensate for the rather higher density of the silicone tissues, and from these fish the land animals developed. Due to their high density and resulting high weight, they tend to be low on the ground, rather reptilian in look. Three pairs of legs are usual in order to distribute the heavy load. There is no sharp dividing line between the quartz armor and the silicone tissue. One merges into the other.

The dominant pure silicone animals only could become mobile and venture far from the temperate equatorial regions of Uller, since they neither froze nor stiffened with cold, nor became incapacitated by heat. Note that all animal life is cold-blooded, with a negligible difference between body and ambient temperatures. Since the animals are silicones, they don't get sluggish like cold snakes.

5. PLANT LIFE

The plants are of the carbon-metabolism, silicate-shell type, like the primitive animals. They spread out from the equator as far as they could go before the baking polar summers killed them. They have normal seasonal growth in the temperate zones and remain dormant and frozen in the winter. At the poles there is no vegetation, not because of the cold winter, but because of the hot summer. The winter

winds frequently blow over dead trees and roll them as far as the equatorial seas. Other dead vegetation, because of the highly silicious water, always gets petrified unless it is eaten first. What with the quartz-speckled hides of the living vegetation and the solid quartz of the dead, a forest is spectacular.

The silicone animals live on the plants. They chew them up, dehydrate them, and convert their silicious outer bark and carbonaceous interiors into silicones for themselves. When silicone tissue is metabolized, the carbon and hydrogen go to CO_2 and H_2O, which are breathed out, while the silicone goes into SiO_2, which is deposited as more teeth and armor. (Compare the terrestrial octopus, which makes armor-plating out of calcium urate instead of excreting urea or uric acid.) The animals can, of course, eat each other too, or make a meal of the small carbonaceous animals of the equatorial seas.

Further note that the animals cannot digest plants when they are cold. They can eat them and store them, but the disposal of the solid water and CO_2 is too difficult a problem. When they warm up, the water in the plants melts and can be disposed of, and things are simpler.

THE FLUORINE PLANET

1. THE STAR AND PLANET

The planet named Niflheim is the fourth planet of Nu Puppis, right angle 6:36, declension -43:09; B8 type star, blue-white and hot, 148 light years distant from Earth, which will require a speed in excess of light to reach it.

Niflheim is 462,000,000 miles from its primary, a little less than the distance of Jupiter from our sun. It thus does not receive too great a total amount of energy, but what it does receive is of high potential, a large fraction of it being in the ultra-violet and higher frequencies. (Watch out for really super-special sunburn, etc., on unwarned personnel.)

The gravity of Niflheim is approximately 1 g, the atmospheric pressure approximately 1 atmosphere, and the average ambient temperature about -60°C; -76°F.

2. ATMOSPHERE

The oxidizer in the atmosphere is free fluorine (F_2) in a rather low concentration, about 4 or 5 percent. With it appears a mad collection of gases. There are a few inert diluents, such as N_2 (nitrogen), argon, helium, neon, etc., but the major fraction consists of CF_4 (carbon tetrafluoride), BF_3 (boron trifluoride), SiF_4 (silicon tetrafluoride), PF_5 (phosphorous pentafluoride), SF_6 (sulphur hexafluoride) and probably others. In other words, the fluorides of all the non-metals that can form fluorides. The phosphorous pentafluoride rains out when the weather gets cold. There is also free oxygen, but no chlorine. That would be liquid

except in very hot weather. It sometimes appears combined with fluorine in chlorine trifluoride. The atmosphere has a slight yellowish tinge.

3. SOIL AND GEOLOGY

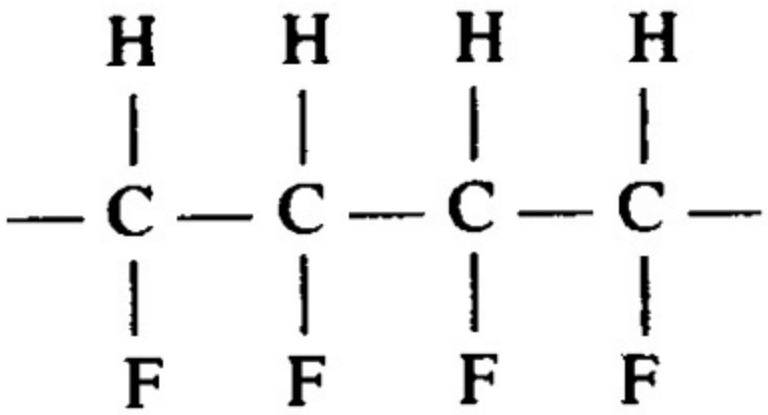
Above the metallic core of the planet, the lithosphere consists exclusively of fluorides of the metals. There are no oxides, sulfides, silicates or chlorides. There are small deposits of such things as bromine trifluoride, but these have no great importance. Since fluorides are weak mechanically, the terrain is flattish. Nothing tough like granite to build mountains out of. Since the fluoride ion is colorless, the color of the soil depends upon the predominant metal in the region. As most of the light metals also have colorless ions, the colored rocks are rather rare.

4. THE WATERS UNDER THE EARTH

They consist of liquid hydrofluoric acid (HF). It melts at -83°C and boils at 19.4°C. In it are dissolved varying quantities of metallic and non-metallic fluorides, such as boron trifluoride, sodium fluoride, etc. When the oceans and lakes freeze, they do so from the bottom up, so there is no layer of ice over free liquid.

5. PLANTS AND PLANT METABOLISM

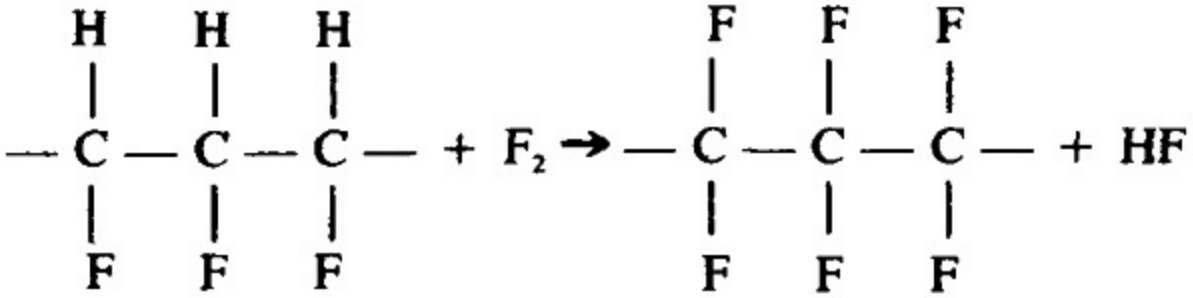
The plants function by photosynthesis, taking HF as water from the soil, and carbon tetrafluoride as the equivalent of carbon dioxide from the air to produce chain compounds, such as:



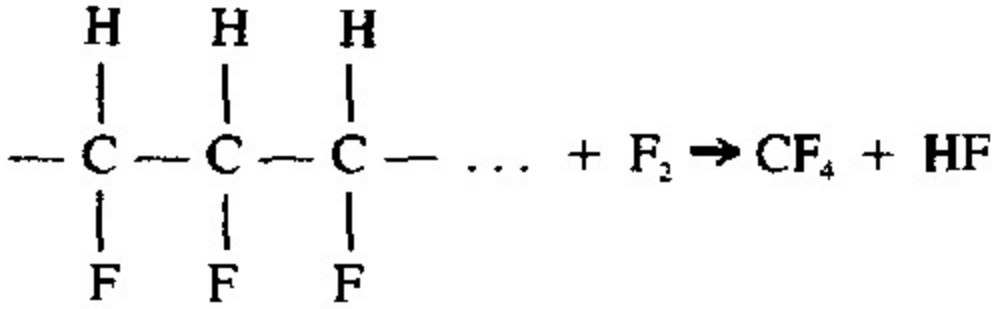
and at the same time liberating free fluorine. This reaction could only take place on a planet receiving lots of ultra-violet because so much energy is needed to break up carbon tetrafluoride and hydrofluoric acid. The plant catalyst (doubling for the magnesium in chlorophyll) is nickel. The plants are colored in various ways. They get their metals from the soil.

6. ANIMALS AND ANIMAL METABOLISM

Animals depend upon two main reactions for their energy, and for the construction of their harder tissues. The soft tissues are about the same as the plant molecules, but the hard tissues are produced by the reaction:



resulting in a teflon boned and shelled organism. He's going to be tough to do much with. Diatoms leave strata of powdered teflon. The main energy reaction is:



The blood catalyst metal is titanium, which results in colorless arterial blood and violet veinous, as the titanium flips back and forth between tri and tetra-valent states.

7. EFFECT ON INTRUDING ITEMS

Water decomposes into oxygen and hydrofluoric acid. All organic matter (earth type) converts into oxygen, carbon tetrafluoride, hydrofluoric acid, etc., with more or less speed. A rubber gas mask lasts about an hour. Glass first frosts and then disappears. Plastics act like rubber, only a little slower. The heavy metals, iron, nickel, copper, monel, etc., stand up well, forming an insoluble coat of fluorides at first and then doing nothing else.

8. WHY GO THERE?

Large natural crystals of fluorides, such as calcium difluoride, titanium tetrafluoride, zirconium tetrafluoride, are extremely useful in optical instruments of various forms. Uranium appears as uranium hexafluoride, all ready for the diffusion process. Compounds of such non-metals as boron are obtainable from the atmosphere in high purity with very little trouble. All metallurgy must be electrical. There are considerable deposits of beryllium, and they occur in high concentration in its ores.

PROLOGUE

On Satan's Footstool

The big armor-tender vibrated, gently and not unpleasantly, as the contragravity field alternated on and off, occasionally varying its normal rate of five hundred to the second when some thermal updraft lifted the vehicle and the automatic radar-altimeter control acted to alter the frequency and lower it again. Sometimes it rocked slightly, like a boat on the water, and, in the big screen which served in lieu of a window at the front of the control cabin, the dingy-yellow landscape would seem to tilt a little. If unshielded human eyes could have endured the rays of Nu Puppis, Niflheim's primary, the whole scene would have appeared a vivid Saint Patrick's Day green, the effect of the blue-predominant light on the yellow atmosphere. The outside 'visor-pickup, however, was fitted with filters which blocked out the gamma-rays and X-rays and most of the ultra-violet-rays, and added the longer light-waves of red and orange which were absent, so that things looked much as they would have under the light of a G0-type star like Sol. The air was faintly yellow, the sky was yellow with a greenish cast, and the clouds were green-gray.

A thousand feet below, the local equivalent of a forest grew, the trees, topped with huge ragged leaves, looking like hundred-foot stalks of celery. There would be animal life down there, too—little round things, four inches across, like eight-legged crabs, gnawing at the vegetation, and bigger things, two feet long, with articulated shell-armor and sixteen legs, which fed on the smaller herbivores. Beyond, in the middleground, was open grassland, if one could so

call a mat of wormlike colorless or pastel-tinted sprouts, and a river meandered through it. On the skyline, fifty miles away, was a range of low dunes and hills, none more than a thousand feet high.

No human had ever set foot on the surface, or breathed the air, of Niflheim. To have done so would have been instant death; the air was a mixture of free fluorine and fluoride gasses, the soil was metallic fluorides, damp with acid rains, and the river was pure hydrofluoric acid. Even the ordinary spacesuit would have been no protection; the glass and rubber and plastic would have disintegrated in a matter of minutes. People came to Niflheim, and worked the mines and uranium refineries and chemical plants, but they did so inside power-driven and contragravity-lifted armor, and they lived on artificial satellites two thousand miles off-planet. This vehicle, for instance, was built and protected as no spaceship ever had to be, completely insulated and entered only through a triple airlock—an outer lock, which would be evacuated outward after it was closed, a middle lock kept evacuated at all times, and an inner lock, evacuated into the interior of the vehicle before the middle lock could be opened. Niflheim was worse than airless, much worse.

The chief engineer sat at his controls, making the minor lateral adjustments in the vehicle's position which were not possible to the automatic controls. One of the radiomen was receiving from the orbital base; the other was saying, over and over, in an exasperatedly patient voice: "Dr. Murillo. Dr. Murillo. Please come in, Dr. Murillo." At his own panel of instruments, a small man with grizzled black hair around a bald crown, and a grizzled beard, chewed nervously at the stump of a dead cigar and listened intently to what was—or for what wasn't—coming in to his headset receiver. A couple of assistants checked dials and refreshed their memories from notebooks and peered anxiously into the big screen. A

large, plump-faced, young man in soiled khaki shirt and shorts, with extremely hairy legs, was doodling on his notepad and eating candy out of a bag. And a black-haired girl in a suit of coveralls three sizes too big for her, and, apparently, not much of anything else, lounged with one knee hooked over her chair-arm, staring into the screen at the distant horizon.

"Dr. Murillo. Dr. Mur—" The radioman broke off in mid-syllable and listened for a moment. "I hear you, doctor, go ahead." Then, a moment later "What's your position, now, doctor?"

"I can see them," the girl said, lifting a hand in front of her. "At two o'clock, about one of my hand's-breadths above the horizon."

The man with the grizzled beard put his face into the fur around the eyepiece of the telescopic-'visor and twisted a dial. "You have good eyes, Miss Quinton," he complimented. "Only four personal armors; Ahmed, ask him where the fifth is."

"We only see four of your personal-armors," the radioman said. "Who's missing, and why?" He waited for a moment, then lowered the hand-phone and turned. "The fifth one's inside the handling-machine. One of the Ullerans. Gorkrink."

The larger of the specks that had appeared on the horizon resolved itself into a handling-machine, a thing like an oversized contragravity-tank, with a bulldozer-blade, a stubby derrick-boom instead of a gun, and jointed, claw-tipped arms to the sides. The smaller dots grew into personal armor—egg-shaped things that sprouted arms and grab-hooks and pushers in all directions. The man with the grizzled beard began talking rapidly into his hand-phone, then hung it up. There was a series of bumps, and the

armor-tender, weightless on contragravity, shook as the handling-machine came aboard.

"You ever see any nuclear bombing, Miss Quinton?" the young man with the hairy legs asked, offering her his candy bag.

"Only by telecast, back Sol-side," she replied, helping herself. "Test-shots at the Federation Navy proving-ground on Mars. I never even heard of nuclear bombs being used for mining till I came here, though."

"Well, if this turns out as well as the other job, three months ago, it'll be something to see," he promised. "These volcanoes have been dormant for, oh, maybe as long as a thousand years; there ought to be a pretty good head of gas down there. And the magma'll be thick, viscous stuff, like basalt on Terra. Of course, this won't be anything like basalt in composition—it'll be intensely compressed metallic fluorides, with a very high metal-content. The volcanoes we shot three months ago yielded a fine flow of lava with all sorts of metals—nickel, beryllium, vanadium, chromium, indium, as well as copper and iron."

"What sort of gas were you speaking about?" she asked.

"Hydrogen. That's what's going to make the fireworks; it combines explosively with fluorine. The hydrogen-fluorine combination is what passes for combustion here; the result is hydrofluoric acid, the local equivalent of water. See, the metallic core of this planet is covered, much less thickly than that of Terra, with fluoride rock—fluorspar, and that sort of thing. There's nothing like granite here, for instance. That's why those big dunes, out there, are the best Niflheim has in the way of mountains. The subsurface hydrogen is produced when the acid filters down through the rock, combines with pure metals underneath."

"Dr. Murillo's inside, now," the radioman said. "Just came out of the inner airlock. He'll be up as soon as he gets out of his pressure-suit."

"As soon as he gets here, I'll touch it off," the bearded man said. "Everything set, de Jong?"

"Everything ready, Dr. Gomes," one of his assistants assured him.

The door at the rear of the control-cabin opened, and Juan Murillo, the seismologist, entered, followed by an assistant. Murillo was a big man, copper-skinned, barrel-chested; he looked like a third-or fourth-generation Martian, of Andes Indian ancestry. He came forward and stood behind Gomes' chair, looking down at the instruments. His assistant stopped at the door. This assistant was not human. He was a biped, vaguely humanoid, but he had four arms and a face like a lizard's, and, except for some equipment on a belt, he was entirely naked.

He spoke rapidly to Murillo, in a squeaking jabber. Murillo turned.

"Yes, if you wish, Gorkrink," he said, in the English-Spanish-Afrikaans-Portuguese mixture that was Sixth Century, A.E., Lingua Terra. Then he turned back to Gomes as the Ulleran sat down in a chair by the door.

"Well, she's all yours, Lourenço, shoot the works."

Gomes stabbed the radio-detonator button in front of him. A voice came out of the PA-speaker overhead: "In sixty seconds, the bombs will be detonated ... thirty seconds ... fifteen seconds ... ten seconds ... five seconds, four seconds, three seconds, two seconds, one second...."

Out on the rolling skyline, fifty miles away, a lancelike ray of blue-white light shot up into the gathering dusk—a clump of

five rays, really, from five deep shafts in an irregular pentagon half a mile across, blended into one by the distance. An instant later, there was a blinding flash, like sheet-lightning, and a huge ball of varicolored fire belched upward, leaving a series of smoke-rings to float more slowly after it. That fireball flattened, then spread to form the mushroom-head of a column of incandescent gas that mounted to overtake it, engorging the smoke-rings as it rose, twisting, writhing, changing shape, turning to dark smoke in one moment and belching flame and crackling with lightning the next. The armor-tender began to pitch and roll; it was all the engineer and one of the assistants could do, together, to keep it level.

"In about half an hour," the large young man told the girl, "the real fireworks should be starting. What's coming up now is just small debris from the nuclear blast. When the shockwaves get down far enough to crack things open, the gas'll come up, and then steam and ash, and then the magma. This one ought to be twice as good as the one we shot three months ago; it ought to be every bit as good as Krakatoa, on Terra, in 59 Pre-Atomic."

"Well, even this much was worth staying over for," the girl said, watching the screen.

"You going on to Uller on the *City of Canberra*?" Lourenço Gomes asked. "I wish I were; I have to stay over and make another shot, in a month or so, and I've had about all of Niflheim I can take, now. The sooner I get onto a planet where they don't ration the air, the better I'll like it."

"Well, what do you know!" the large young man with the hairy legs mock-marveled. "He doesn't like our nice planet!"

"Nice planet!" Gomes muttered something. "They call Terra God's Footstool; well, I'll give you one guess who uses this

thing to prop his cloven hoofs on."

"When are you going to Terra?" the girl asked him.

"Terra? I don't know, a year, two years. But I'm going to Uller on the next ship—the *City of Pretoria*—if we get the next blast off in time. They want me to design some improvements on a couple of power-reactors, so I'll probably see you when I get there."

"Here she comes!" the chief engineer called. "Watch the base of the column!"

The pillar of fiery smoke and dust, still boiling up from where the bombs had gone off far underground, was being violently agitated at the bottom. A series of new flashes broke out, lifting and spreading the incandescent radioactive gasses, and then a great gush of flame rose. A column of pure hydrogen must have rushed up into the vacuum created by the explosion; the next blast of flame, in a lateral sheet, came at nearly ten thousand feet above the ground, and great rags of fire, changing from red to violet and back through the spectrum to red again, went soaring away to dissipate in the upper atmosphere. Then geysers of hot ash and molten rock spouted upward; some of the white-hot debris landed almost at the acid river, half-way to the armor-tender.

"We've started a first-class earthquake, too," the Hispano-Indian Martian Murillo said, looking at the instruments. "About six big cracks opening in the rock-structure. You know, when this quiets down and cools off, we'll have more ore on the surface than we can handle in ten years, and more than we could have mined by ordinary means in fifty."

About four miles from the original blast, another eruption began with a terrific gas-explosion.

"Well, that finishes our work," the large young man said, going to a kitbag in the corner of the cabin and getting out a bottle. "Get some of those plastic cups, over there, somebody; this one calls for a drink."

"That's right," Gomes said. "You do something once, it may be an accident; you repeat the performance, and it's a success." He began pushing papers aside on his desk, and the girl in the too-ample coveralls brought drinking cups.

The Ulleran, in the background, rose quickly and squeaked apologetically. Murillo nodded. "Yes, of course, Gorkrink. No need for you to stay here." The Ulleran went out, closing the door behind him.

"That taboo against Ullerans and Terrans watching each other eat and drink," Murillo said. "What is that, part of their religion?"

"No, it's their version of modesty," the girl replied. "Like some of our sex-inhibitions, which they can't even begin to understand.... But you were speaking to him in Lingua Terra; I didn't know any of them understood it."

"Gorkrink does," Murillo said, uncorking the bottle and pouring into the plastic cups. "None of them can speak it, of course, because of the structure of their vocal organs, any more than we can speak their languages without artificial aids. But I can talk to him in Lingua Terra without having to put one of those damn gags in my mouth, and he can pass my instructions on to the others. He's been a big help; I'll be sorry to lose him."

"Lose him?"

"Yes, his year's up; he's going back to Uller on the *Canberra*. You know, it's impossible to keep some trace of fluorine from the air in the handling-machines, or even out on the