

THE MARTIAN  
ANDY WEIR

A NOVEL



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ANDY WEIR



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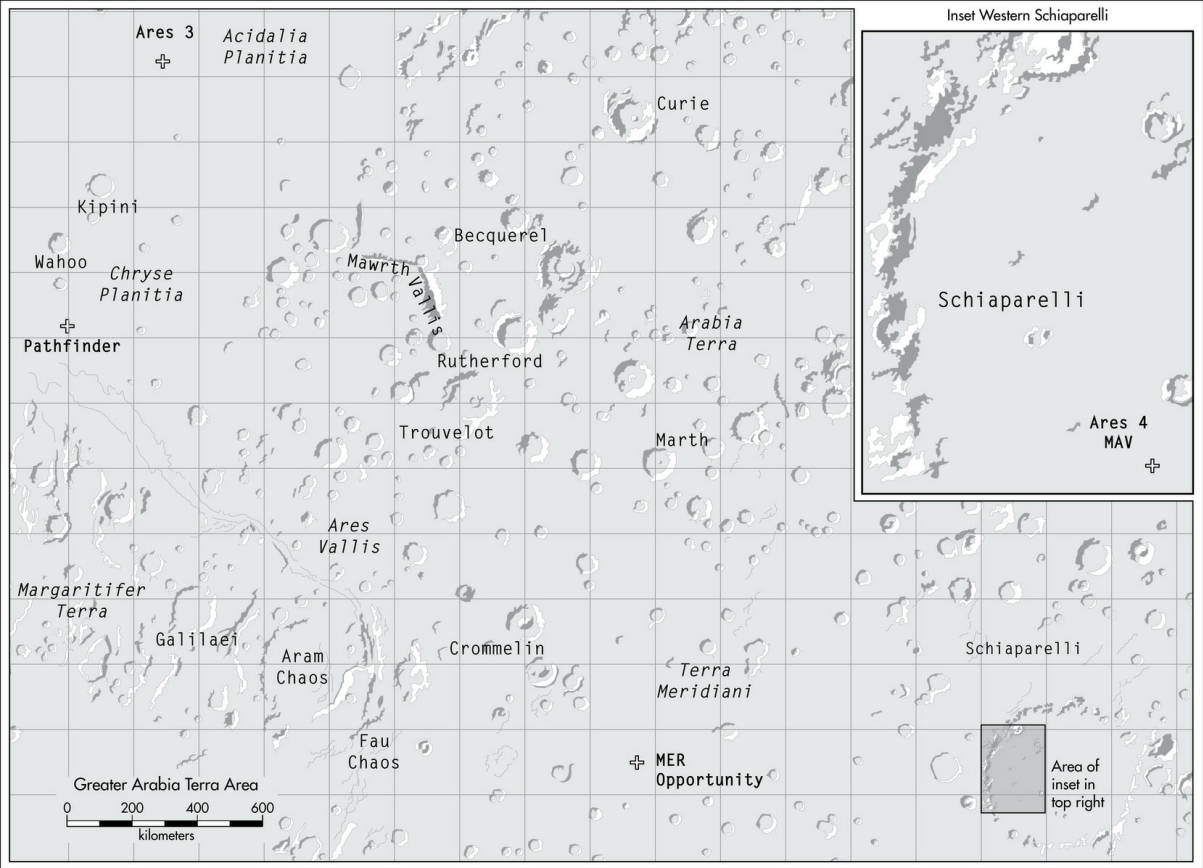
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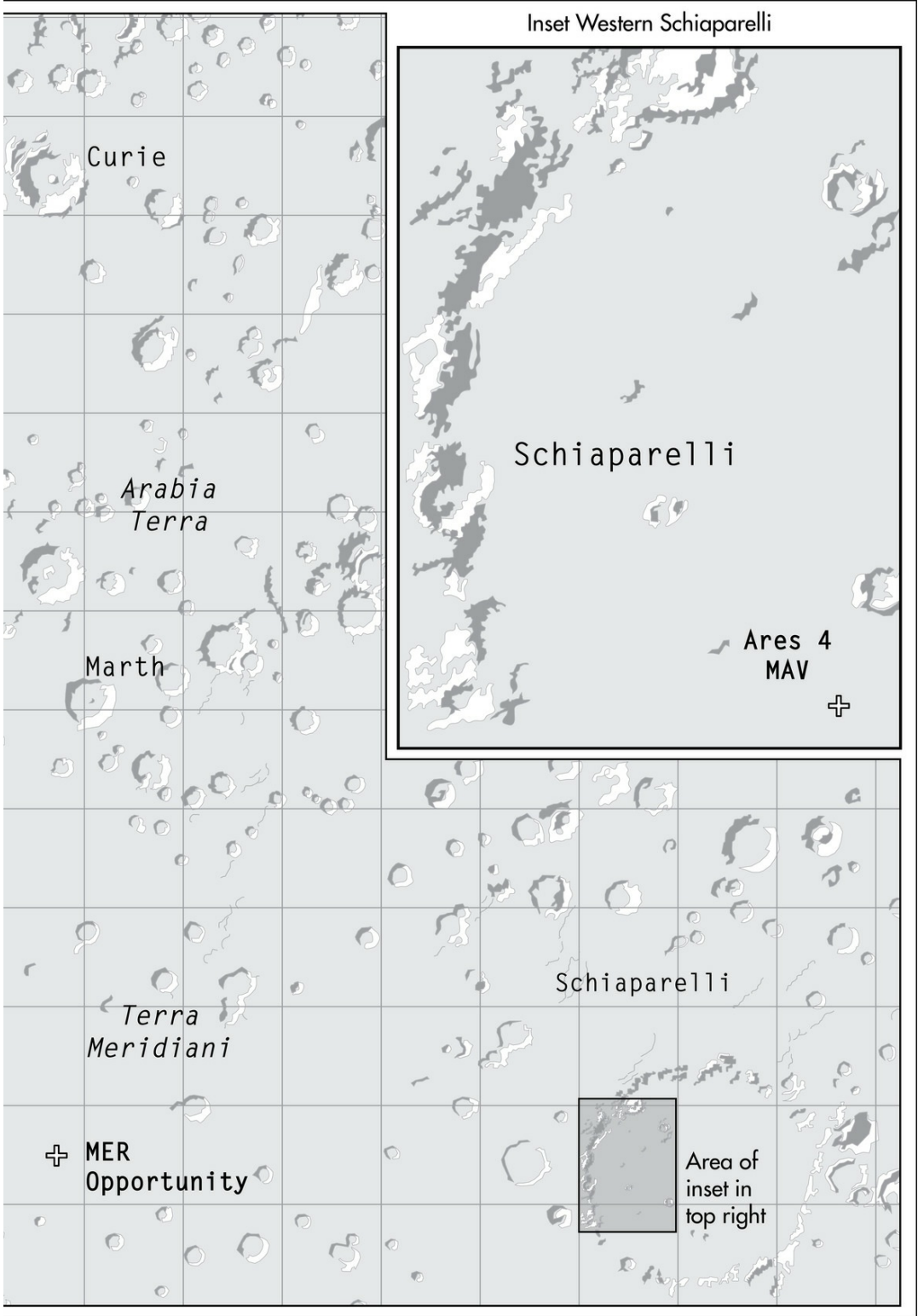
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For Mom,  
who calls me "Pickle,"  
and Dad,  
who calls me "Dude."







LOG ENTRY: SOL 6

I'm pretty much fucked.

That's my considered opinion.

Fucked.

Six days into what should be the greatest two months of my life, and it's turned into a nightmare.

I don't even know who'll read this. I guess someone will find it eventually. Maybe a hundred years from now.

For the record...I didn't die on Sol 6. Certainly the rest of the crew thought I did, and I can't blame them. Maybe there'll be a day of national mourning for me, and my Wikipedia page will say, "Mark Watney is the only human being to have died on Mars."

And it'll be right, probably. 'Cause I'll surely die here. Just not on Sol 6 when everyone thinks I did.

Let's see...where do I begin?

The Ares Program. Mankind reaching out to Mars to send people to another planet for the very first time and expand the horizons of humanity blah, blah, blah. The Ares 1 crew did their thing and came back heroes. They got the parades and fame and love of the world.

Ares 2 did the same thing, in a different location on Mars. They got a firm handshake and a hot cup of coffee when they got home.

Ares 3. Well, that was my mission. Okay, not *mine* per se. Commander Lewis was in charge. I was just one of her crew. Actually, I was the very lowest ranked member of the crew. I would only be "in command" of the mission if I were the only remaining person.

What do you know? I'm in command.

I wonder if this log will be recovered before the rest of the crew die of old age. I presume they got back to Earth all right. Guys, if you're reading this: It wasn't your fault. You did what you had to do. In your position I would have done the same thing. I don't blame you, and I'm glad you



survived.

I guess I should explain how Mars missions work, for any layman who may be reading this. We got to Earth orbit the normal way, through an ordinary ship to *Hermes*. All the Ares missions use *Hermes* to get to and from Mars. It's really big and cost a lot so NASA built only one.

Once we got to *Hermes*, four additional unmanned missions brought us fuel and supplies while we prepared for our trip. Once everything was a go, we set out for Mars. But not very fast. Gone are the days of heavy chemical fuel burns and trans-Mars injection orbits.

*Hermes* is powered by ion engines. They throw argon out the back of the ship really fast to get a tiny amount of acceleration. The thing is, it doesn't take much reactant mass, so a little argon (and a nuclear reactor to power things) let us accelerate constantly the whole way there. You'd be amazed at how fast you can get going with a tiny acceleration over a long time.

I could regale you with tales of how we had great fun on the trip, but I won't. I don't feel like reliving it right now. Suffice it to say we got to Mars 124 days later without strangling each other.

From there, we took the MDV (Mars descent vehicle) to the surface. The MDV is basically a big can with some light thrusters and parachutes attached. Its sole purpose is to get six humans from Mars orbit to the surface without killing any of them.

And now we come to the real trick of Mars exploration: having all of our shit there in advance.

A total of fourteen unmanned missions deposited everything we would need for surface operations. They tried their best to land all the supply vessels in the same general area, and did a reasonably good job. Supplies aren't nearly so fragile as humans and can hit the ground really hard. But they tend to bounce around a lot.

Naturally, they didn't send us to Mars until they'd confirmed that all the supplies had made it to the surface and their containers weren't breached. Start to finish, including supply missions, a Mars mission takes about three years. In fact, there were Ares 3 supplies en route to Mars while the Ares 2 crew were on their way home.

The most important piece of the advance supplies, of course, was the MAV. The Mars ascent vehicle. That was how we would get back to *Hermes* after surface operations were complete. The MAV was soft-landed

(as opposed to the balloon bounce-fest the other supplies had). Of course, it was in constant communication with Houston, and if there had been any problems with it, we would have passed by Mars and gone home without ever landing.

The MAV is pretty cool. Turns out, through a neat set of chemical reactions with the Martian atmosphere, for every kilogram of hydrogen you bring to Mars, you can make thirteen kilograms of fuel. It's a slow process, though. It takes twenty-four months to fill the tank. That's why they sent it long before we got here.

You can imagine how disappointed I was when I discovered the MAV was gone.

It was a ridiculous sequence of events that led to me almost dying, and an even more ridiculous sequence that led to me surviving.

The mission is designed to handle sandstorm gusts up to 150 kph. So Houston got understandably nervous when we got whacked with 175 kph winds. We all got in our flight space suits and huddled in the middle of the Hab, just in case it lost pressure. But the Hab wasn't the problem.

The MAV is a spaceship. It has a lot of delicate parts. It can put up with storms to a certain extent, but it can't just get sandblasted forever. After an hour and a half of sustained wind, NASA gave the order to abort. Nobody wanted to stop a monthlong mission after only six days, but if the MAV took any more punishment, we'd all have gotten stranded down there.

We had to go out in the storm to get from the Hab to the MAV. That was going to be risky, but what choice did we have?

Everyone made it but me.

Our main communications dish, which relayed signals from the Hab to *Hermes*, acted like a parachute, getting torn from its foundation and carried with the torrent. Along the way, it crashed through the reception antenna array. Then one of those long thin antennae slammed into me end-first. It tore through my suit like a bullet through butter, and I felt the worst pain of my life as it ripped open my side. I vaguely remember having the wind knocked out of me (pulled out of me, really) and my ears popping painfully as the pressure of my suit escaped.

The last thing I remember was seeing Johanssen hopelessly reaching out toward me.

I awoke to the oxygen alarm in my suit. A steady, obnoxious beeping that eventually roused me from a deep and profound desire to just fucking die.

The storm had abated; I was facedown, almost totally buried in sand. As I groggily came to, I wondered why I wasn't more dead.

The antenna had enough force to punch through the suit and my side, but it had been stopped by my pelvis. So there was only one hole in the suit (and a hole in me, of course).

I had been knocked back quite a ways and rolled down a steep hill. Somehow I landed facedown, which forced the antenna to a strongly oblique angle that put a lot of torque on the hole in the suit. It made a weak seal.

Then, the copious blood from my wound trickled down toward the hole. As the blood reached the site of the breach, the water in it quickly evaporated from the airflow and low pressure, leaving a gunky residue behind. More blood came in behind it and was also reduced to gunk. Eventually, it sealed the gaps around the hole and reduced the leak to something the suit could counteract.

The suit did its job admirably. Sensing the drop in pressure, it constantly flooded itself with air from my nitrogen tank to equalize. Once the leak became manageable, it only had to trickle new air in slowly to relieve the air lost.

After a while, the CO<sub>2</sub> (carbon dioxide) absorbers in the suit were expended. That's really the limiting factor to life support. Not the amount of oxygen you bring with you, but the amount of CO<sub>2</sub> you can remove. In the Hab, I have the oxygenator, a large piece of equipment that breaks apart CO<sub>2</sub> to give the oxygen back. But the space suits have to be portable, so they use a simple chemical absorption process with expendable filters. I'd been asleep long enough that my filters were useless.

The suit saw this problem and moved into an emergency mode the engineers call "bloodletting." Having no way to separate out the CO<sub>2</sub>, the suit deliberately vented air to the Martian atmosphere, then backfilled with nitrogen. Between the breach and the bloodletting, it quickly ran out of nitrogen. All it had left was my oxygen tank.

So it did the only thing it could to keep me alive. It started backfilling with pure oxygen. I now risked dying from oxygen toxicity, as the excessively high amount of oxygen threatened to burn up my nervous

system, lungs, and eyes. An ironic death for someone with a leaky space suit: too much oxygen.

Every step of the way would have had beeping alarms, alerts, and warnings. But it was the high-oxygen warning that woke me.

The sheer volume of training for a space mission is astounding. I'd spent a week back on Earth practicing emergency space suit drills. I knew what to do.

Carefully reaching to the side of my helmet, I got the breach kit. It's nothing more than a funnel with a valve at the small end and an unbelievably sticky resin on the wide end. The idea is you have the valve open and stick the wide end over a hole. The air can escape through the valve, so it doesn't interfere with the resin making a good seal. Then you close the valve, and you've sealed the breach.

The tricky part was getting the antenna out of the way. I pulled it out as fast as I could, wincing as the sudden pressure drop dizzied me and made the wound in my side scream in agony.

I got the breach kit over the hole and sealed it. It held. The suit backfilled the missing air with yet more oxygen. Checking my arm readouts, I saw the suit was now at 85 percent oxygen. For reference, Earth's atmosphere is about 21 percent. I'd be okay, so long as I didn't spend too much time like that.

I stumbled up the hill back toward the Hab. As I crested the rise, I saw something that made me very happy and something that made me very sad: The Hab was intact (yay!) and the MAV was gone (boo!).

Right that moment I knew I was screwed. But I didn't want to just die out on the surface. I limped back to the Hab and fumbled my way into an airlock. As soon as it equalized, I threw off my helmet.

Once inside the Hab, I doffed the suit and got my first good look at the injury. It would need stitches. Fortunately, all of us had been trained in basic medical procedures, and the Hab had excellent medical supplies. A quick shot of local anesthetic, irrigate the wound, nine stitches, and I was done. I'd be taking antibiotics for a couple of weeks, but other than that I'd be fine.

I knew it was hopeless, but I tried firing up the communications array. No signal, of course. The primary satellite dish had broken off, remember? And it took the reception antennae with it. The Hab had secondary and tertiary communications systems, but they were both just for talking to the

MAV, which would use its much more powerful systems to relay to *Hermes*. Thing is, that only works if the MAV is still around.

I had no way to talk to *Hermes*. In time, I could locate the dish out on the surface, but it would take weeks for me to rig up any repairs, and that would be too late. In an abort, *Hermes* would leave orbit within twenty-four hours. The orbital dynamics made the trip safer and shorter the earlier you left, so why wait?

Checking out my suit, I saw the antenna had plowed through my bio-monitor computer. When on an EVA, all the crew's suits are networked so we can see each other's status. The rest of the crew would have seen the pressure in my suit drop to nearly zero, followed immediately by my bio-signs going flat. Add to that watching me tumble down a hill with a spear through me in the middle of a sandstorm...yeah. They thought I was dead. How could they not?

They may have even had a brief discussion about recovering my body, but regulations are clear. In the event a crewman dies on Mars, he stays on Mars. Leaving his body behind reduces weight for the MAV on the trip back. That means more disposable fuel and a larger margin of error for the return thrust. No point in giving that up for sentimentality.

So that's the situation. I'm stranded on Mars. I have no way to communicate with *Hermes* or Earth. Everyone thinks I'm dead. I'm in a Hab designed to last thirty-one days.

If the oxygenator breaks down, I'll suffocate. If the water reclaimer breaks down, I'll die of thirst. If the Hab breaches, I'll just kind of explode. If none of those things happen, I'll eventually run out of food and starve to death.

So yeah. I'm fucked.

LOG ENTRY: SOL 7

Okay, I've had a good night's sleep, and things don't seem as hopeless as they did yesterday.

Today I took stock of supplies and did a quick EVA to check up on the external equipment. Here's my situation:

The surface mission was supposed to be thirty-one days. For redundancy, the supply probes had enough food to last the whole crew fifty-six days. That way if one or two probes had problems, we'd still have enough food to complete the mission.

We were six days in when all hell broke loose, so that leaves enough food to feed six people for fifty days. I'm just one guy, so it'll last me three hundred days. And that's if I don't ration it. So I've got a fair bit of time.

I'm pretty flush on EVA suits, too. Each crew member had two space suits: a flight spacesuit to wear during descent and ascent, and the much bulkier and more robust EVA suit to wear when doing surface operations. My flight spacesuit has a hole in it, and of course the crew was wearing the other five when they returned to *Hermes*. But all six EVA suits are still here and in perfect condition.

The Hab stood up to the storm without any problems. Outside, things aren't so rosy. I can't find the satellite dish. It probably got blown kilometers away.

The MAV is gone, of course. My crewmates took it up to *Hermes*. Though the bottom half (the landing stage) is still here. No reason to take that back up when weight is the enemy. It includes the landing gear, the fuel plant, and anything else NASA figured it wouldn't need for the trip back up to orbit.

The MDV is on its side and there's a breach in the hull. Looks like the storm ripped the cowling off the reserve chute (which we didn't have to use on landing). Once the chute was exposed, it dragged the MDV all over the place, smashing it against every rock in the area. Not that the MDV would be much use to me. Its thrusters can't even lift its own weight. But it might

have been valuable for parts. Might still be.

Both rovers are half-buried in sand, but they're in good shape otherwise. Their pressure seals are intact. Makes sense. Operating procedure when a storm hits is to stop motion and wait for the storm to pass. They're made to stand up to punishment. I'll be able to dig them out with a day or so of work.

I've lost communication with the weather stations, placed a kilometer away from the Hab in four directions. They might be in perfect working order for all I know. The Hab's communications are so weak right now it probably can't even reach a kilometer.

The solar cell array was covered in sand, rendering it useless (hint: solar cells need sunlight to make electricity). But once I swept the cells off, they returned to full efficiency. Whatever I end up doing, I'll have plenty of power for it. Two hundred square meters of solar cells, with hydrogen fuel cells to store plenty of reserve. All I need to do is sweep them off every few days.

Things indoors are great, thanks to the Hab's sturdy design.

I ran a full diagnostic on the oxygenator. Twice. It's perfect. If anything goes wrong with it, there's a short-term spare I can use. But it's solely for emergency use while repairing the main one. The spare doesn't actually pull CO<sub>2</sub> apart and recapture the oxygen. It just absorbs the CO<sub>2</sub> the same way the space suits do. It's intended to last five days before it saturates the filters, which means thirty days for me (just one person breathing, instead of six). So there's some insurance there.

The water reclaimer is working fine, too. The bad news is there's no backup. If it stops working, I'll be drinking reserve water while I rig up a primitive distillery to boil piss. Also, I'll lose half a liter of water per day to breathing until the humidity in the Hab reaches its maximum and water starts condensing on every surface. Then I'll be licking the walls. Yay. Anyway, for now, no problems with the water reclaimer.

So yeah. Food, water, shelter all taken care of. I'm going to start rationing food right now. Meals are pretty minimal already, but I think I can eat a three-fourths portion per meal and still be all right. That should turn my three hundred days of food into four hundred. Foraging around the medical area, I found the main bottle of vitamins. There's enough multivitamins there to last years. So I won't have any nutritional problems (though I'll still starve to death when I'm out of food, no matter how many

vitamins I take).

The medical area has morphine for emergencies. And there's enough there for a lethal dose. I'm not going to slowly starve to death, I'll tell you that. If I get to that point, I'll take an easier way out.

Everyone on the mission had two specialties. I'm a botanist and mechanical engineer; basically, the mission's fix-it man who played with plants. The mechanical engineering might save my life if something breaks.

I've been thinking about how to survive this. It's not completely hopeless. There'll be humans back on Mars in about four years when Ares 4 arrives (assuming they didn't cancel the program in the wake of my "death").

Ares 4 will be landing at the Schiaparelli crater, which is about 3200 kilometers away from my location here in Acidalia Planitia. No way for me to get there on my own. But if I could communicate, I might be able to get a rescue. Not sure how they'd manage that with the resources on hand, but NASA has a lot of smart people.

So that's my mission now. Find a way to communicate with Earth. If I can't manage that, find a way to communicate with *Hermes* when it returns in four years with the Ares 4 crew.

Of course, I don't have any plan for surviving four years on one year of food. But one thing at a time here. For now, I'm well fed and have a purpose: Fix the damn radio.

#### LOG ENTRY: SOL 10

Well, I've done three EVAs and haven't found any hint of the communications dish.

I dug out one of the rovers and had a good drive around, but after days of wandering, I think it's time to give up. The storm probably blew the dish far away and then erased any drag-marks or scuffs that might have led to a trail. Probably buried it, too.

I spent most of today out at what's left of the communications array. It's really a sorry sight. I may as well yell toward Earth for all the good that damned thing will do me.

I could throw together a rudimentary dish out of metal I find around the base, but this isn't some walkie-talkie I'm working with here. Communicating from Mars to Earth is a pretty big deal, and requires extremely specialized equipment. I won't be able to whip something up



with tinfoil and gum.

I need to ration my EVAs as well as food. The CO<sub>2</sub> filters are not cleanable. Once they're saturated, they're done. The mission accounted for a four-hour EVA per crew member per day. Fortunately, CO<sub>2</sub> filters are light and small, so NASA had the luxury of sending more than we needed. All told, I have about 1500 hours' worth of CO<sub>2</sub> filters. After that, any EVAs I do will have to be managed with bloodletting the air.

Fifteen hundred hours may sound like a lot, but I'm faced with spending at least four years here if I'm going to have any hope of rescue, with a minimum of several hours per week dedicated to sweeping off the solar array. Anyway. No needless EVAs.

In other news, I'm starting to come up with an idea for food. My botany background may come in useful after all.

Why bring a botanist to Mars? After all, it's famous for not having anything growing there. Well, the idea was to figure out how well things grow in Martian gravity, and see what, if anything, we can do with Martian soil. The short answer is: quite a lot...almost. Martian soil has the basic building blocks needed for plant growth, but there's a lot of stuff going on in Earth soil that Mars soil doesn't have, even when it's placed in an Earth atmosphere and given plenty of water. Bacterial activity, certain nutrients provided by animal life, etc. None of that is happening on Mars. One of my tasks for the mission was to see how plants grow here, in various combinations of Earth and Mars soil and atmosphere.

That's why I have a small amount of Earth soil and a bunch of plant seeds with me.

I can't get too excited, however. It's about the amount of soil you'd put in a window box, and the only seeds I have are a few species of grass and ferns. They're the most rugged and easily grown plants on Earth, so NASA picked them as the test subjects.

So I have two problems: not enough dirt, and nothing edible to plant in it.

But I'm a botanist, damn it. I should be able to find a way to make this happen. If I don't, I'll be a really hungry botanist in about a year.

LOG ENTRY: SOL 11

I wonder how the Cubs are doing.

I got my undergrad degree at the University of Chicago. Half the people who studied botany were hippies who thought they could return to some natural world system. Somehow feeding seven billion people through pure gathering. They spent most of their time working out better ways to grow pot. I didn't like them. I've always been in it for the science, not for any New World Order bullshit.

When they made compost heaps and tried to conserve every little ounce of living matter, I laughed at them. "Look at the silly hippies! Look at their pathetic attempts to simulate a complex global ecosystem in their backyard."

Of course, now I'm doing exactly that. I'm saving every scrap of biomatter I can find. Every time I finish a meal, the leftovers go to the compost bucket. As for other biological material...

The Hab has sophisticated toilets. Shit is usually vaccum-dried, then accumulated in sealed bags to be discarded on the surface.

Not anymore!

In fact, I even did an EVA to recover the previous bags of shit from before the crew left. Being completely desiccated, this particular shit didn't have bacteria in it anymore, but it still had complex proteins and would serve as useful manure. Adding it to water and active bacteria would quickly get it inundated, replacing any population killed by the Toilet of Doom.

I found a big container and put a bit of water in it, then added the dried shit. Since then, I've added my own shit to it as well. The worse it smells, the better things are going. That's the bacteria at work!

Once I get some Martian soil in here, I can mix in the shit and spread it out. Then I can sprinkle the Earth soil on top. You might not think that would be an important step, but it is. There are dozens of species of bacteria living in Earth soil, and they're critical to plant growth. They'll spread out and breed like...well, like a bacterial infection.

People have been using human waste as fertilizer for centuries. It's even got a pleasant name: "night soil." Normally, it's not an ideal way to grow crops, because it spreads disease: Human waste has pathogens in it that, you guessed it, infect humans. But it's not a problem for me. The only pathogens in this waste are the ones I already have.

Within a week, the Martian soil will be ready for plants to germinate in.

But I won't plant yet. I'll bring in more lifeless soil from outside and spread some of the live soil over it. It'll "infect" the new soil and I'll have double what I started with. After another week, I'll double it again. And so on. Of course, all the while, I'll be adding all new manure to the effort.

My asshole is doing as much to keep me alive as my brain.

This isn't a new concept I just came up with. People have speculated on how to make crop soil out of Martian dirt for decades. I'll just be putting it to the test for the first time.

I searched through the food supplies and found all sorts of things that I can plant. Peas, for instance. Plenty of beans, too. I also found several potatoes. If *any* of them can still germinate after their ordeal, that'll be great. With a nearly infinite supply of vitamins, all I need are calories of any kind to survive.

The total floor space of the Hab is about 92 square meters. I plan to dedicate all of it to this endeavor. I don't mind walking on dirt. It'll be a lot of work, but I'm going to need to cover the entire floor to a depth of 10 centimeters. That means I'll have to transport 9.2 cubic meters of Martian soil into the Hab. I can get maybe one-tenth of a cubic meter in through the airlock at a time, and it'll be backbreaking work to collect it. But in the end, if everything goes to plan, I'll have 92 square meters of crop-able soil.

Hell yeah I'm a botanist! Fear my botany powers!

#### LOG ENTRY: SOL 15

Ugh! This is backbreaking work!

I spent twelve hours today on EVAs to bring dirt into the Hab. I only managed to cover a small corner of the base, maybe five square meters. At this rate it'll take me weeks to get all the soil in. But hey, time is one thing I've got.

The first few EVAs were pretty inefficient; me filling small containers and bringing them in through the airlock. Then I got wise and just put one big container in the airlock itself and filled that with small containers till it was full. That sped things up a lot because the airlock takes about ten minutes to get through.

I ache all over. And the shovels I have are made for taking samples, not heavy digging. My back is killing me. I foraged in the medical supplies and found some Vicodin. I took it about ten minutes ago. Should be kicking in soon.

Anyway, it's nice to see progress. Time to start getting the bacteria to work on these minerals. After lunch. No three-fourths ration today. I've earned a full meal.

LOG ENTRY: SOL 16

One complication I hadn't thought of: water.

Turns out being on the surface of Mars for a few million years eliminates all the water in the soil. My master's degree in botany makes me pretty sure plants need wet dirt to grow in. Not to mention the bacteria that has to live in the dirt first.

Fortunately, I have water. But not as much as I want. To be viable, soil needs 40 liters of water per cubic meter. My overall plan calls for 9.2 cubic meters of soil. So I'll eventually need 368 liters of water to feed it.

The Hab has an excellent water reclaimer. Best technology available on Earth. So NASA figured, "Why send a lot of water up there? Just send enough for an emergency." Humans need three liters of water per day to be comfortable. They gave us 50 liters each, making 300 liters total in the Hab.

I'm willing to dedicate all but an emergency 50 liters to the cause. That means I can feed 62.5 square meters at a depth of 10 centimeters. About two-thirds of the Hab's floor. It'll have to do. That's the long-term plan. For today, my goal was five square meters.

I wadded up blankets and uniforms from my departed crewmates to serve as one edge of a planter box with the curved walls of the Hab being the rest of the perimeter. It was as close to five square meters as I could manage. I filled it with sand to a depth of 10 centimeters. Then I sacrificed 20 liters of precious water to the dirt gods.

Then things got disgusting. I dumped my big container o' shit onto the soil and nearly puked from the smell. I mixed this soil and shit together with a shovel, and spread it out evenly again. Then I sprinkled the Earth soil on top. Get to work, bacteria. I'm counting on you. That smell's going to stick around for a while, too. It's not like I can open a window. Still, you get used to it.

In other news, today is Thanksgiving. My family will be gathering in Chicago for the usual feast at my parents' house. My guess is it won't be much fun, what with me having died ten days ago. Hell, they probably just got done with my funeral.