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Optical Illusions of the Lower Atmosphere

Before any sea was the sea, it was the sea over the future. Before any home was a home, it was a seabed, the now-home missing its giant cephalopod and trilobite, dry-home whispering of saline and unicellular precursors of life.

It was the autumn of pretending I was under an enormous, ancient ocean. It was the autumn of being reluctant to leave my apartment, of closing myself in. It was the autumn of being very still and very quiet.

During the Pre-Cambrian era, an ocean covered Minnesota, which is to say, there was no Minnesota save sedimentary seabed. Though it seems rash to dismiss home so easily as something that might never have been. I carry and cultivate in me a sickness for home that includes its past, its cephalopods, its could-be-life. Is it unreasonable to suspect that the seabed once weighed itself against a sickness for the future, for conifer and erupting cliff and even the red steppes of the taconite mines?

The layers of this ocean have names and colors and life they greet with measured opportunity and hostility. Cambrian, Ordovician, Silurian, Cretaceous. Each era had its own ocean, even if ocean were a retreating ghost or patience for the next encroaching sea. During the Cambrian, the ocean over Minnesota brought forth the brachiopods, sea slugs, graptolites, and trilobites, whose fossils still cover the northeastern cliffs. The Ordovician, whose advent the sea creatures may have noticed in the way they register the subtle changes in the day's light or the tides, heralded more complex biology: cephalopods, bryozoans, mollusks, and worms whose circulatory systems promised us our soon-blood and some-day-vessels and if-you're-lucky hearts.

And then, during the Silurian, the sea over Minnesota, sea full up with life stretching its mistake-laden helical arms into a wealth of descendants, vanished as if it never had been. And then, in the Devonian appeared a sea in the same form but made different for the disappearing. And then, the new sea retreated once more and a newer same sea emerged to haunt its own beds during the Cretaceous, bringing with it ammonoids, oysters, and clams.

Imagining the oceans atop and below me during the autumn when I was very still and very quiet allowed a world I couldn't look at directly to be different, false and yet real as a haunting. The ocean became an invisible cloudscape, a before-world saturating the present when summoned and given form by the accumulation of its many names.

It was the autumn I started a new job researching the treatment of bacterial infections in critically ill people, though I strayed frequently from documenting research on pathology to studying the behavior of bacteria, the opportunities we give them or the licenses they take that drive our knowledge about them into a trajectory whose aim is extermination.

I study the Kingdom of Monera, the mostly microscopic universe composed of one-celled prokaryotes. I study one part of the multiverse. My dad taught me about the possible multiverse when I was a

child, about how many of our lives might be lived in parallel, how a choice or a story can unspool in the fates of multiple selves, though no one can really say how and few wish to think of consequences sown or reaped without choice.

When I study bacteria for work, I study them indirectly as the effect they bear on a life. I research treatment, pharmacodynamics, antibiotic troughs, and resistance. And when I learn about bacteria as a part of my ocean only for this autumn, I study the protection they offer each other, their resistance toward destruction, the forms of their communities known through microscopy and light scatter, their bodies and strange breath, their kinship, their homes, and their struggles.

Seeking an understanding of Monera means confronting how to define life and how and when to protect or end it. It is a seeking that illuminates the reality that, in this universe, I am never entirely myself but instead a haphazard collection of ocean and microbiota, a form whose cohesion and story may be, in part, illusory.

Colonies of bacteria, like many lives that exist on a spectrum of susceptible to resistant depending on their strength and what is thrown at them and who will protect them, belie the demarcations we've come to expect between a population and individuals, between one body and many bodies that function as one. Not as a collective consciousness, that myth to which we attach ourselves when experiences overlap uncannily, but through a sense of one another's bodies communicated in faint, yet inescapable, signals.

It was the autumn when someone I love deeply was beaten so badly that she suffered a traumatic brain injury and sent me a stack of photos showing the bruises on her arms, back, and chest. The photos smelled strangely of her. The bruises in close-up could have been storm clouds or histology reports, cross-sections of sky or cell.

I took long showers after my loved one was beaten. The narratives of the beating flung themselves in different directions; memory proved predictably unreliable, and different species of fear and great pain inserted themselves into every story I heard. I didn't know what to do or feel or believe, and water helped. In my mind always: the shapes of the bruises, the many colors, the way that injured skin appears very soft. In the shower, I pressed my head into the wall, all the unknowingness in my forehead drawn to borders of water and skin and plaster.

It was the autumn of being afraid to go outside, though I wasn't really afraid. I wanted to see how silent I could be, how real and different a world I could build over myself if I remained still. I wanted to become an illusion, first to those around me and then perhaps a flickering question even to myself.

How do you approach knowing something you'll never be able to know fully? Or something that you can only know in many forms, many identities, faces shifting and superimposing? Why does it matter what cloudscape you bring to stand in front of a story you can't know or whose pieces you can't bear to see?

When I learned of what did or did not occur, when I couldn't stop picturing the grasp of her hair and the slam of her head into the floor, when I didn't know what I wasn't there to see or stop, I created a multitude of stories about what happened. I made many worlds of the violence and its precursors, all unreliable in their own way, all unknowable and carried tightly in abominable mystery. And then I built an ocean and a sky to subsume it.



It was the autumn I accumulated the names of optical illusions of the lower atmosphere—Novaya Zemlya, Bravais' Arc, Spectre of the Brocken, Fata Morgana, Alexander's Band, Belt of Venus—to teach myself that all stories about another's body are incomplete and unknowable.

Novaya Zemlya can usually only be seen near the poles where drastic temperature differences in the atmosphere create a layer-cake air in which sunlight is sandwiched and refracted in the between-spaces. The illusion happens when the sun's rays enter a temperature inversion where they bend to match the arc of the Earth at such an angle that they excavate the image of the sun from below the horizon and raise it distorted on their backs. Novaya Zemlya presents the sun as orange anvil, rising earlier than predicted as a vision of nuclear explosion—that still and flattened celestial flame—with no pillar to connect it to a devastated earth.

Fata Morgana is similar to Novaya Zemlya because it requires rays of sunlight to bend as they pass through a temperature inversion. A layer of cold air compressed beneath expansive warm air holds dust that scatters the sun's rays, squeezing them along the planet's curve until they produce arcs of light coalescing into strange forms. The bend of the rays tosses up several images of an object seen from a distance, and the visions rearrange themselves upside-down and right-side-up, stretched out and flattened, interposed upon each other above the object now made unrecognizable by all of its ghostly and jumbled selves pressing down. Fata Morgana is a terrifying and impenetrable castle in the air.

What can be built, story upon story, when the narratives you're confronted with trail off in many directions, and, when grasped, contain only pieces of truth? What can you collect of the world to build haphazardly atop yourself? What can you fit together? What can you see? What can you obscure once you've seen?

One morning during the autumn of being very still and very quiet, I discovered Marcin Ignac's art project *Cindermedusae*, which consists of jellyfish-like creatures assembled in JavaScript, a language that emphasizes interaction between the viewer and the creation, but also between all parts of the creation. Ignac used the principles of procedural geometry to make unreal objects—beings built on the two-dimensional or digital plane with a pencil, paint, or pixels—look real by mimicking the dance of light.

With a coded web of illusion, procedural geometry invokes the third dimension and the reflective lushness granted to objects by their thickness. See *render*: to represent, to perform creation, to melt down into parts that might eventually be changed beyond recognition.

Ignac constructed life from spheres and lines that became bending forces. He lent animation with sine waves and diffused color and tone to mimic the subsurface scattering that occurs when light enters a transparent object and is dispersed within at different angles before departing.

Consider the revelation of human skin, what light scatter reveals as it enters and is thrown off its straight course by collagen, blood vessel, keratin, and protein. Red light scatters broadly and may be absorbed as its energy is reduced, lending a blue appearance to veins in the deep. Scattering is not a gift of true form's face, but of one of its temporary manifestations. Real because it's a little false.

Our brains create entire worlds and stories from haphazard and piecemeal information, always patching together, the world a tasting menu where we're forever imagining what the full meal might be, even as tell ourselves we've eaten it uncountable times.

How do you know the truth of a story when the story and the truth live only as multiples, when the numerous truths are both as temporary and as permanent as an era, always shifting, moving on to something new that has always, like the old, been there in some dream of itself?

Alexander's Band is an area of darkness between two rainbows. It's a reminder that a surfeit of light can be difficult to see, that our senses don't always capture what's there when what's there is too much. Within the rainbow sandwich, water droplets reflect rays of light that never reach the observer. Alexander's Band is, unlike other illusions, an area of erasure rather than presence, an illusion unseen rather than seen, a darkness formed of prismatic angles of light so small they're known only to themselves.

Like most people who work in the biological sciences, I find myself not unpleasantly troubled by the myriad natures of small and peculiar life, or, at least, life dissimilar to and largely outgunned by mine. Bacteria can be pathogenic but are also the givers of life on the planet. They're colonizers, commensals, opportunists, collaborators, killers. They want to go on, but they'll also sacrifice themselves in oscillatory waves of death that transfer strength to others. They inhabit bodies that are difficult to relate to our own even as they inhabit us. They are suspect, with the invitation that suspicion engenders to look closer, to make a frightening friend. To summon one's powers of intellectual enchantment for the purpose of being seduced by something dangerous, to be seduced in turn by the fear-annihilating knowledge of another's body and life, a powerful or weak body and life depending on circumstance and the stories you tell yourself about how you arrived here and what you'll do to stay.

Sometime during the Late Cambrian's leak into the Ordovician, and as the Ordovician took hold in a way that made its light and oceans and bodies look like they belonged to eternity—that trick of the unnamed to claim immortality—oceanic organisms called cyanobacteria formed biofilms and coated the ocean floor in the mats of their bodies.

And when a colony of cyanobacteria became too dense, too expansive, too risk-free, a daughter mass tore apart filaments that formed her bond to the collective body and traveled away, becoming both the bodies she contained and the broken body of the parent carried with her. Instead of flagellae, she had a filament that oscillated, like the soil that removes and replaces bacteria during a rainstorm, like the shit through our bodies that displaces whole communities every day, like a maddening word spoken again and again until it becomes unfamiliar. She floated in a water column until she could come by some safety.

Bravais' Arc begins with crystalline hexagonal columns of ice that lie on their long sides in clouds. Instead of a threatening hail, ice forms a hover, a tucked-in cirrostratus sleep. When scattered sunlight enters the prisms' top faces and refracts through the side, a brilliant rainbow smile forms where the white light passes through the ice and is transformed.

Do you know what the difference is between mystery and horror? In horror, something terrible is happening, and everyone holds a piece of the puzzle, and no one speaks their piece. In mystery, a collector emerges, a presence with no relevant secrets save the ones that give her insight into what's been hidden. The collector watches and gathers and reveals the true identities and stories of those who might oth-



erwise be beset with horror. The funny thing is, without a collector, even a villain is caught up in the horror, playing a role and trapped in their ongoing dearth of revelation.

I'm heartened a little by the fact that the collector can never truly know the story. She knows one story, the one she's pieced together. She's good at knowing that all people hint at secrets in different ways because they're incapable of speaking a truth that may not exist in one form, and if it doesn't exist in one form, is it even a truth? What she's after is not an explanation, not even an isolation of facts or a circumlocution. She's there to loosen people from the roles in which they've been caught, there to unfurl trajectories shortened or stymied by signals held in many hearts beating in close proximity.

I'm heartened a little by how many of us are filled with regrets, with the capacity to wonder at what's gone missing in our own stories or the paths they've taken away from prediction or fantasy, especially when we wake in the wolf hours with the city or forest humming to itself. I'm heartened because regret means that we don't view our lives as a linear plodding along, but instead as a starburst, possibilities like filaments spread out in near-infinite directions.

We could be path-followers and plodders or rings of selves accumulating and spreading outward like the years a tree pushes from its heart without leaving behind a one, years of plenty and dearth and storm in an orbit both expansive and still. We could be data maps of social networks existing only in relation to all we've ever known and to those they've known. We could be a family tree with its roots in the past, our hearts pulling inward all the ancestries we'll never know to write messages on atria and ventricle, plotting our fates into the future. But there is the small matter of us being filled interminably with regret, and I've considered it in the wolf hours, and I believe we are starbursts containing the ghosts and half-lives and half-truths of many possible and incomplete stories.

The Spectre of the Brocken can only be seen when looking at one's shadow and then only from a great height, lending it its alternative name: the Glory of the Pilot, when airplane becomes body, seat of consciousness haloed in shadow. The Spectre is blue in its inner cushioning around the observer, red radiating outward. It reveals itself when sunlight enters air pockets inside of a cloud-swaddled water droplet and is thrown backward by the droplet's vibratory force. It is an illusion of light imposed upon the blocking of light.

During work one afternoon, I read about researchers who build libraries of patterns produced by scattering light across a bacterial colony. The colony's morphology yields each pattern, the light merely an elucidating coax toward visibility. Scatter: the gift of a body's previously unknown form.

Light scatter occurs when light enters the surface of an object, and the proceeding interactions with what it finds there cause its rays to undergo a change in direction. Sometimes the interaction is straightforward, but in other cases, light may be scattered numerous times as it encounters different regions under the surface, regions that, to light, are so different from their surrounding geographies that they may as well be different worlds.

Bacterial patterns are produced when a colony is scanned with a laser in an interrogating wavefront, which captures information on the colony's structure in code. The code is interpreted by assessing how the wavefront scatters at the far field of the electromagnetic spectrum. Which is only to say that everything is more than what it seems, that revelation is often twinned with interaction, bacterial bodies

revealed through a meeting of photon and colony, and that reality may be composed of scattered and piecemeal illusions.

A Light Pillar finds its origin in the enormous and mobile skating rink in the sky made by hexagonal ice crystals falling through the air. If the ice meets turbulence, refracted light is thrown above and below the giant two-sided mirror into a column, a shot through the heart of the sky.

Because I study bacteria and not botany or architecture or entomology, there's no field to immerse myself in when my life outside of science becomes incomprehensible. When I can't live with my thoughts, I don't have an observation notebook or vision of a magnificent bird or journey of discovery to return my lost self to myself. I have only what's revealed by light scatter on the far field.

I've been told I lack vulnerability, that I am a fortress and a cipher. There are people who live their lives inwardly and those who build themselves outwardly. I'm the former, expression and vulnerability emerging in my gaze at vulnerable things that are difficult to know fully and a love that grows from trying to know them.

Very little violence has been done to me, and I've had little illness that I could comprehend with the full dread of possible consequences. I tried to explain to a doctor how someone I love was hurt and how I thought I'd be okay once she was well but how I never became okay. I lived in constant expectation of more hurt. I checked on my own hurt every night before bed and watched for the okay to slide in and take its place, as if it were a locked door, a gas burner cold to the touch. *You saw it*, the doctor said. *Though she lived it, she didn't see it like others did.* To see violence, to watch someone's story unfold painfully and not be able to know or to change it, never to own the direction they've headed either with or against their will.

Though I neither experienced nor saw violence. I received a stack of photos that looked as if they should be turned face up one by one in divination, an outward haruspicy. Or moved into connective places like a puzzle, becoming a constellation that, once identified, couldn't be unseen or fail to guide.

It is this: That with love, you can see the person's story spread out like a starburst even as you can't know a thing outside yourself at all. It is this: that the destruction, even her face into the floor, her broken glasses, is the destruction of the universe. That words like *face* and *glasses* extend in many directions in a fear that erases everything when someone targets the loved body like it's not a history that suffuses the whole world. That no one might see how love is the same as a body suffusing the whole world. That's it's no matter how much knowledge you accumulate if you can't make love and salvation meet.

Earthquake Light is an illusion of white and blue streaks in the sky that occurs when the planet's plates are under extreme stress, usually in the area of a vertical tectonic fault. Two theories try to explain this threatening gas flame of an aurora. One says that the grinding of Earth's plates breaks the peroxy bond linking organic materials deep within the planet, allowing oxygen to gain electrons and become an anion, enter the atmosphere, and emit light as plasma.

The other theory is more a guess as to collective breakage. It holds that when quartz, abundant in the earth's crust, creates an electric field, or when chemical bonds snap under pressure, the resulting voltage is seen far aboveground. Earthquake Light is an illusion of release. As below, so above. The



illusion brings forth the vestiges of transformation and the delightful mystery of the ominous ground into being by the planet's brutality.

While there's much written and said and sung about the importance of home, what's left to each lost child is how home—the form of it, its story, the carriage of it in the marrow—changes along with the bodies that find themselves transformed. The bodies that are not what their ancestors were yet remain built of eons worth of the old ones.

In the Ordovician, a new colony of cyanobacteria defining itself in freedom, breakage, and a weaving together of its traveling parts, had to find shelter or build it. Cyanobacteria constructed oncolites, spheres made of sediment that could move with water as if the homes themselves were motile and nucleated cells, or stromatolites, towers of sediment formed in the shallows, layers piled atop one another by flagellae and steadied by cement-like excretions to form skyscrapers for microscopic beings.

Studying bacterial evolution, behavior, community-forming, and home-building is difficult because no one can truly know a story that's been carried on outside of their bodies and their time and because no one quite knows how to determine what parts of an ancient pattern or symmetry were made by a living force. There are no stories save the ones we paste on the world in exchange for some sense of ourselves—many branching truths of us and our loves and fears extending in all the directions we can radiate in the wolf hours of regret.

Venus' Girdle occurs at dawn or dusk when sunlight is red and dust gathers high in the atmosphere. All illusions are about circumstance—the chance interplay of shapes, time, forms of matter coming together to produce a sight we call unreal. As if all of our visual interpretation weren't subject to a simultaneous surfeit and withholding of information. As if we shouldn't cultivate vigilance for the intersections that halo us, arc over us, build far-off cities for our eyes only because we happened to be there watching the world change shape in a moment, before it returned to itself and the assurance that other worlds are only a gratuitous trick.

Venus' Girdle is also called the anti-twilight. It's the fight against outgoing or oncoming darkness, the pink glow that stretches across the sky separated only from the horizon by a dark stripe of Earth's own shadow. Also known as the Belt of Venus, it forms when dust scatters red sunlight, throwing it into an arc that often refuses its borders and suffuses the air-thought-sky to encircle all objects in a pink glow.

As era melted unknowingly into era, as segmentation of bodies—an isolation, a bringing together of the isolated—led to greater specialization and the diversity born of opportunity and agony, the microbes that gave the future world of giants its first breaths carried along.

Collenia, a genus of cyanobacteria, began stealing electrons from the water that was our homes' past to carry out photosynthesis. Though they were only one-celled creatures, they pocketed the ocean's electrons away, millions of years before anyone drew the ellipses around a sphere meant to convey how all matter can never be said to be fixed, can never be said to be *there*. Into the folds of the outer membrane of *Collenia* the oceanic electron went, and out came oxygen, and into the atmosphere from the ocean drifted the oxygen, and into an environment some semblance of we were born, screaming for breath like it was our birthright.

And into the ocean's salty depths settled more oxygen, into the arms of the iron waiting in patient dissolution, and soon was born iron oxide. In the ocean that once covered my Minnesota home, iron oxides would become the ores we call magnetite and hematite, would sandwich themselves into shale and chert and become bands of red, silver, and black, oscillating according to *Collenia's* generosity with its discovery. Many hard years, some good, all written into the body of the banded iron formation named the Animikie Group, now mined for its minerals.

It is so easy to believe that everything around us and under us is inert, that our homes were here always, that it has always been like this, that there are not billions of voices trying to enrich the illusion of identity and love and loss we've built. Where the voices are paths, stabs in the dark, half-truths pieced together, guesses as old as bacteria's gift of a useless byproduct back to the ancient sea and sky.

The Green Flash guards itself. You have to be in the right place at the right time to see it, and even then, you might regard it as merely a neuro-electrical glitch or as the sheen of something in your eye. It can only be seen when flying toward the setting sun, and what it lacks in the arousal of visual awe—it's a small green dot that appears above the sun for about a second—it makes up for in its assertion that time and space can be bent, that prisms guiding and separating light into brilliant color can be made out of your once-predictable home.

To see the Green Flash, you need the sunset to slow as you fly westward so that the sunset elongates as your flight makes the same moment happen over and over atop itself in its own illusion of time. When the sunset is paused, Earth's atmosphere becomes the flat face and angles of a prism, separating sunlight into its different colors until blue light scatters into disappearance and the Green Flash appears at its demise.

Just because an illusion jumbles and confuses the senses or the sense of what's happening doesn't mean that an illusion doesn't exist or is not a real manifestation of the real world.

In time, I went outside. I let go of the cephalopods, the ocean above me, the accumulation of illusion. I saw the person I love who had been beaten. Someone said, outside of her hearing: *She keeps talking about it. You can't keep talking about your feelings.* Which I understood. I would never talk about my feelings. I would talk about an ocean and bacteria and strange forms made by light.

But I sat with her, and she talked about her feelings. She talked about fear, humiliation, pain, entrapment. And we talked about how we both were mostly okay, and we held our secrets in the darkness of the bodies we've been given, and I recalled that darkness is often a trick of light. We held our secrets in the faith that our selves will remain a mystery and a miracle, an ancient set of stories they'll keep inscribing on the walls of our dark and illuminated hearts.

And even though I didn't know the story of what had truly happened, I knew. And she knew that I knew, and something became real that wasn't real before. Even if it were still illusion, it was revelation all the same. A trick of the light.

So much depends on the line of sight.

So much depends on the gaps we fill between small and scattered pieces.

