MORNING EARTH

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Yearning To Be Round

John Caddy

3. Meet Your Birth Mother

What is Earth?

Sound like a dumb question? Maybe. There are many answers, of course. Some answers are more accurate and useful than others. For our exploration of the environment, here is one answer that most everyone can agree with:

• Earth is the planet where we live; the planet that is third from the star locally named Sol.

There are more answers which are also true, but in a different way:

• Earth is a system of life.
• Earth is a ball rolling across the floor of Time.
• Earth is a Dancer twirling her way across an ocean of stars.
• Earth is the living planet whose true name is Gaia.
• Earth is the Birth-Mother we have tried to abandon and forget.

Understanding Earth is a lot like trying to understand your mother. When we are young kids, all we want to know about Mother is that she is there and will take care of us. But as we mature we come to a point where we want to know Mother as an entity. Often this knowledge is a little uncomfortable—she is, after all, Mom.

Earth is our Mother, too. For most of your childhood, you took Mother Earth pretty much for granted. As long as she provided you with air to breathe, water to drink, food to grow with, and a place to hang out, you probably figured you knew enough about her.

You have now, by exploring Morning Earth, come to a place where you will learn to know the Earth Mother better.

Just as when you know your human mother better, you may discover, in this course of study, things about Earth that make you uncomfortable. These ‘awkward’ things may be facts about human impacts on Earth—ways we are hurting her, or they may simply be the kind of discomfort people feel when they put on a new pair of eyeglasses. Things may look different and a bit strained.

At the completion of this exploration of Earth, and humanity’s relations with Earth, we hope that you will “see” life differently, and “see” your personal connections to Earth in new ways even if it’s a little uncomfortable at first.

You have probably heard the old saying about “seeing the world through rose-colored glasses.” When we say it about ourselves, we probably mean we’re feeling ‘on top of the world.’ But when we say that about someone else, we usually mean that they are being foolishly optimistic or romantic—that they are not seeing things as they really are.

What Glasses Do You See Life Through?

Where Did Earth Come From?

Let me re-tell you a story from the Mandan Indians.

Long, long ago, in the First Time, Coyote the Trickster-God who was also First Creator, was walking around the world one day when he saw the Human Beings. He grinned, with his red tongue lolling over his teeth. People seemed very odd to Coyote, Only two legs—they could not walk properly—only lurch forward as if falling! No fur! Always yapping! He tried to imagine being something so strange. “What would being a human be like?” he said.

So Coyote put himself into a kernel of corn in the humans' garden, and waited until a girl ate the corn. When she swallowed the kernel of corn, it didn't stop at her stomach but went right to her womb and made her pregnant. In the First Time, things like this could happen.

So in nine months Coyote was born as a human being. The girl who bore him vanished into the Spirit world, for she had given birth to a Spirit. When he was a little boy, he was a little different from the others, because he would always ask everyone he saw, “Who am I? Where did I come from? Are you my mother?” People would laugh and shake their heads.

Then Coyote took to wandering the prairies, and when he came to Cottonwood tree by a stream he would say “Hello. Who am I? Where did I come from? Are you my mother?” And Cottonwood would just shake its leaves.

When Coyote saw Red–tailed Hawk circling the sky above him, he cupped his hands to his mouth and yelled out, “Hello. Who am I? Where did I come from? Are you my mother?” But Hawk just said “Skreeee” and waved his wings.

Coyote grew into a man with the humans, and everyone knew he was different, and maybe a little holy, because he never stopped asking his questions: “Who am I? Where did I come from?” But he was well liked, for he was a good hunter and a strong warrior, and a fine dancer to the Powers. And, he was very good at playing tricks.

One time Coyote went off alone on a long hunt. He was far from the people's town when a great storm seized the sky and black clouds rolled across the prairie toward him. Before he knew it the storm was on top of him. Coyote stood his ground and stared up at Thunderhead with rain lashing his face and cried, “Hello. Who am I? Where did I come from? Are you my mother?”

Thunderhead roared and sent down a bolt of lightning that whapped Coyote right between the eyes!

Then there was a flurry of motion and a yip-yip-yipping and a brown streak raced across the prairies to a nearby butte and sat on top, panting with his red tongue lolling over his teeth, and Coyote remembered everything. He chased his tail for a minute, laughing, then he barked three times at Thunderstorm, rolled over and over in the grass and dust and barked “Hello Mother!” How good to have four legs! What a good trick he had played on himself!

Coyote jumped up and raced toward the village. When he arrived he ran right to the center of the lodges and barked “I am Coyote and I come from the Earth, my mother.” And the people gathered round to hear him.

And among the smiling people was the girl, returned from the Spirit world. And now, every year at this time, Coyote returns and leads the people in the dance, asking everyone he sees, “Who am I? Where did I come from? Are you my mother?”

Just as Coyote’s questions are good questions to ask yourself, they are excellent inquiries to make of Mother Earth. Let’s re-phrase them:

- What is Earth?
- Where did she come from?

Background

Five or six billion years ago, so long ago that we can't really imagine it, a process began that resulted in the birth of our sun and the solar system, including Earth.

Our Solar system (sun, planets, asteroids, comets, cosmic dust) is a sub-whole of an inconceivably large whole called the Milky Way Galaxy.

Our galaxy is an enormous disk which is shaped like a cookie with a thick center. Just as the planets orbit our sun at the solar system's center, the galaxy orbits its center, a dense cluster of old stars.

On a clear summer night, when you look up and see a dense band of stars across the sky, you are looking toward the center of our galaxy. Because the Milky Way galaxy is turning, it has a pinwheel shape. Our Solar system is located in one of the "spiral arms" of this gigantic pinwheel, near the cookie's outer edge.

Thought Experiment to see the Milky Way

In your mind, pierce the center of a large cookie with a sharp pencil, so the cookie can spin on the pencil. Hold the pencil & cookie in front of your eyes so you are seeing it edge-on. Nibble a small bite. Imagine that somewhere on that fresh edge your teeth have exposed is an infinitely tiny solar system and an even more tiny planet Earth. If someone on that teensy planet looks toward the pencil, they will be looking through the thickest part of the galaxy, which is why we see so many stars when we look at the middle of the night sky.

The Milky Way is so large it contains some 100,000 million stars . At its thickest point our galaxy is 2000 light years thick, and it is 160,000 light years from edge to edge , which means that it takes light 160,000 years to travel from one edge of the cookie to the other.

The Milky Way galaxy is huge, but it’s only of middling size compared to some others. It takes 200 million years to rotate once on its axis. The Universe, or Cosmos, is so mind–boggling large it contains about 100,000 million galaxies, many much larger than ours. With telescopes we can observe galaxies and their stars at all stages of their “lives,” from birth to collapse.

Solar System Genesis

About five billion years ago, in our neighborhood of the galaxy, a large star became a supernova.(A supernova is the sudden explosion of most of the material in a star, resulting in an extremely bright, short-lived object that emits vast amounts of energy and matter, which in turn becomes a nebula, a dense cloud of gases and stardust.
When that dying star went supernova, the dust and debris shot outward in all directions. The action of gravity on that nebula slowly formed it into a rotating disk. At the center of the disk a protostar developed, a denser portion of the rotating cloud where, through gravitational attraction, most of the matter in the cloud accumulated.

This protostar gradually became our Sun, which contains 99.9% of the matter in the solar system. Near the sun enough dust and gas from the supernova gathered to condense into the inner planets Mercury, Venus, Earth and Mars.

Earth started off very hot, so all the condensed matter was liquid. The outside of Earth was touching space, of course, which is cold, so the outside of this ball of burning liquid cooled into a thin crust of rock, just like a cup of cocoa “skins over” on the surface.

Elizabet Sahtouris, in her book *Earthdance*, describes the process like this:

> *While it was still very thin, this crust melted again and again, each time letting the heaviest metal elements sink back into the core while lighter elements formed a foam of rock around those fiery insides.*

One thing that kept the young Earth hot was constant growth. She kept growing for a long time—millions of years—because many small solid objects (planetesimals) kept crashing into her. She embraced each one. She grew by accretion, by her gravity pulling in and capturing more and more material. Each time she captured an object, it slammed into the earth. In each collision, great heat was released. At first, like any new thing, Earth grew rapidly—the solar system was full of cosmic debris from the supernova.. Later, growth virtually stopped, as most cosmic debris became part of the planets, and some formed the asteroid belt. Earth barely grows at all today, because her atmosphere burns up most, but not quite all, captured space debris (meteors).

Earth’s Structure

Today, now that Earth is fully grown, she has a thicker crust of solid rock on the outside, but compared to her size, the crust is still thin. Deep inside Earth is a solid inner core of iron. This solid metal inner core is 3/4 the size of the moon.

Thought Experiment:

Imagine Earth to be a basketball. Imagine a tennis ball of hot but solid iron floating at its center. This inner core “tennis ball” is surrounded by a thick liquid outer core “soccer ball” which is also made mostly of iron. Between the skin of the basketball (Earth’s crust) and the outside of the soccer ball is the mantle, which is semi-liquid (or plastic).

- The whole “basketball” is 7,900 miles across.
- The crust (or lithosphere—”sphere of rock”), the skin of the “basketball”, is 15 to 25 miles thick, or deep.
- The mantle under it is some 1,800 miles deep and 3,600 miles across.
- The liquid outer core “soccer ball” is 2,700 miles across.
- the iron tennis ball core is 1500 miles across.

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The Geodynamo

A dynamo is a device which changes motion into electricity. As it does this, it generates a magnetic field. The geo-dynamo is the Planet Earth.

In the summer of 1996, scientists announced a new discovery: Earth’s inner core rotates slightly faster than the rest of the planet, and this faster rotation helps produce and affects the large magnetic field surrounding Earth. This magnetic field is generated within the liquid iron “soccer ball” outer core.

Moon’s birth

During the very early existence of Earth, while it was still violently growing by pulling in planetesimals, there was one collision bigger than all the rest. An enormous object that must have been the size of planet Mars struck Earth a glancing blow so hard that a huge chunk of Earth’s mantle was torn off and hurled into space. This debris became rings of smaller rocks, which gradually accumulated into the Moon.

Earth’s Crust Formation

Elizabet Sahtouris, in her book *Earthdance*, describes Earth’s further crust-forming process like this:

> “Today's Earth has a thicker crust (15–25 miles thick), broken up into great plates (called tectonic plates) that ride on the denser mantle surrounding a solid core. We can still see the hot liquefied elements of the mantle pouring out through volcanoes puncturing the crust. And in earthquakes we can feel the motion of the great tectonic plates as they slide about creating new geological formations.”

> “ At first, when the Earth's crust cracked here and there, the liquid insides oozed out as lava. Lava, as the pressure that keeps it together is released, separates into heavy atoms that cool into more crusty rock, into water that hisses up as steam, and into other atoms light enough to float over or off the surface of the planet as gases. We now believe the water steaming off the hot crust stayed high above an early atmosphere of poisonous (from our point of view) gases for what may have been a long time, but eventually formed clouds that condensed into rain. The rain poured down so hard and for so long that the seas began pooling on top of the heavier rock. As more and more lava oozed through cracks in the Earth's

crust, the crust itself grew thicker and lumpier; as new clouds gathered and fell in cycles, the seas grew ever bigger and deeper.“

“As the Earth's crust grew thicker, new streams of lava broke through it with greater force. Spitting volcanoes shot their fiery insides high into the air, forming mountains as the lava cooled and hot ashes settled down. More mountains were formed when Earthquakes cracked the crust and slid parts of it over one another, and when the crust heaved and bulged without breaking. Rocks sliding over one another were ground into sand and dust, like the dust on the Moon and on Mars.”

“Huge dust clouds were created when meteors of all sizes—some of them as large as small planets—struck the Earth, smashing into the crust, pitting it, breaking it up, mixing it with the broken space rocks themselves.”

“The gases floating around the planet, those just heavy enough to be held by its gravity, were nothing like the air we breathe now. There was no oxygen, but only a mixture of gases which, had the Earth not come alive, would have eventually settled into something like the atmosphere on Venus and Mars today—an atmosphere without oxygen around a lifeless planet.”

“What, then, did the Earth have that Venus and Mars did not? “

The Goldilocks Effect

Many scientists have noted that if conditions on Earth were just a little different, life would not be possible here. You recall that in the story of Goldilocks and the Three Bears, Goldilocks was never happy unless things were just right. Earth’s “just right” conditions for life are called by Earth Scientists the **Goldilocks Effect**. You could also call it a triumph of balance.

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• Earth is just the right distance from the sun for water to be liquid; if the Earth were closer to the Sun, like Venus, the water would be vaporized; if farther, like Mars, it would turn to ice. Living tissue, of course, is mostly water.

• Without liquid water, no life. Without liquid water, no geological erosion, transport and deposition on Earth’s surface; no minerals available to build bodies.

• Earth's atmosphere has a mix of gases that maintains a temperature range "just right" for life: the gases maintain a remarkable balance.

• Oxygen, essential to almost all life, is an example. If oxygen were increased by 4 percent, virtually everything on Earth would go up in flames at the first lightning flash.

• lower concentrations would slow down or eliminate the chemical processes needed for living things to function.

• Carbon dioxide provides another example of fine balance. At less than one-half of 1 percent of atmospheric volume, it is still essential to keeping temperatures warm enough for life through its role in trapping some solar radiation.

• When carbon dioxide levels reach just 1 percent, however, a runaway greenhouse effect can take hold, eventually leading to a climate like that of Venus.

• Earth’s mass is large enough so that its gravity can hold an atmosphere (gravity holds the air close to the planet). An atmosphere allows the fluid cycling of elements, as in the water cycle. If Earth were much larger, its gravity would hold an atmosphere too dense to admit light from the sun; the surface would be too dark for photosynthesis.

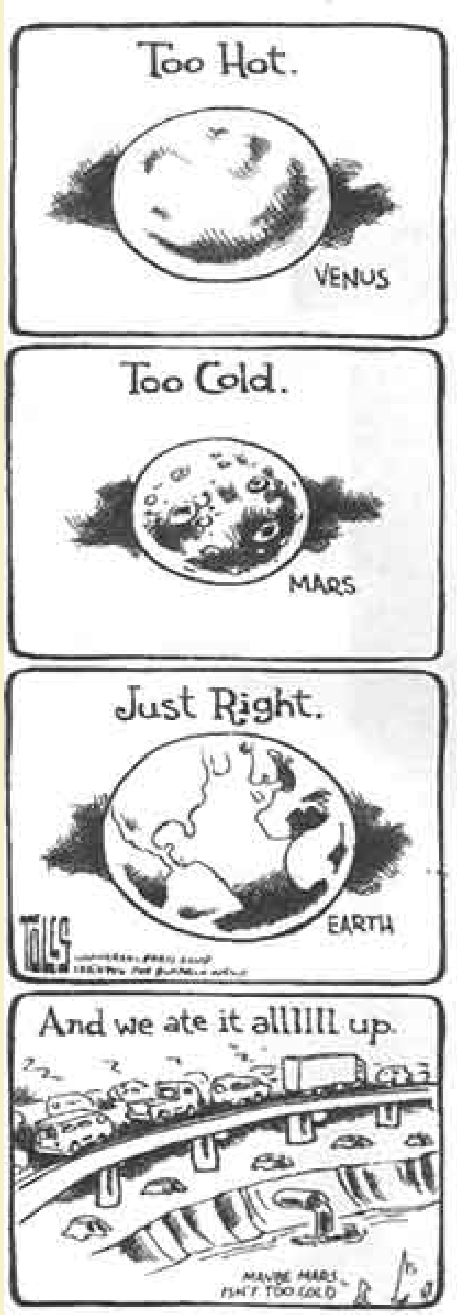
Some thinkers have pointed to the Goldilocks Effect as an argument for the existence of a Creator, claiming that such a fine and unlikely balance could not have happened randomly.

Others point to the Goldilocks Effect to argue against the presence of life elsewhere in the Universe. But the Universe is large and marvelous and has room for almost infinite possibilities.

Even the cartoonists get into the Goldilocks act, this time making a clear protest of how humans treat Earth as if it were Baby Bear’s porridge.

Sahtouris continues:

“Everything on Earth—oceans and rivers, mountains and fertile fields, forests and flowers, creatures that float or fly or crawl or climb, everything, including ourselves—is actually made from the same original but recycled materials, except for the small input of new meteors {and “snowballs” of cometary water].



Our world has created itself as new arrangements of the same atoms that started out inside a star, then formed the molten metal, crusty rock, and gases of a newborn planet—a planet that covered itself in seas as we have seen and is now ready to go on with its dance of life.“

Picture Credit: Sack,Minneapolis Star Tribune

How does Earth nurture her children?

Atmosphere and Oceans

But as she continued to develop, she became better looking. She formed an atmosphere, a sphere of gases surrounding the planet's entire surface, held to the surface by gravity. Once she formed an atmosphere, she formed water, and learned to rain. Can you imagine how long it had to rain to create the oceans?

Some scientists think that comets (cosmic ice-balls) crashed into Earth and supplied water from their ice and maybe even the first chemical compounds that life needed to begin. To be sure, water ice from the comet belt does enter earth's atmosphere every day.

Others scientists are sure there was enough hydrogen and oxygen in Earth's molten interior to escape through her crust in volcanoes and earthquakes and form this original water.

Once she had oceans and clouds, she began to look like the great beauty she would become. She became mostly blue and white.

Then somehow, in a way we do not fully understand, Earth came to life. The first living things were incredibly small microbes, single cell bacteria even smaller than the cells in your body. In the process of living, these bacteria gradually changed Earth's original atmosphere into the balance of gases it now is made of, which allows us to breathe. The atmosphere is made of these gases: nitrogen (78%), oxygen (21%), argon (0.93%), carbon dioxide (0.03%), water vapor (% changes all the time) and traces of neon, helium, methane, krypton, hydrogen, xenon, and ozone. The atmosphere is held to the Earth by gravity.

Life Helps Build Earth

We have a habit of thinking of Earth as inert and dead—just rock. And we have a habit of thinking of Life as living *on* Earth, life as *inhabiting* Earth. But those habits of thinking can get in the way of understanding how Earth works.

In fact, much of the Earth we know has been created by living organisms.

• The activity of early microbes created our very air. Cyanobacteria invented photosynthesis. Oxygen is a by-product of that process.

• Sea life has created much of the rock in Earth's crust. For example, some of the most abundant algae in the ocean are foraminifera and diatoms, tiny plant-like organisms that pull silica out of the water and make shells around themselves. When they die, their shells sink to the bottom in huge numbers and after many millions of years, become limestone.

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Sea life, in the form of ancient iron-concentrating bacteria, has also created the deposits of iron that we mine, and probably trhe bauxite that we mine for aluminum.

• Swamp vegetation created the vast coal beds we depend on.

• Life created all the petroleum and natural gas there is.

There are many other examples. The point is that Earth's crust is partly the result of life. So Life doesn't just use Earth as a stage where it plays out its dramas. Some of the stage was created by Life.

For more on this subject see Chapter 12, The Biosphere.

Earth's Atmos-Sphere (sphere of gas)

In the last reading we compared Earth's structure to a series of nesting spheres, a tennis ball core inside a soccer ball inside a basketball. The atmosphere is a final very thin sphere of gases surrounding the basketball (Earth's crust). The atmosphere is transparent, so we can think of Earth's basketball as surrounded by a thin, delicate shell of glass. "Thin" is a relative term, of course. Most of the atmosphere is "only" 40 to 50 miles thick (or high); above that it gradually thins out to about 400 miles.

The atmosphere protects the earth by absorbing and scattering harmful radiation and causing extraterrestrial solid matter, meteors, to burn from the heat generated by air friction.

Earth, herself a sphere, is made up of a series of visualized (but not imaginary) spheres, the nested balls we described above.

The Root Principles of Ecology

The question we asked above was, "How does Earth go about nurturing her children?" That is an enormous question. It will take weeks to just begin to answer it. The study of Ecology is the study of how Earth nourishes Life.

Through creative process, we can explore Six Root Principles of Ecology. These six Principles are introduced in detail in How Does Life Work? Here is a brief list to remind you.

1. Life Lives in Circles: Life Materials Continuously Cycle

2. Life is Powered by a Flow of Energy from the Sun

3. All Lives Transform: Being is Becoming

4. All Lives Seek Balance

5. All Lives Interlive

6. We All Belong to the Biosphere

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