CHAPTER 1

THE COSMIC JOURNEY
OUR PLACE IN TIME

EARTH'S MOON AND FOSSILS

Buckle up; it's going to be a bumpy ride. The car makers have built us a very special ATV. It's not only an all-terrain vehicle; it's an all-time vehicle. You're probably going to want to ride shotgun—the views are spectacular!

We begin at the beginning—literally the beginning—nearly 14 billion years ago. The headlights are on because it's pitch black. In the beams you can see the dust swirling. The dust spins faster and faster. Up ahead it's collecting into what looks like a giant CD—a CD with a smoldering fireball in the middle.

The fireball gradually changes from tomato red to white. It flashes, like a match being lit. Then it dies out. The fireball flashes again. Then it dies out again. Suddenly there is a burst of white light. We can turn off the headlights now. The sun will take over. Our time-o-meter says we're 5 billion years from home.

Pillars of gas give rise to stars such as our own sun. The Hubble telescope, which orbits the earth, took this photo of deep space with four cameras. One camera magnifies the image to show scientists more detail. When that photo is shrunk to fit the scale of the other three, the final image has a step shape.

We're in the middle of rush-hour traffic. There are a million worlds of all sizes circling our sun. A few thousand of them are pretty big. Not a one is going to be awarded good driver of the year. A head-on collision blows two worlds to smithereens. We dodge the fragments flying past. It's cosmic bumper cars! Worlds are crashing into one another—some destroyed, others nudging one another until they crush together. All this wreckage is thinning out the traffic.

The larger worlds look as though they are crumpling. Their gravity is sucking in the bumps, smoothing the surface and creating spheres. Anything that managed to avoid a major accident is growing bigger and bigger. Now as these giants travel the beltway around the sun they pull smaller worlds into them—joining, crumpling, joining, crumpling—again and again. The smaller worlds that don't get pulled in far enough to make contact careen off course. Many are totaled in collisions. Others are yanked in by the sun and disappear in a giant fireball. More are tossed out of the galaxy into the cold. There are a few left that have found good commuter lanes. Earth is one of the lucky ones that hasn't been used as a spare part, blown up, burned up, or taken an exit ramp.

The light dims when we zoom in closer to Earth. There's still a lot of dust and gas around us. The sun's light just can't make it through. When we flick on our high beams we see a lumpy, pockmarked Earth. We watch Earth smash into smaller worlds, turning them into powder. It collects their dust like bugs on a windshield. We need our fog lights because Earth is covered in steam. The heat from all the collisions gets trapped by the vapor. Turn up the air conditioning, because things are getting hot. Earth's surface melts into an ocean of lava. It glows red.

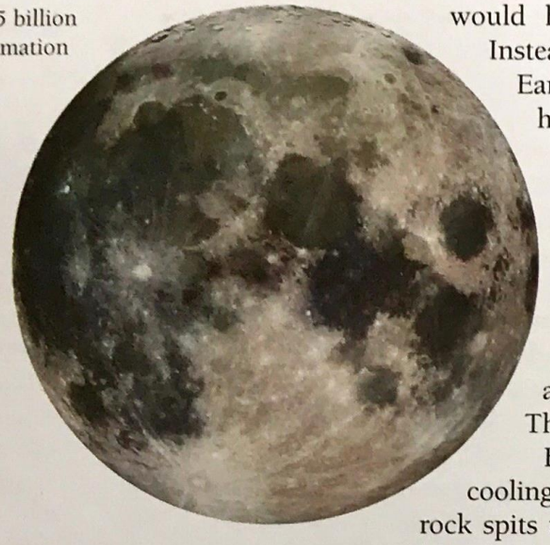
Look out! Earth is on collision course with a big world. At first it looks as if Earth will crack in half when they crash. If the colliding world had been any bigger Earth

AGES OF LIFE ON EARTH

545–251 million years ago
Paleozoic Era
paleo + *zoic* =
"ancient" + "life"

251–65 million years ago
Mesozoic Era
meso + *zoic* =
"middle" + "life"

65 million years ago to the present
Cenozoic Era
ceno + *zoic* =
"modern" + "life"



Earth's moon, 4.5 billion years after its formation

would have been blown to bits. Instead, a good-size chunk of Earth breaks off and is sent hurtling away. It's our moon.

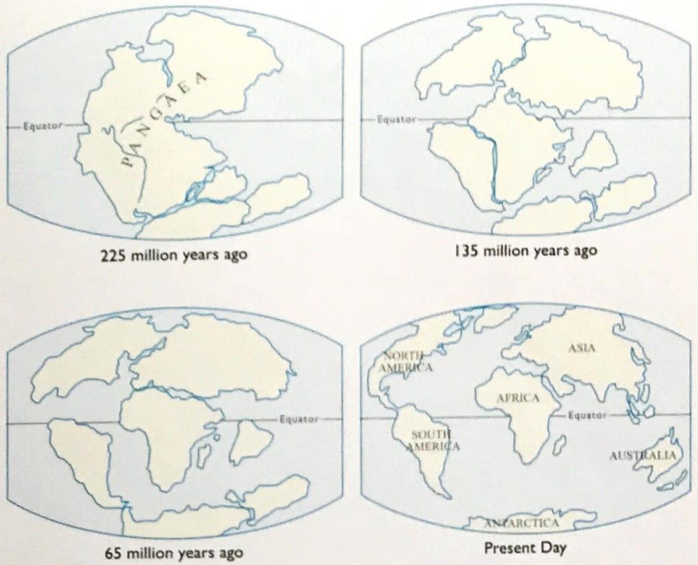
Days on Earth are short. They're just a few hours long. Earth spins madly. But the moon begins to tug at Earth creating a drag. The moon pulls and Earth gradually slows its rotation and the days grow longer. The moon drifts off.

Below us Earth looks like it's cooling. A thin crust forms. Boiling rock spits upward from cracks in the crust. It's a volcanic fireworks display. Asteroids striking Earth raise clouds of dust—poof, poof. It's impossible to see ahead. Even the sun can't get through the mess. Turn on the heater; it's getting cold out there without the sunshine. Earth freezes. But look! There are fewer and fewer collisions now and it looks as if the dust is settling. It's a sunrise!

Turn on the windshield wipers because here comes the rain. The craters from the collisions are filling up. If we were to pull back they would look like puddles, but they are the oceans. It rains in torrents. Earth looks like a giant swimming pool. The only land we see now comes from the occasional crater rim tall enough to stick out of the water.

Splash! Splash! Comets and asteroids smash into Earth. Space dust carries life-building atoms and chemicals, jump-starting life on earth. When our time-o-meter reads 3.6 billion years from home, life has begun to blossom.

We're cruising along at about 3 billion years from home when land starts forming on Earth. But, look—the continents are moving all around in slow motion. They're crashing into one another. On impact they buckle like a front fender in a car wreck. The crust crinkles and mountain ranges thrust upward. Volcanoes erupt. Lava leaks.



Think of the earth as a hard-boiled egg. Both the egg and the earth have three main layers. Crack the shell of the egg and slide the pieces around on the slippery white. This is how the tectonic plates move across the earth's mantle. The yolk represents the earth's core.

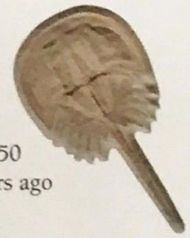
Earth's thin crust is not an unbroken coating like the shell of an egg. It is made up of a dozen or more giant drifting plates. The continents ride these floating solid rock slabs called tectonic plates.

Now the time-o-meter reads 600 million years from home. Earth looks nothing like the globe we live on. There's no land at all on the northern half. It's all water. One giant clump of land sits in the southern half. The land moves. It's moving at the same speed it will always move—about an inch a year. A tree grows faster than that. But since we're whizzing through time the land looks as though it is zipping around the globe. One minute there are two chunks of land, the next there is one huge supercontinent. Earth looks like a water planet with one island.

It's getting hot again. Let's hope the snails don't mind the heat. Wait; is that a bug coming out of the ocean?

There's no slowing down now. We're 255 million years from home and we're dodging plumes of molten lava shooting into the sky. Hold on, there's lots of turbulence. That island on Earth is beginning to break up. Things are getting rocky. Rain is pelting us. Volcanoes are erupting. Landmasses

Snail fossil, Iowa, United States, 300 million years ago



Horseshoe crab fossil, Eichstatt, Germany, 150 million years ago

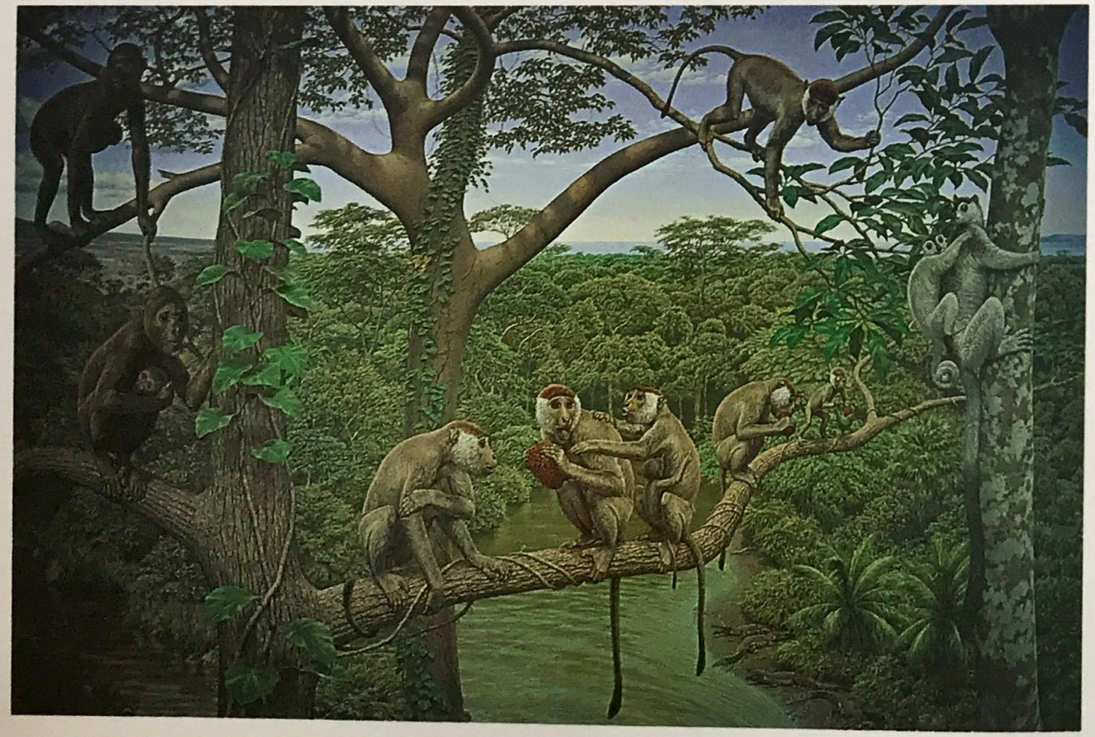
are smashing into landmasses. The reptiles don't even seem to notice.

When our time-o-meter hits the 100-million-year mark, South America and Africa split. They are forced apart by movement below them. You can see where they used to fit together; now a river of ocean separates them. Why that's a horseshoe crab! Things are starting to look more familiar—but not quite. There are oceans inside the continents. And through it all, the dinosaur walks.

Watch out! Incoming asteroid. Direct hit with Earth. What's that stink like rotten eggs? Sulfur! Sulfur and dust. The asteroid knocks it all into the air. We're 65 million years from home. The dust is blocking out the sun. The dinosaurs are dying.

From where we're watching we can see the continents drifting farther apart. India collides with Asia and mountains crumple upward. Is that a monkey? It looks a bit like

Monkey-like primates feast on fruits in this artist's reconstruction from fossil evidence. About 34 million years ago, the part of Egypt in this painting was a lush rainforest, not the desert it is today.



one. The trees are full of them. Life is changing so quickly now it's a blur.

To give us an idea of how rapidly life on Earth progressed in the scheme of this 14-billion-year cosmic journey, imagine squeezing all the events into a single calendar year. We begin time on New Year's Day and end in the present, when the clock strikes midnight one year later. It would be September on our "all-time calendar" before our solar system took shape. A week later Earth would form. Two weeks after that life appears on Earth. In early October our oldest rocks crop up out of that global ocean.

In December, Earth is beefing up its atmosphere with oxygen. Now things begin to happen fast:

December 20—we see the first fish in those oceans.

December 21—Earth loses that barren rock look when plants begin to grow on land.

December 22—insects and animals follow the plants.

December 23—the first trees, the first reptiles.

December 26—the dinosaurs!

December 29—the first birds.

December 30—dinosaurs become extinct just as the first flowers bloom.

The last day of the year dawns and humans are still nowhere in sight. The day drags on as we look for evidence of others like us. It's 8:10 in the evening before the first **hominids** appear. We're hominids, but these fellows don't look much like us at all. They look more like our ape cousins walking around on two legs. With only eight minutes left until the clock strikes twelve there are *still* no humans.

Almost everything we know about humans from written history happens in that last ten-second countdown—10, 9, 8, 7.... To discover our unwritten past—what happened in those moments before the countdown—we need to turn our all-time vehicle back into an all-terrain vehicle. We're going to drive straight down inside Earth. We're going to plunge into the crust. It's a graveyard down there. It's time to dig up the past.

A hominid is a member of the family of mammals named *Hominidae*. We humans, big-brained hominids with articulate speech, are the only surviving species of this family. Extinct hominids include all the species discussed in this book that habitually walked on two legs.