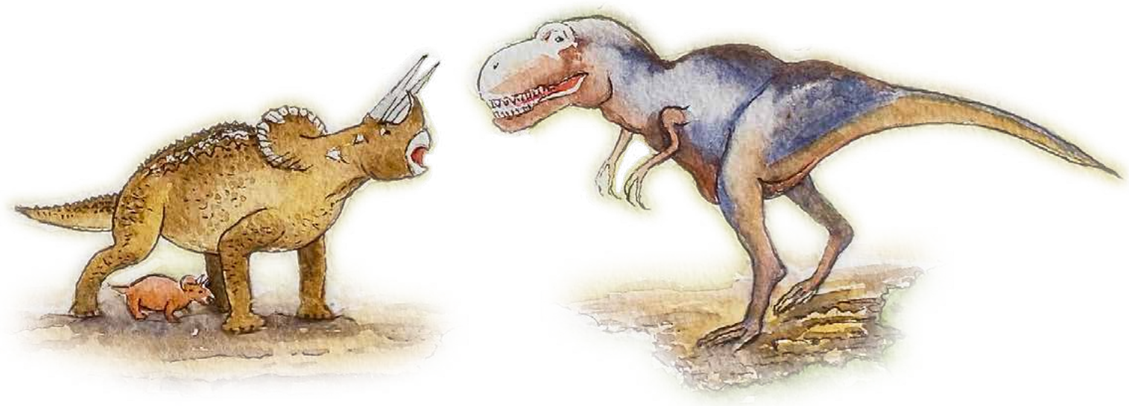
THE OLD WORLD

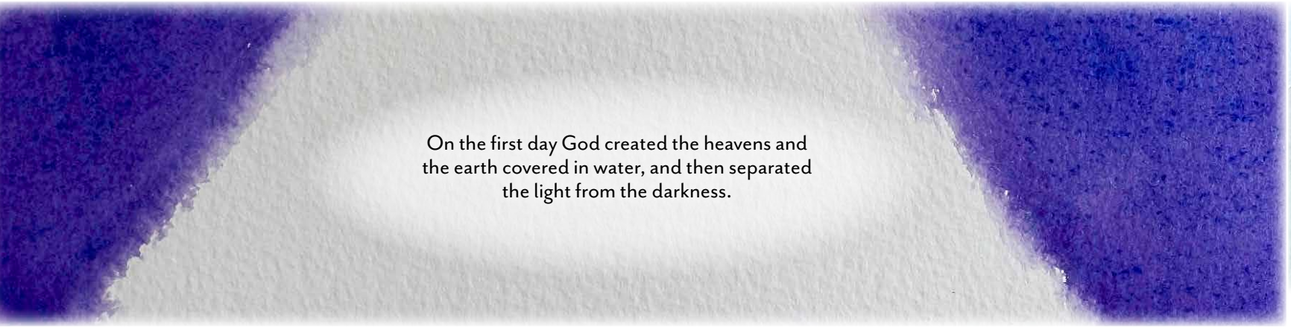
Clues from the Bible and science allow us to reconstruct the world before Noah's Flood—its continents and oceans and its communities of plants and animals. Many of these communities are now extinct, but we can find out about them by studying their remains in the fossil record.

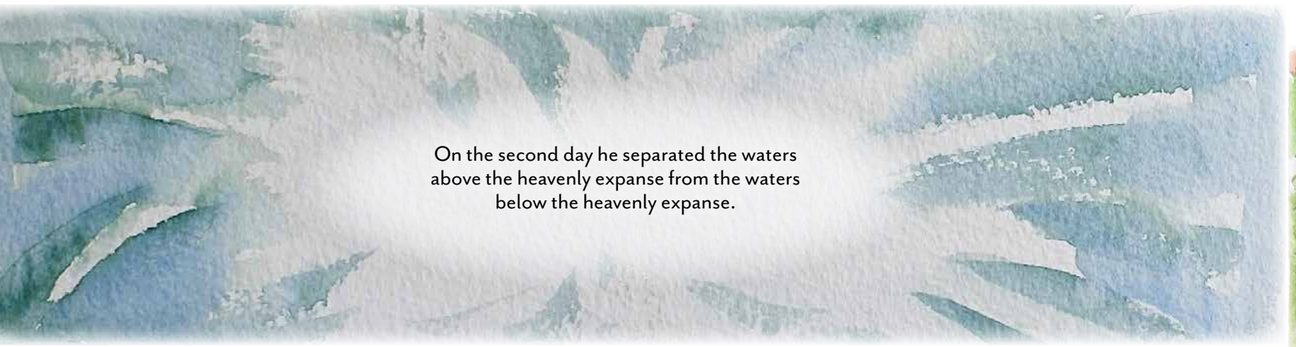


CREATION WEEK

We begin our reconstruction of the earth's history by considering what the Bible says about the earth's origins. It is important to start with the Bible because God the Creator inspired its human authors to write down exactly what he wanted them to, without any mistakes or errors.

The Bible's account of Creation (Genesis 1:1-2:4) tells us that God made the heavens, the earth, and everything in them in just six days:





▼On the third day he separated the dry land from the seas and made the plants.

▲On the fourth day he created the sun, moon, and stars.

▲On the fifth day he created the flying creatures and the swimming creatures.

▲On the sixth day he created the land animals and the first people—Adam (from the dust) and Eve (from Adam's side).

▼By the end of the sixth day, Creation was finished. And so on the seventh day God rested from all that he had done.

HOW LONG AGO DID CREATION TAKE PLACE?

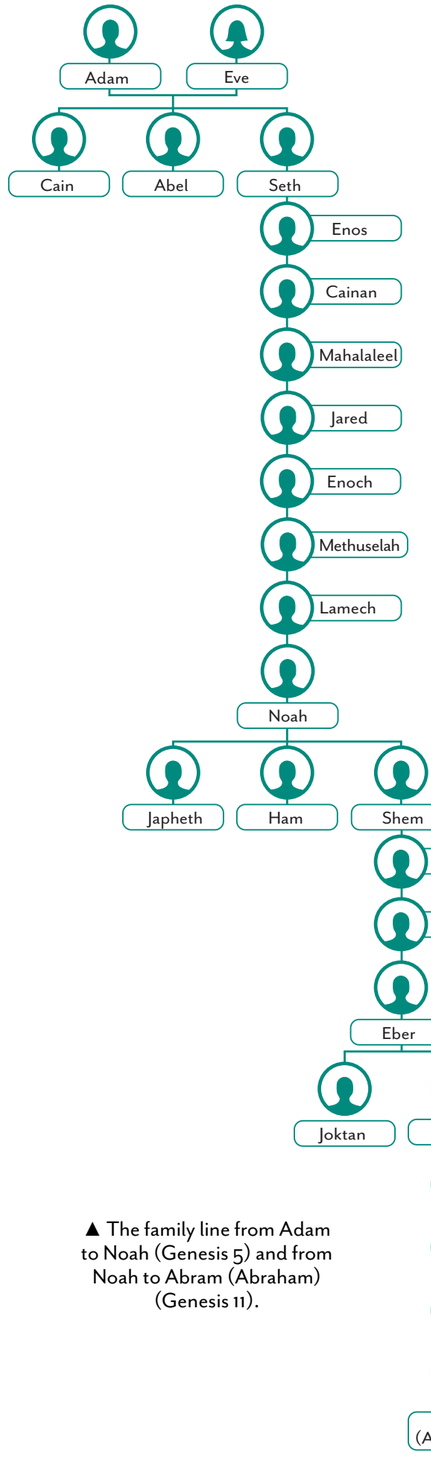
The Bible also gives us information that allows us to work out how long ago Creation took place.

Two chapters in Genesis provide important clues: Genesis 5, which traces the family line from Adam to Noah, and Genesis 11, which traces the family line from Noah to Abraham. By adding up the ages in these family lines we can in principle work out when Adam was created.

WERE THE CREATION DAYS ORDINARY DAYS?

There are many reasons to think that the days of Creation were ordinary days, each about twenty-four hours long:

1. Genesis 1:5 uses the Hebrew word *day* to describe the daylight portion of a day and the entire light/dark cycle—in other words a normal day.
2. Each day of Creation is given a number. Elsewhere in the Old Testament this always means a normal day.
3. Each day consists of an evening and a morning. Again, this always refers to a normal day elsewhere in the Old Testament.
4. Genesis 1 does not use other Hebrew words for time (e.g. *olam*—meaning *antiquity* or *eon*), which could have more clearly conveyed the idea of long or indefinite creation-days.
5. Exodus 20:8-11 draws a parallel between the Creation week and our week. We are to remember the Sabbath day and keep it holy because God created in six days and rested on the seventh.



▲ The family line from Adam to Noah (Genesis 5) and from Noah to Abram (Abraham) (Genesis 11).

The task is complicated somewhat by the fact that different manuscripts of the Old Testament give different numbers. On the one hand, the standard Hebrew text of the Old Testament—the Masoretic text—suggests that Adam was created about 2,000 years before Abraham. On the other hand, the Greek text of the Old Testament—the Septuagint—suggests this period may have been about 1,300 years longer. Most scholars favor the Masoretic text, though some prefer the Septuagint. The difference between them is small, however, when both are contrasted with the long ages of conventional chronology.

Since we know that Jesus lived about 2,000 years ago and Abraham about 2,000 years before that, we can sum the ages to estimate that Creation must have taken place about 6,000 years ago (according to the Masoretic text) or 7,300 years ago (according to the Septuagint text).

Many people (including most scientists) do not accept such a recent date for Creation. They think that the world is billions of years old, and they appeal to dating methods based on the decay of radioactive atoms to support a much longer time scale. We can see from below, however, that there are many problems with these methods.

RADIOMETRIC DATING AND ITS ASSUMPTIONS

Radiometric dating uses naturally occurring radioactive elements to date rocks and minerals. Unstable, radioactive parent atoms decay through a series of intermediate steps until stable, non-radioactive daughter atoms form. The accumulation of daughter atoms allows the sample's age to be calculated.

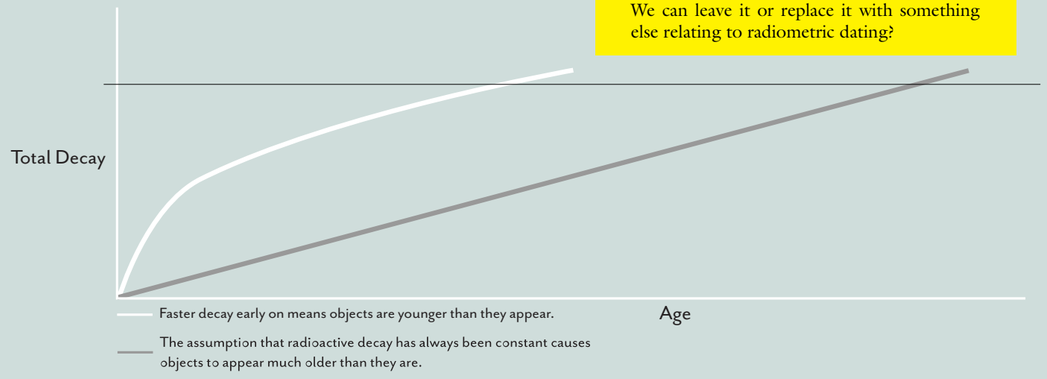
Three assumptions must be made:

1. The rock or mineral contained a known quantity of daughter atoms in the beginning.
2. The amounts of parent and daughter atoms have not been altered by anything besides radioactive decay.
3. The rate of decay has been constant.

But biblical creationists think there are good reasons to challenge each of these assumptions:

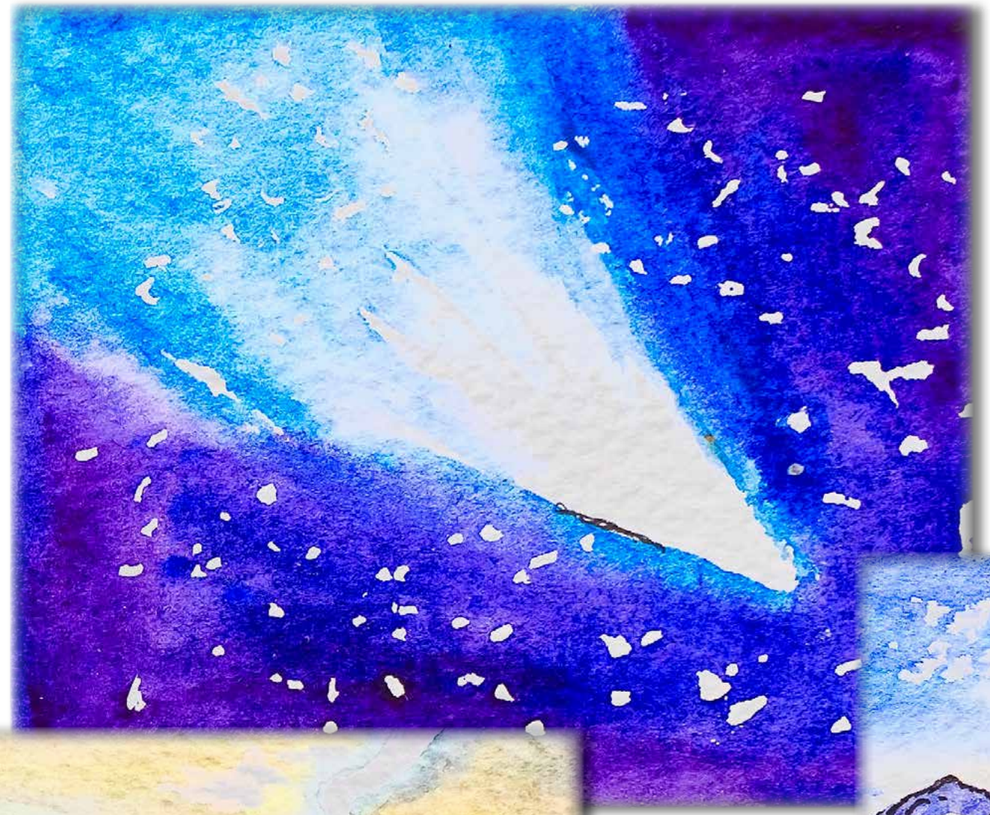
1. The original quantity of daughter atoms is often uncertain.
2. Many processes besides radioactive decay can alter the amounts of parent and daughter atoms in a rock or mineral.
3. There is evidence that radioactive decay rates were higher during Creation and the Flood than today, which would make radiometric dates too old.

Note: I made this chart to fill the empty space. We can leave it or replace it with something else relating to radiometric dating?

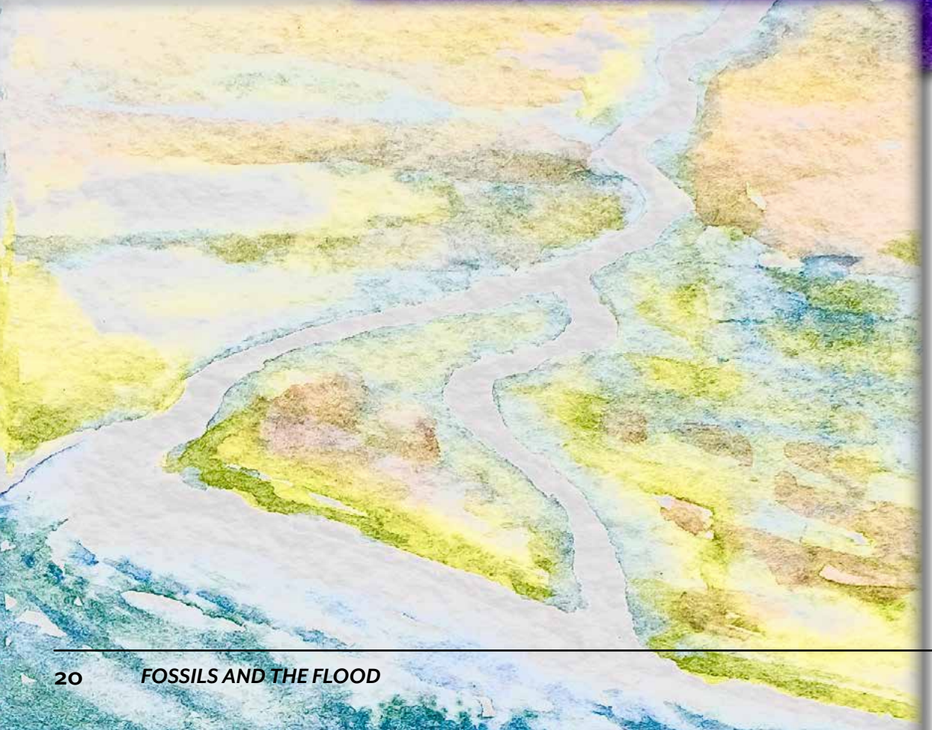


Furthermore, there is much scientific evidence that points to a young world. This evidence includes:

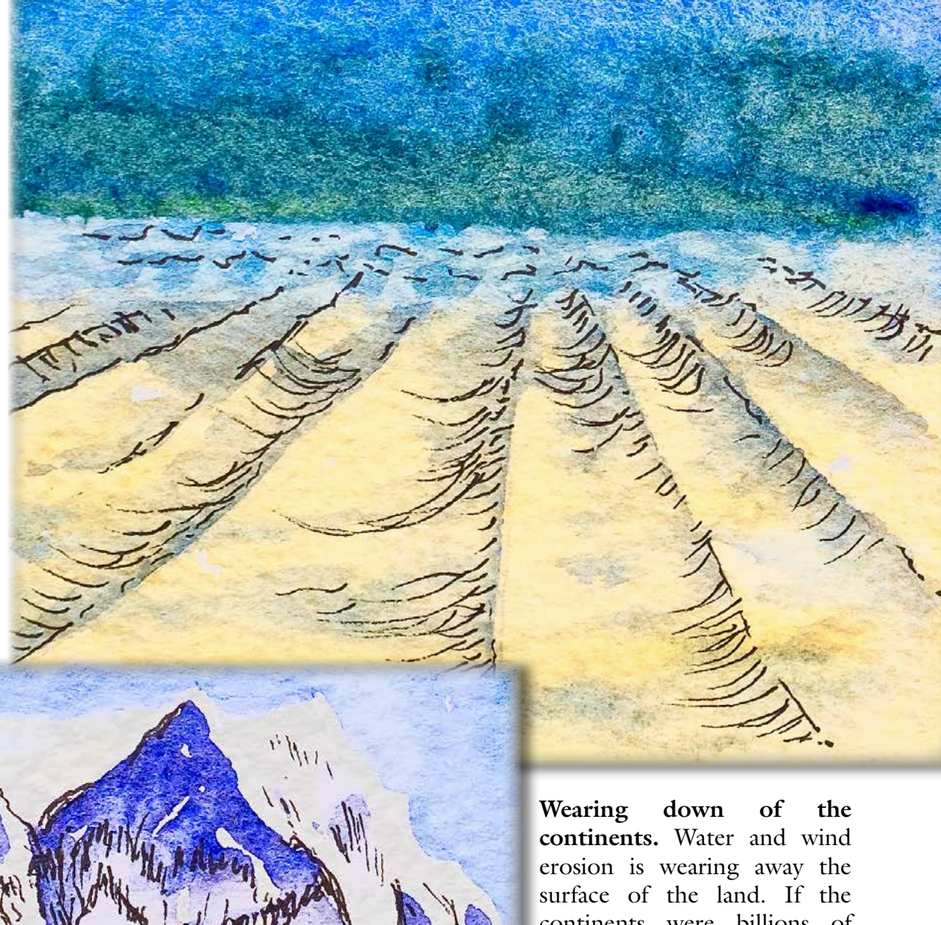
Short comet lifetimes. Comets are mostly ice and dust, and they lose material every time they orbit close to the sun. They cannot survive more than about 10,000 years. It is hard to explain how the number of comets in our solar system could have been sustained for billions of years.



Saltiness of the oceans. Every year, rivers and other sources wash large amounts of salt into the oceans, and most of it builds up there. If the oceans were billions of years old they ought to be much saltier than they are today.



Sediment build-up in the oceans. Rivers also carry sediments into the ocean. The average thickness of the sediments on the seafloor is less than 1,300 feet (400 meters). The oceans ought to have been filled many times over in hundreds of millions of years.



Wearing down of the continents. Water and wind erosion is wearing away the surface of the land. If the continents were billions of years old they ought to have been worn down to sea level hundreds of times—but we still have high-standing continents that appear not to have completed even one such cycle.

THE CREATED WORLD I. CONTINENTS AND OCEANS

What was the world like when God made it? This is not an easy question to answer but the Bible and geology provide some important clues.

Genesis 1:9-10 tells us that on the third day of Creation, God gathered the waters into one place and made the dry land appear. He called the waters "seas" and the dry land "earth". So it is reasonable to conclude that the world back then had oceans and continents much as today.

But in many other respects the world before the Flood was very different from today's world. We know this because the Bible tells us that the Flood destroyed the old world in the days of Noah (2 Peter 3:6). The world we see today bears the marks of that awesome judgement.

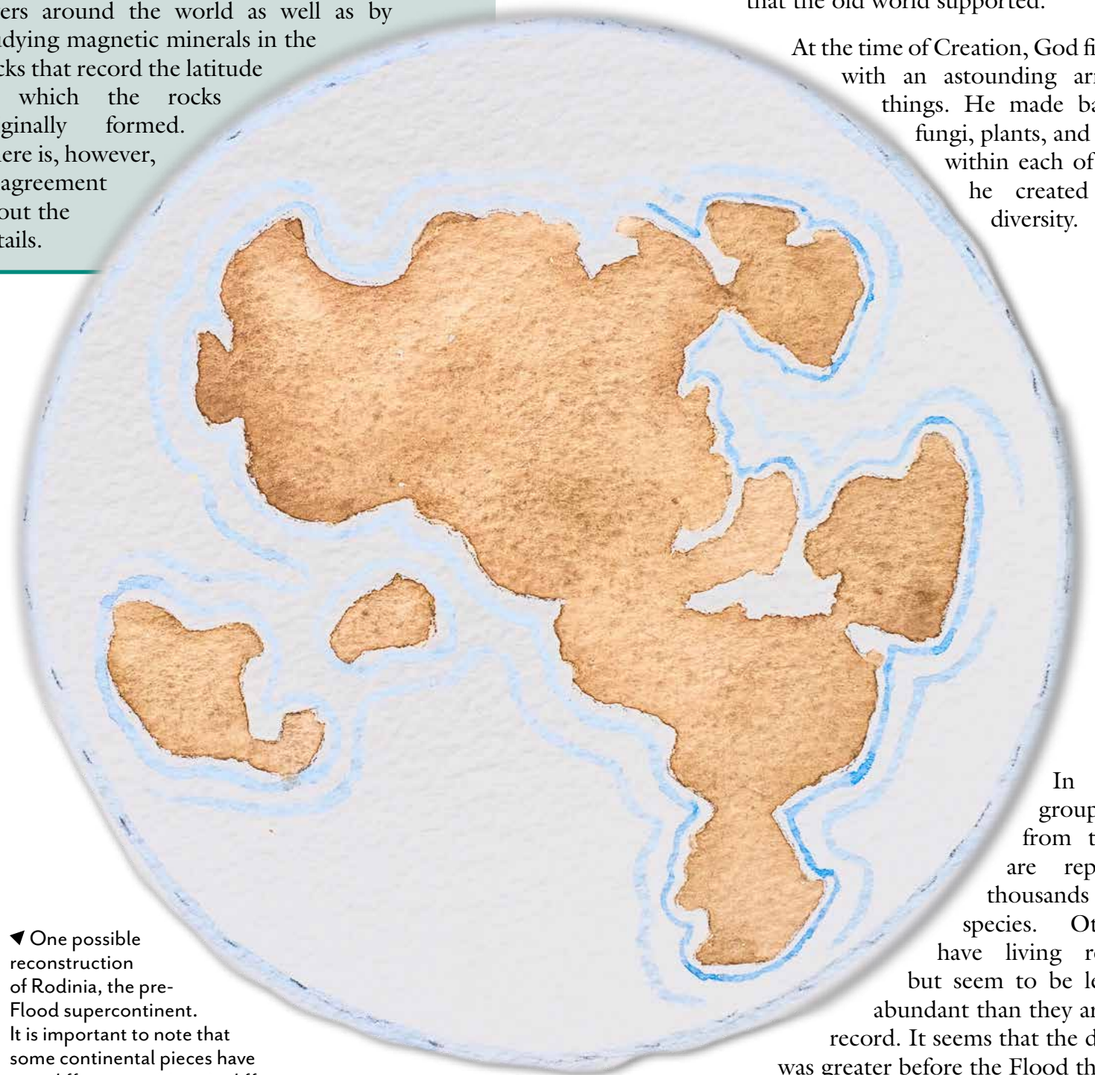
Clues preserved in the earth's rock layers indicate that most of the earth's landmasses were originally gathered together to form one super-sized continent. Scientists have named this **supercontinent** Rodinia (meaning *motherland*). This supercontinent was probably made up of large areas of land separated by shallow seas and waterways.

During the Flood this supercontinent broke apart and the pieces moved around. By studying the continental fragments that remain—fragments that geologists call **cratons**—scientists can piece together how those fragments might originally have been arranged.

Putting the broken and scattered pieces of the puzzle back together is difficult. But it seems likely the continent we now know as North America was near the center of the original supercontinent, with Australia and East Antarctica along its western edge.

RECONSTRUCTING RODINIA

Geological evidence indicates that the earth's continents are not fixed but moved around in the past. Scientists study clues in the rocks to work out how the continents used to be arranged. Rodinia was reconstructed by matching up rock layers around the world as well as by studying magnetic minerals in the rocks that record the latitude at which the rocks originally formed. There is, however, disagreement about the details.



◀ One possible reconstruction of Rodinia, the pre-Flood supercontinent. It is important to note that some continental pieces have very different positions in different reconstructions. This reconstruction will almost certainly have to be revised with additional study.

THE CREATED WORLD II. LIVING THINGS

Another difference between today's world and the old world was in the diversity of living things that the old world supported.

At the time of Creation, God filled the world with an astounding array of living things. He made bacteria, algae, fungi, plants, and animals—and within each of these groups he created even more diversity.

In fact, some groups missing from today's world are represented by thousands of fossil species. Other groups have living representatives but seem to be less diverse or abundant than they are in the fossil record. It seems that the diversity of life was greater before the Flood than today.

At the time of Creation, God made different environments to provide homes for all these creatures, just as in today's world there are grasslands, forests, deserts, lakes, and seas. These major habitats—each with its own climate and populated by a distinctive community of plants and animals—is called a **biome**. Each biome provided many ecological niches, and God made creatures in a bewildering range of sizes, shapes, and diets to fill these niches.

Deserts, grasslands, and tropical rainforests are examples of modern **biomes**. Each biome has its own climate and is populated by a distinctive set of plants and animals.

God's extraordinary design went even further. Today, the same biome can be found in many different places on the earth's surface, yet it is populated by a different set of plants and animals in different locations. This allows an even greater variety of creatures to live on the earth.

For example, grassland biomes include the North American prairies, the South American pampas, the African savanna, the Asian steppe, and the Australian plains—yet each supports a distinctive set of animals. In the beginning, it appears that God did something similar by creating the same environment in more than one place on the earth's surface in order to maximize the amount of diversity that could be supported.

Some of the biomes originally created by God are now extinct, along with the creatures that lived in them. We can find out about these biomes, however, by studying the remains left behind in the fossil record. Over the next few pages we will take a close look at some of the biomes in the old world before the Flood. We will begin with an extraordinary biome that was floating over the deep ocean, before moving on to shallow ocean biomes, coastal biomes, and land biomes.

The presence of the same biome in many places on the earth's surface allows for an even greater range of plants and animals to be supported. For example, grasslands are found on several of today's continents and each provides a home for particular herbivores:

North American prairie with an American bison.

South American pampas with a llama.

African savanna with a springbok.

Asian steppe with a saiga antelope.

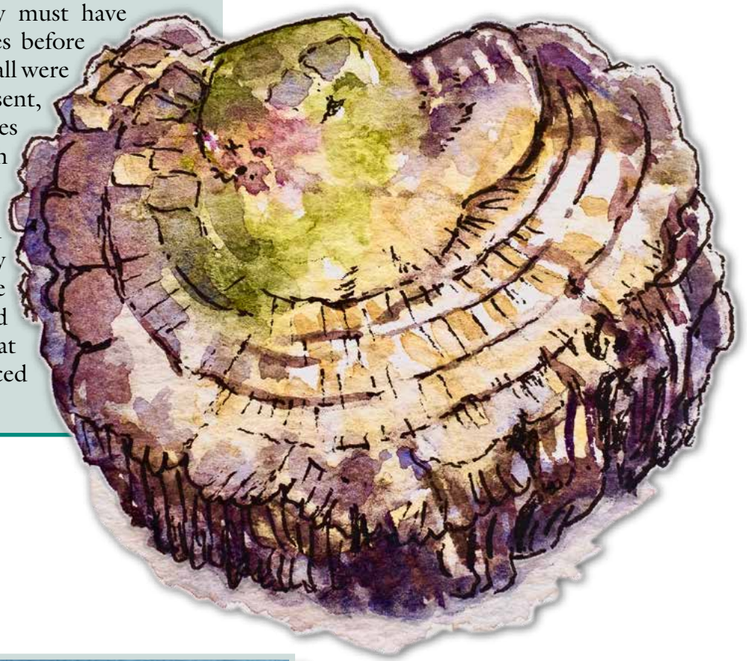
Australian plain with a kangaroo.

WHAT WAS EARTH'S CLIMATE LIKE BEFORE THE FLOOD?

Fossilized plants—and especially their growth rings—provide some important insights into the climatic conditions of the pre-Flood world.

The range of plant types buried in Flood sediments suggests that they must have grown in a variety of climates before the Flood. Temperatures overall were probably higher than at present, and the temperate zones probably extended much farther towards the poles.

Some fossil trees buried during the Flood display growth rings with evidence of seasonality, late frosts, and severe droughts, indicating that the higher latitudes experienced distinct seasonal changes.



▲ Growth rings in fossilized trees from the Purbeck Formation (Upper Jurassic) of Dorset, England, indicate they must have grown in a strongly seasonal environment.

◀ This photograph shows the hollows left where the fossilized stumps once stood.

THE FLOATING FOREST

The first of the major, pre-Flood biomes we will consider is the floating forest, a vast, thick mat of vegetation that floated over the deep, open ocean. Judging by the amount of fossilized plant material it left behind, this mat was probably the size of an entire continent.

At the edges of the floating forest grew small plants without true roots or leaves. They were well suited for life close to the water.

Farther into the floating forest there were small to medium-sized branching and bush-like plants. Some resembled ferns, while others were more like clubmosses. They were a bit less dependent on water, with tougher stems and extra vessels to carry water.

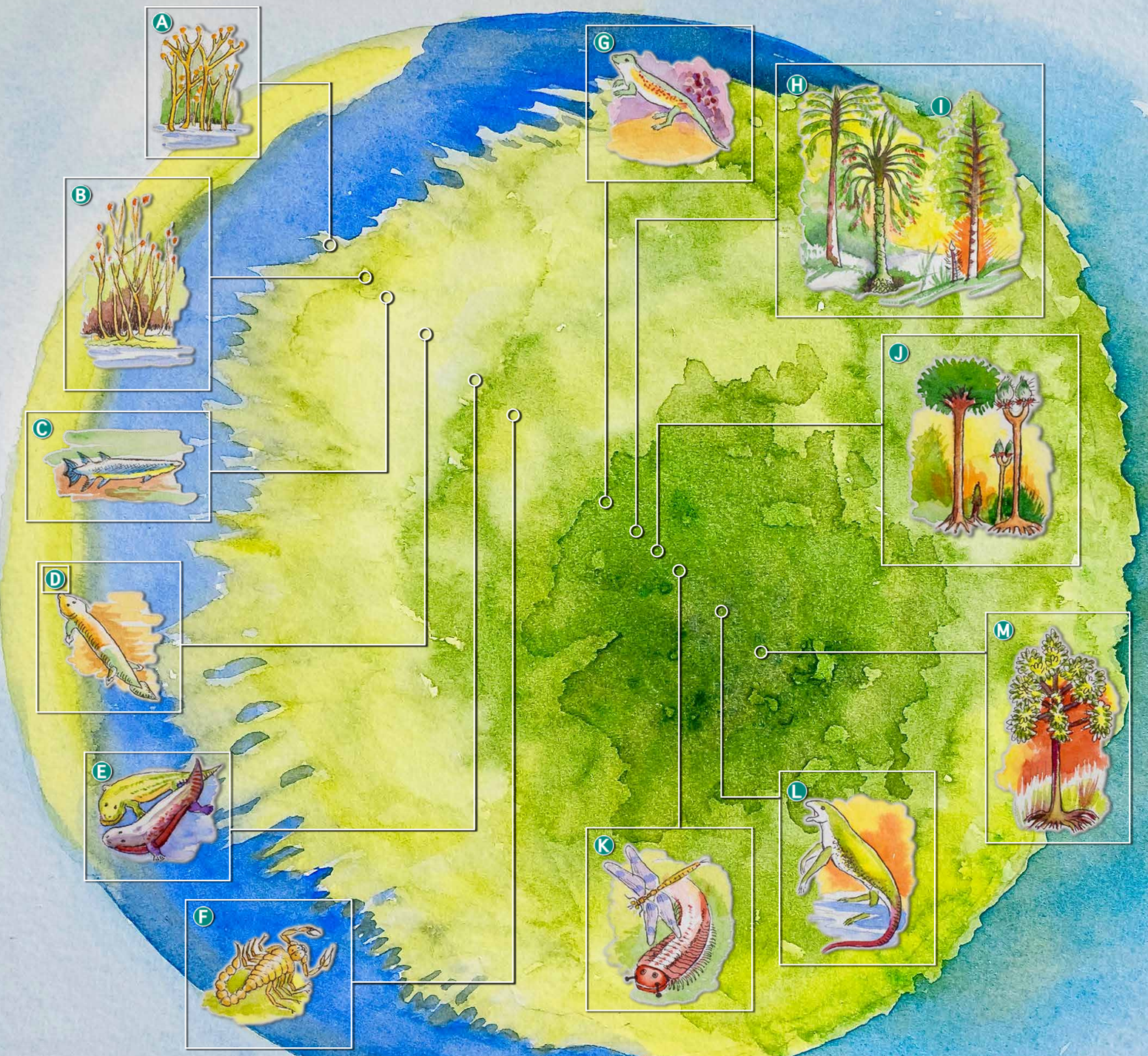
Large trees, including lycopsids and clubmosses, grew in the center of the floating forest. Here the mat was thick enough to support trunks up to 100 feet (30 meters) tall and 6 feet (2 meters) around.

Many strange animals inhabited this floating forest. Scurrying through the leaf litter were insects, spiders, scorpions, and cockroaches. Giant millipede-like animals made wide trackways resembling tire marks.

The air above the floating forest buzzed with winged insects, including *Meganeura*, a giant dragonfly-like creature with a wingspan up to 30 inches (76 centimeters) from tip to tip.

Other strange creatures lurked in shallow pools on the floating mat. They had feet and legs (not fins) but in other ways were quite fish-like. These animals seem to have been well suited for life in an ecosystem that was neither fully aquatic nor fully terrestrial.

Towards the center of the floating forest were animals more suited to life away from the water, including reptiles such as *Hylonomus*.

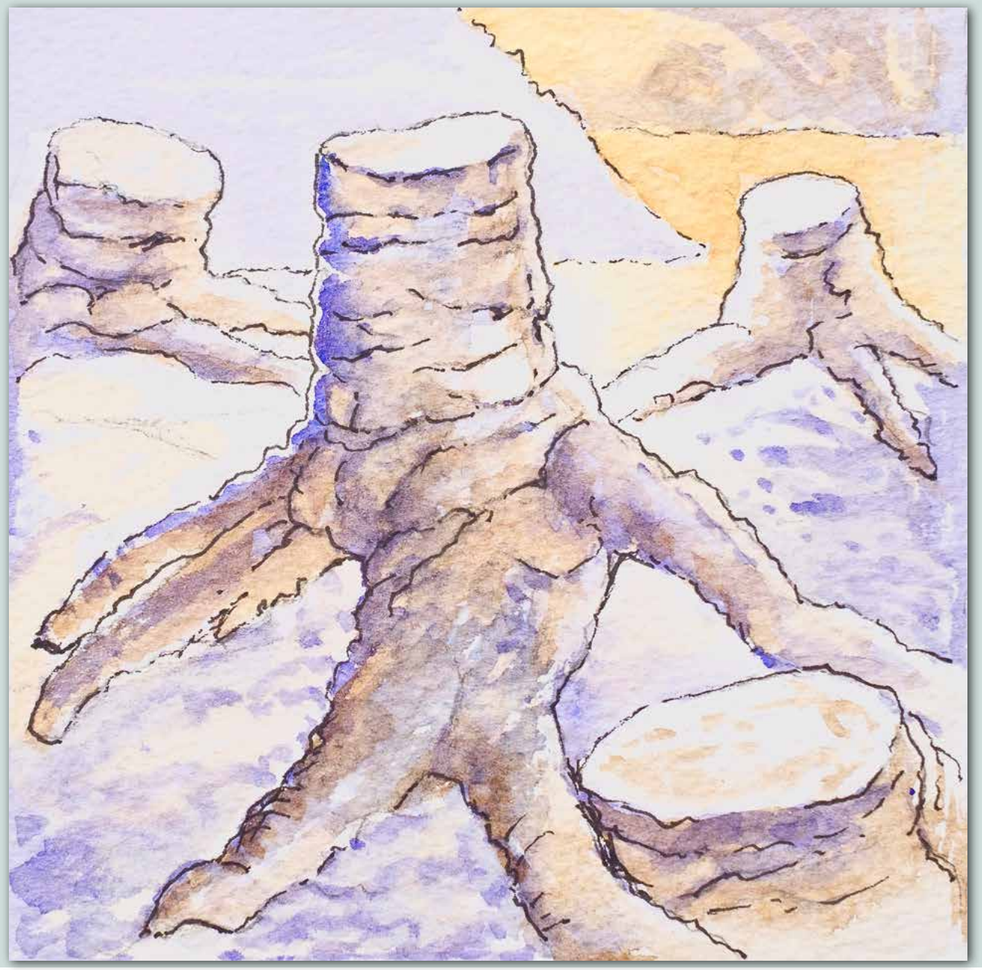


A *Cooksonia*.
B *Rhynia* and *Zosterophyllum*.
C *Eusthenopteron*.
D *Tiktaalik*.
E *Ichthyostega* and *Acanthostega*.
F *Pulmonoscorpius*.
G *Westlothiana*.
H *Neuropteris* and *Psaronius*.
I *Calamites*.
J *Sigillaria* and *Lepidodendron*.
K *Meganeura* and *Arthropleura*.
L *Hylonomus*.
M *Cordaites*.

THE GIANT CLUBMOSSES OF FOSSIL GROVE, GLASGOW, SCOTLAND

In a building in Glasgow's Victoria Park is the famous Fossil Grove, a group of eleven large tree stumps belonging to giant clubmosses. They have been preserved exactly where they were found back in 1887. In fact, the stumps are not the remains of the actual trees, but rather the result of sediment filling the hollow insides of the trees. The outermost layer of woody material rotted away to leave these extraordinary natural casts—a mute testimony to the long-lost pre-Flood floating forest.

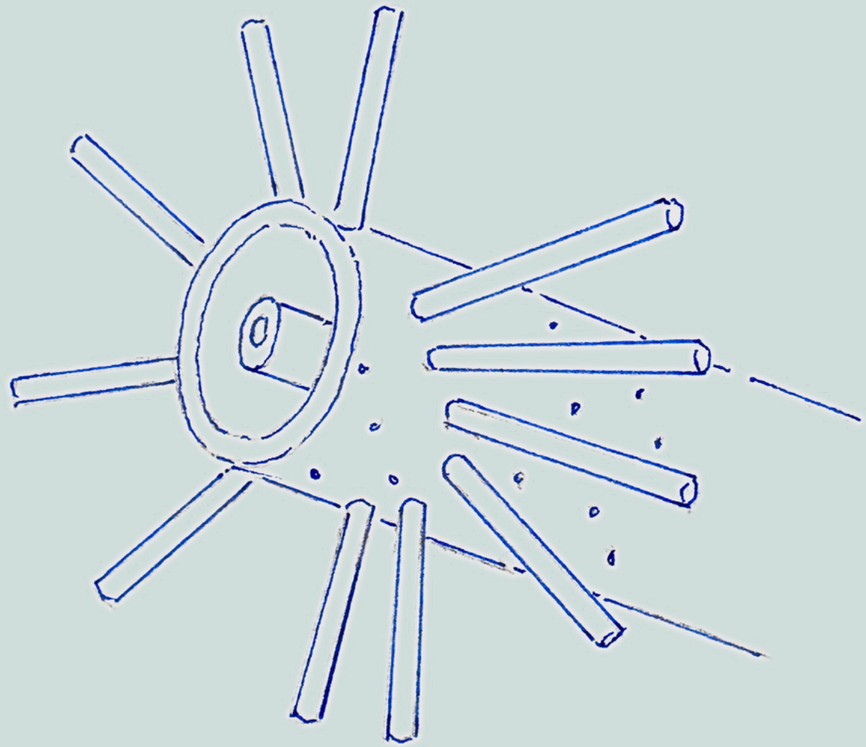
Thomas Nugent / CC BY-SA 2.0



PLANTS THAT GREW IN WATER

Evidence that some of these trees grew in water, not in soil, can be seen by examining their anatomy. For instance, lycopsids had roots called **stigmaria** with secondary rootlets arranged around the roots like spokes around a wheel. This type of root pattern is found only in water plants. Also, the trees, roots, and rootlets appear to have been hollow and filled with air when the plants were living—an ideal design for floating in water.

▲ Fossil specimen and ▼ life reconstruction showing the spoke-like-arrangement of *Stigmaria* rootlets.



SALTY, HOT-WATER REEFS

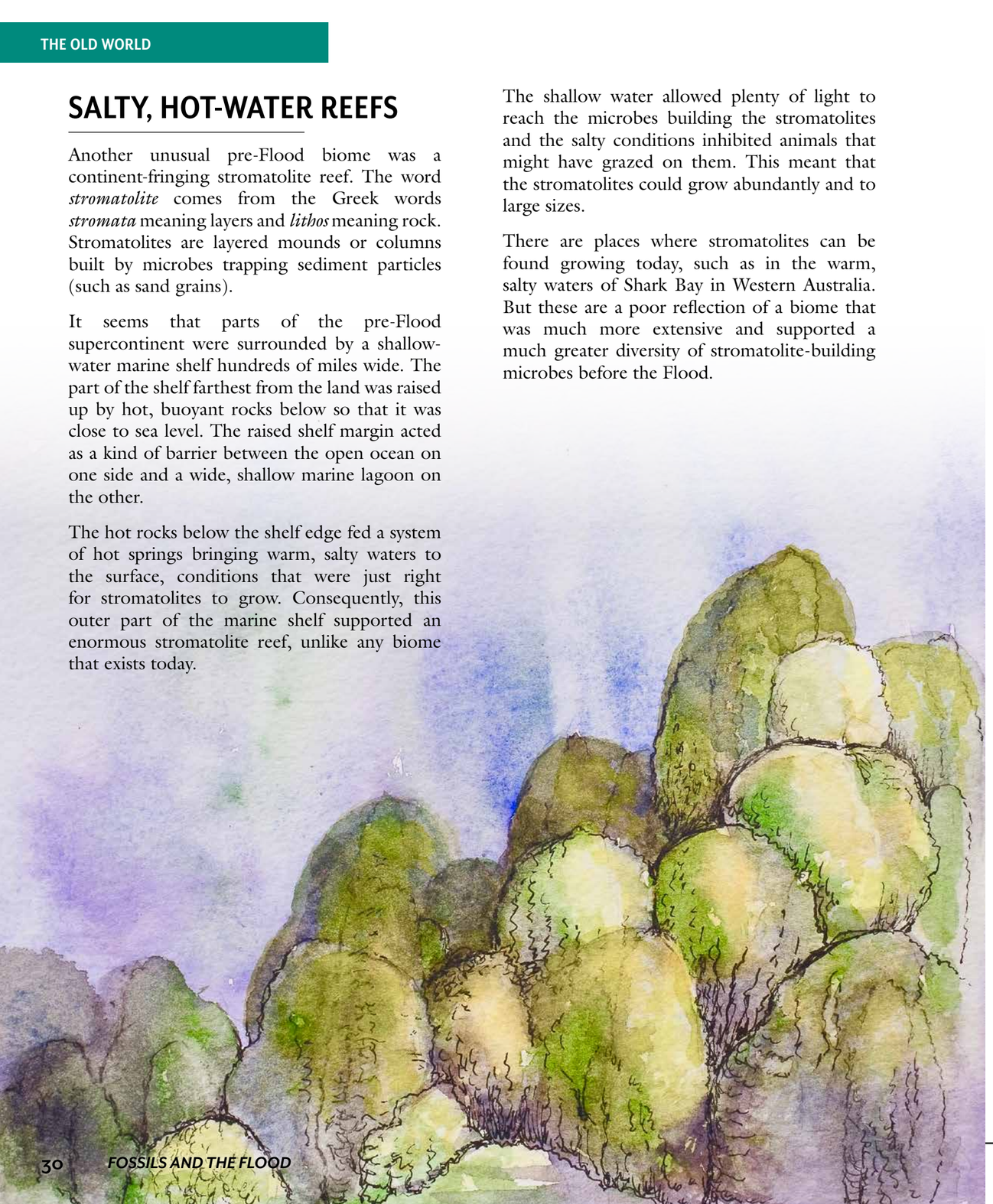
Another unusual pre-Flood biome was a continent-fringing stromatolite reef. The word *stromatolite* comes from the Greek words *stromata* meaning layers and *lithos* meaning rock. Stromatolites are layered mounds or columns built by microbes trapping sediment particles (such as sand grains).

It seems that parts of the pre-Flood supercontinent were surrounded by a shallow-water marine shelf hundreds of miles wide. The part of the shelf farthest from the land was raised up by hot, buoyant rocks below so that it was close to sea level. The raised shelf margin acted as a kind of barrier between the open ocean on one side and a wide, shallow marine lagoon on the other.

The hot rocks below the shelf edge fed a system of hot springs bringing warm, salty waters to the surface, conditions that were just right for stromatolites to grow. Consequently, this outer part of the marine shelf supported an enormous stromatolite reef, unlike any biome that exists today.

The shallow water allowed plenty of light to reach the microbes building the stromatolites and the salty conditions inhibited animals that might have grazed on them. This meant that the stromatolites could grow abundantly and to large sizes.

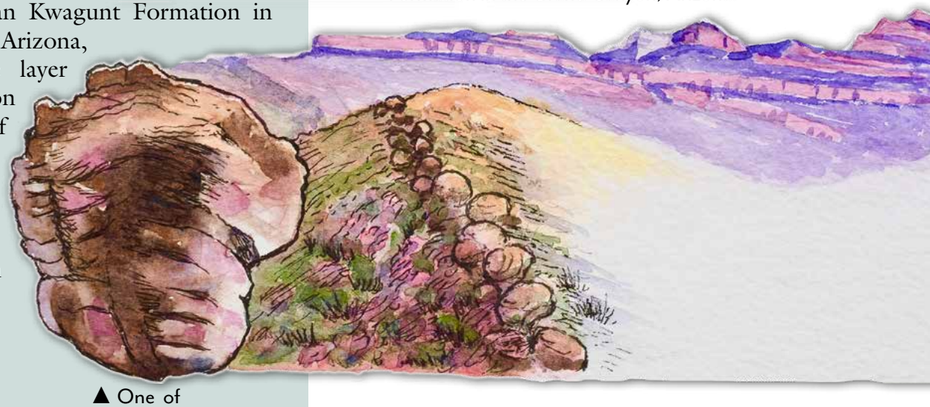
There are places where stromatolites can be found growing today, such as in the warm, salty waters of Shark Bay in Western Australia. But these are a poor reflection of a biome that was much more extensive and supported a much greater diversity of stromatolite-building microbes before the Flood.



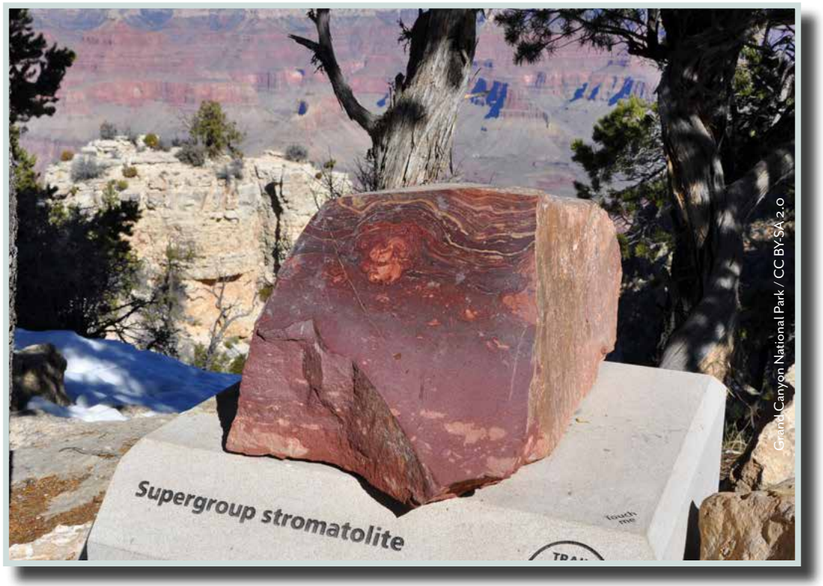
STROMATOLITES IN THE GRAND CANYON, ARIZONA

One place where you can see fossilized stromatolites that were growing before the Flood is in the Precambrian Kwagunt Formation in the Grand Canyon, Arizona, USA. An extensive layer within this formation contains hundreds of mushroom-shaped stromatolites, each about 8.2 feet (2.5 meters) tall. They probably grew in the shallow, warm, and salty waters of a stromatolite reef that fringed the margins of the pre-Flood supercontinent.

▼ The stromatolite bed in the Precambrian Kwagunt Formation in the Grand Canyon, Arizona.



▲ One of the many mushroom-shaped stromatolites in the bed.



Grand Canyon National Park / CC BY-SA 2.0

▲ This stromatolite cross section on display at the Grand Canyon clearly demonstrates its layered structure.

LIVING ON THE MARINE SHELF I: THE EDIACARANS

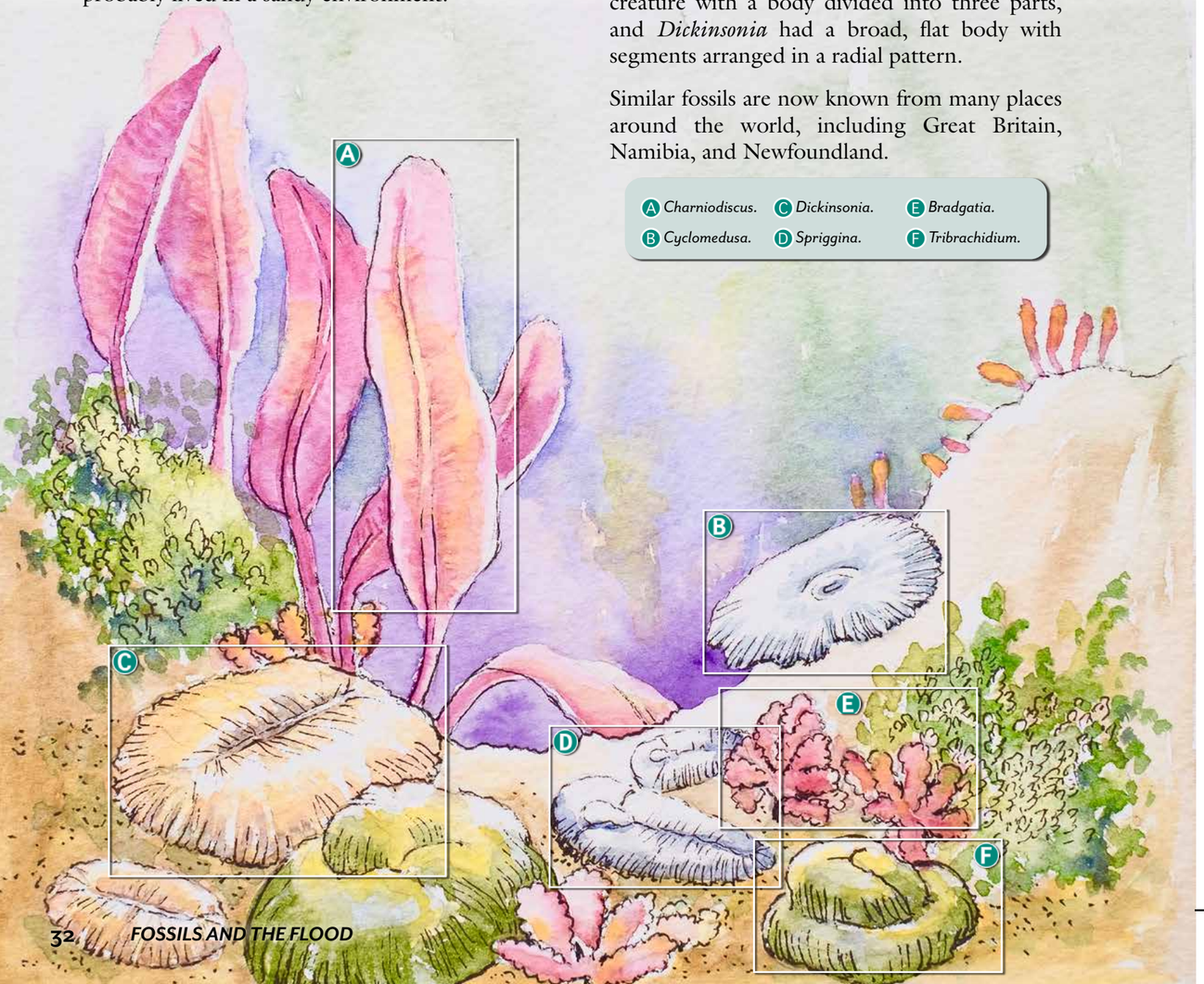
The shallow waters of the marine lagoon behind the stromatolite reef were home to many creatures.

In the deepest waters closest to the reef there were large, soft-bodied animals called Ediacarans, named after the Ediacara Hills in South Australia where their fossils were discovered. Their fossils are mostly preserved in sandstone, so they probably lived in a sandy environment.

Most of the Ediacaran animals had bodies with a quilted appearance, and some seem to have lived in dense colonies. A few might be classified in modern groups if they were living today, but most were unlike any creatures in the modern world.

Spriggina was a worm-like animal with a head shaped like a horseshoe. *Cyclomedusa*, an enigmatic creature, had a circular body and concentric rings. *Charniodiscus* had an elongated frond-like body attached to the seafloor, while *Bradgatia* had a cabbage-like appearance with six or more fronds radiating from a central anchor point. *Tribrachidium* was a disc-shaped creature with a body divided into three parts, and *Dickinsonia* had a broad, flat body with segments arranged in a radial pattern.

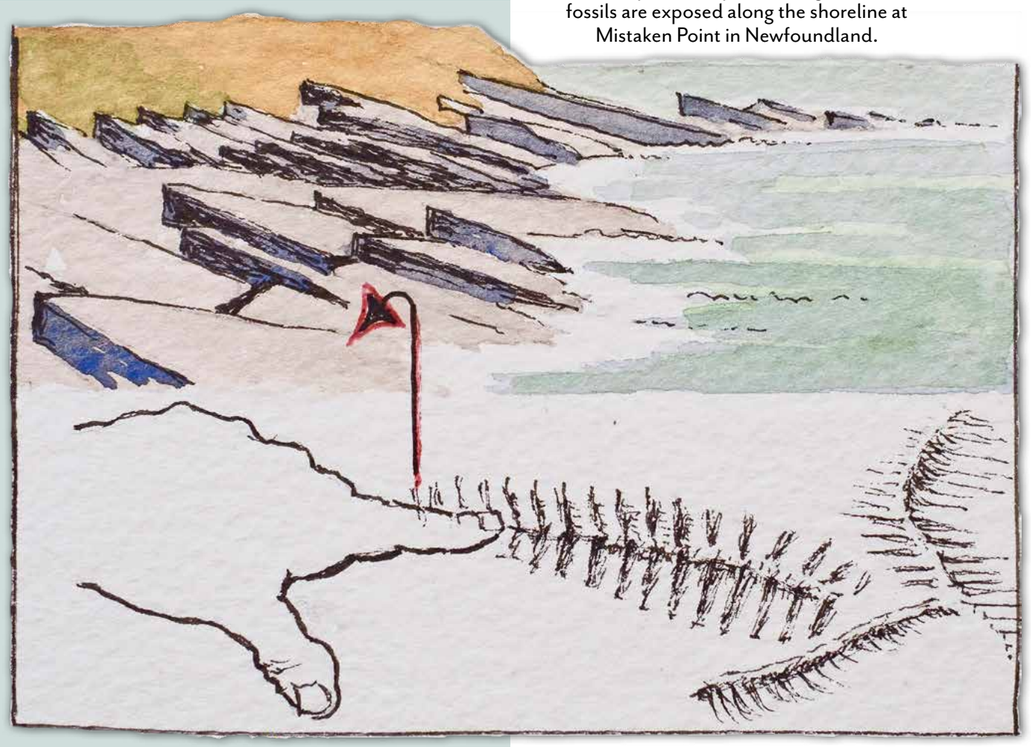
Similar fossils are now known from many places around the world, including Great Britain, Namibia, and Newfoundland.



A *Charniodiscus*. B *Cyclomedusa*. C *Dickinsonia*. D *Spriggina*. E *Bradgatia*. F *Tribrachidium*.

EDIACARANS AT MISTAKEN POINT, NEWFOUNDLAND

▼ Multiple rock layers bearing Ediacaran fossils are exposed along the shoreline at Mistaken Point in Newfoundland.



Mistaken Point, on the southernmost tip of the Avalon Peninsula in Newfoundland, is famous for its Ediacaran fossils. Frond-like, bush-like, and spindle-like forms are found in large numbers on the exposed rock surfaces. There are also abundant disc-shaped forms. Some are similar to fossils from the Charnwood Forest in England but others have not been found anywhere else in the world. These soft-bodied animals probably lived in moderately deep water and were preserved at the beginning of the Flood when they were smothered by volcanic ash carried by submarine currents.

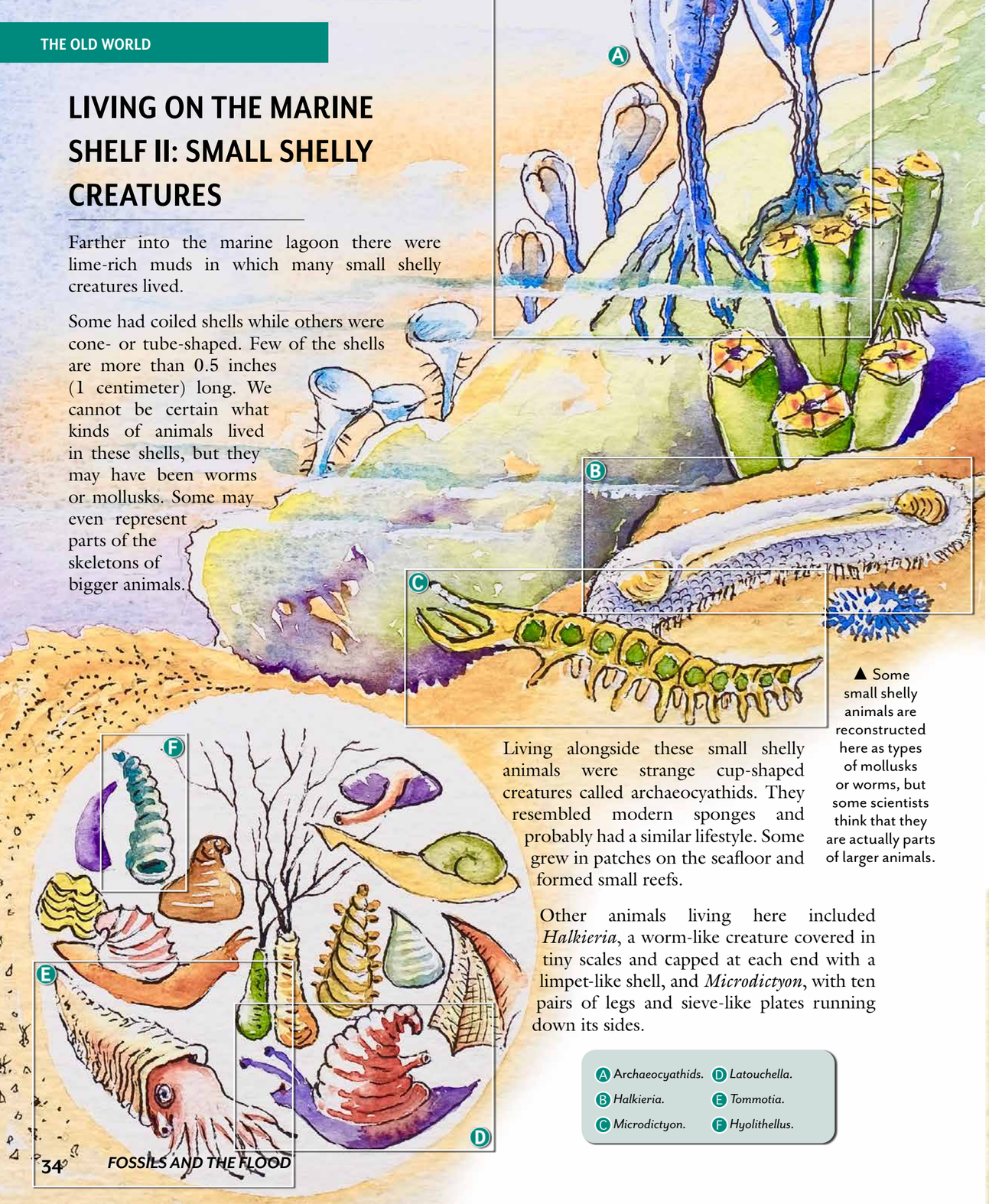
▲ A spindle-shaped fossil called *Fractofusus* on one of the bedding planes.

▼ A digital representation showing what *Fractofusus* may have looked like.

LIVING ON THE MARINE SHELF II: SMALL SHELLY CREATURES

Farther into the marine lagoon there were lime-rich muds in which many small shelly creatures lived.

Some had coiled shells while others were cone- or tube-shaped. Few of the shells are more than 0.5 inches (1 centimeter) long. We cannot be certain what kinds of animals lived in these shells, but they may have been worms or mollusks. Some may even represent parts of the skeletons of bigger animals.



▲ Some small shelly animals are reconstructed here as types of mollusks or worms, but some scientists think that they are actually parts of larger animals.

Living alongside these small shelly animals were strange cup-shaped creatures called archaeocyathids. They resembled modern sponges and probably had a similar lifestyle. Some grew in patches on the seafloor and formed small reefs.

Other animals living here included *Halkieria*, a worm-like creature covered in tiny scales and capped at each end with a limpet-like shell, and *Microdictyon*, with ten pairs of legs and sieve-like plates running down its sides.

A Archaeocyathids.
B *Halkieria*.
C *Microdictyon*.
D *Latouchella*.
E *Tommotia*.
F *Hyolithellus*.

SMALL SHELLY CREATURES OF THE SIBERIAN PLATFORM

The fossilized remains of these small shelly animals were first discovered in rocks exposed along the Lena and Aldan Rivers in a remote and inaccessible part of Siberia.

Since then, similar fossils have been found in many other places around the world, including China, India, Canada, England, France, and Australia. Scientists sometimes refer to these fossils as the Tommotian fauna, after the subdivision of Cambrian rocks in which they were first identified.

▼ Spectacular pillars of rock along the Lena River in the Sakha Republic (Yakutia) are composed of Lower Cambrian (Tommotian) sediments yielding fossils of the small shelly creatures.

LIVING ON THE MARINE SHELF III: THE ATDABANIAN ANIMALS

The part of the marine lagoon nearest the land teemed with yet more strange animals.

The giant predatory arthropod *Anomalocaris* and the fish-like vertebrate *Myllokunmingia* swam above the seafloor, while trilobites such as *Olenellus* lived on the muddy sea bottom or burrowed into it.

On the seabed, worms such as *Paraselkirkia* waited for passing prey in their U-shaped burrows while clusters of brachiopods such as *Longtancunella* strained tiny food particles from the seawater. *Quadrolaminiella* had a long vase-shaped body and was probably a kind of sponge.

One oddity was *Hallucigenia*, with its multiple legs and shoulder spines. It may have been a type of spiny velvet worm. *Paucipodia* was similar but lacked the paired spines on its back.

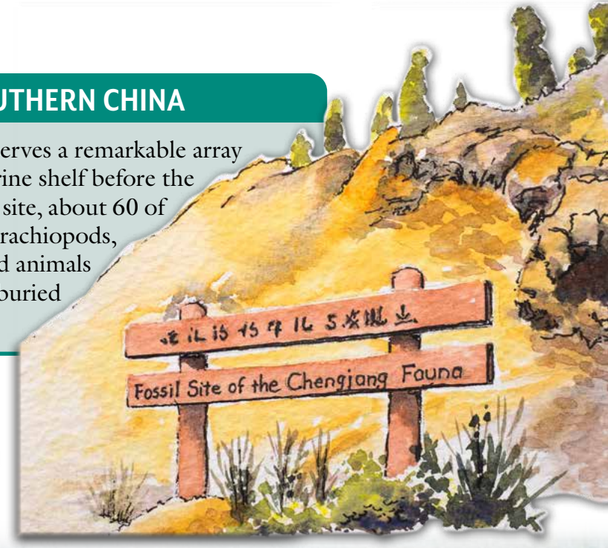
There were also echinoderms, but not like the starfish and sea urchins that we are familiar with. The enigmatic *Helicoplacus* was shaped like the bob on the end of a plumb line and covered with small armor plates. It did not have the five-fold symmetry of modern echinoderms.

Another strange creature was *Eldonia*, with its soft, disc-shaped body and tentacles. Although it somewhat resembled a jellyfish, it is not known exactly what kind of animal *Eldonia* was.

A *Anomalocaris*. B *Quadrolaminiella*. C *Myllokunmingia*. D *Paraselkirkia*. E *Paucipodia*. F *Hallucigenia*. G *Olenellus*. H *Helicoplacus*. I *Longtancunella*. J *Eldonia*.

ATDABANIAN FAUNA OF CHENGJIANG, SOUTHERN CHINA

The Chengjiang fossil deposit in southern China preserves a remarkable array of animals that populated this part of the shallow marine shelf before the Flood. More than 150 species have been found at this site, about 60 of them arthropods. Others include worms, sponges, brachiopods, and what seem to be vertebrates. Even the soft-bodied animals are well preserved, suggesting that they were rapidly buried by catastrophic sediment flows during the Flood.



▶ The Lower Cambrian (Atdabanian) rocks of Chengjiang in Yunnan Province, China, are famous for their exquisite fossils that represent a diverse assemblage of invertebrates and vertebrates and include the preservation of both hard and soft tissues.

EXTENSIVE INLAND SEAS: THE MARINE PALEOZOIC

An extensive shallow sea may have covered much of the supercontinent itself. In these inland waters lived a community of organisms distinctively different to the Atdabanian fauna.

These waters were rich in brachiopods. Some burrowed into the sediments, while others (such as *Rafinesquina* and *Platystrophia*) made their home on the seabed and filtered food from the passing currents. There were trilobites of many kinds, including phacopids (such as *Flexicalymene*) and asaphids (such as *Isotelus*).

Gastropods (such as *Cyclonema*) were also present, though less abundant and diverse than the brachiopods.

Thickets of crinoids (such as *Cincinnaticrinus*) colonized the seafloor alongside sponges, corals and bryozoans, sometimes constructing reef-like environments. Corals (such as *Protaraea*) were encrusters, growing as thin sheets on the shells of other animals. Others grew singly, such as the horn corals *Streptelasma* and *Grewingkia*. Bryozoans also included encrusting forms, while other types (such as *Constellaria*) grew as branching colonies attached to the seafloor.

Lurking in the depths were large, predatory animals (such as the eurypterid *Megalograptus*). Other predators, such as the straight-shelled nautiloid *Isorthoceras*, cruised the waters above. And starfish (such as *Promopalaeaster*) crawled across the seabed in search of prey.

▲ Upper Ordovician shales and limestones in a road cut along Interstate 75 in northern Kentucky, with the city of Cincinnati, Ohio, USA, in the background.

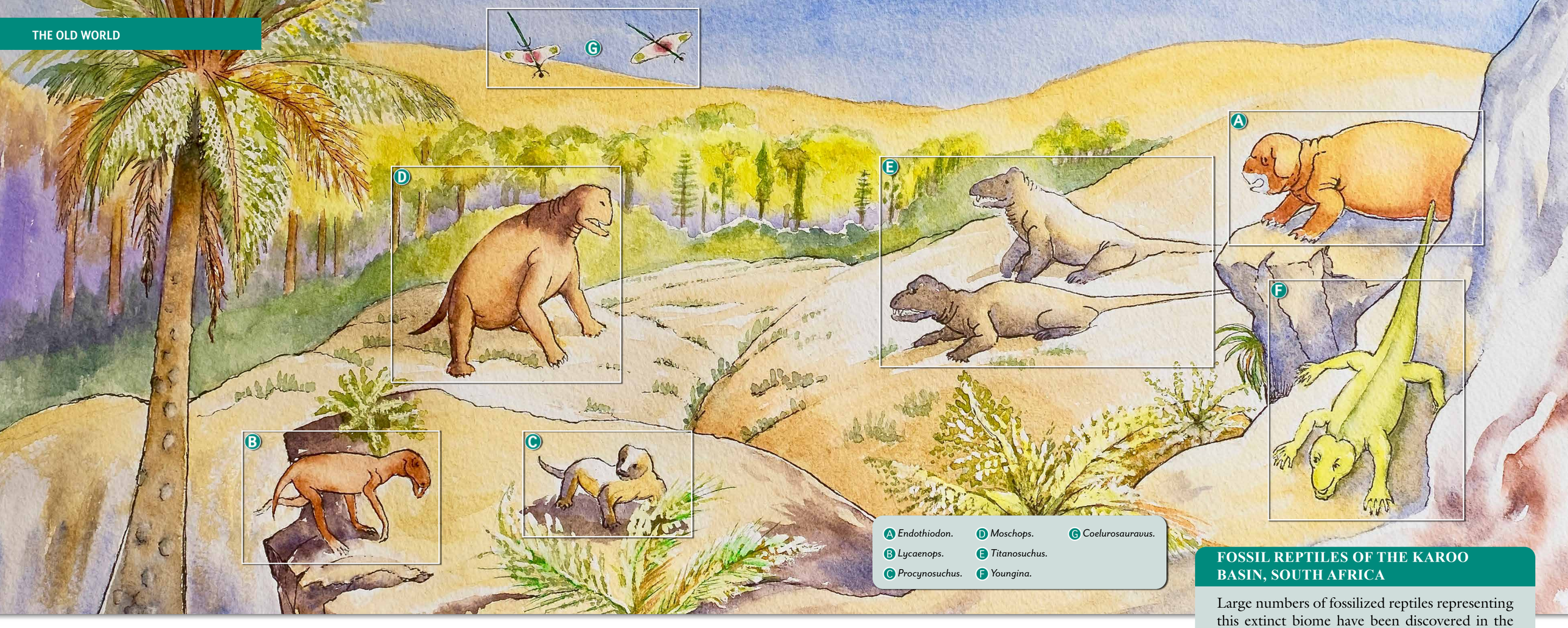
FOSSIL FAUNA OF THE CINCINNATIAN ROCKS OF OHIO

Fossils of the kinds described here can be found in great abundance in the Upper Ordovician rocks exposed along the interstate highways of the Cincinnati area of Ohio, USA. In fact, the trilobite *Isotelus maximus* is the state fossil of Ohio.

Road cuts near Cincinnati expose stacks of alternating thin layers of limestone and shale. The limestone beds are packed full of fossil brachiopods, bryozoans, and crinoids, often in a broken condition.

Only rarely are whole fossils found. It seems that during the Flood turbulent waves uprooted these creatures from the places where they were living and transported them some distance before burial.

A *Flexicalymene*.
B *Isotelus*.
C *Rafinesquina*.
D *Platystrophia*.
E *Cyclonema*.
F *Cincinnaticrinus*.
G *Streptelasma*.
H *Grewingkia*.
I *Protaraea*.
J *Constellaria*.
K *Promopalaeaster*.
L *Megalograptus*.
M *Isorthoceras*.



A *Endothiodon.* D *Moschops.* G *Coelurosauravus.*
B *Lycaenops.* E *Titanosuchus.*
C *Procynosuchus.* F *Youngina.*

THE FRINGES OF THE LAND: COASTAL DUNES AND FORESTS

Reptiles thrived in the sand dunes and forests fringing the coasts of the pre-Flood supercontinent. Gymnosperm plants such as seed ferns and conifers dominated the forests.

Most of the animals inhabiting this biome were therapsids, a very diverse group with a peculiar mixture of reptile-like and mammal-like characteristics.

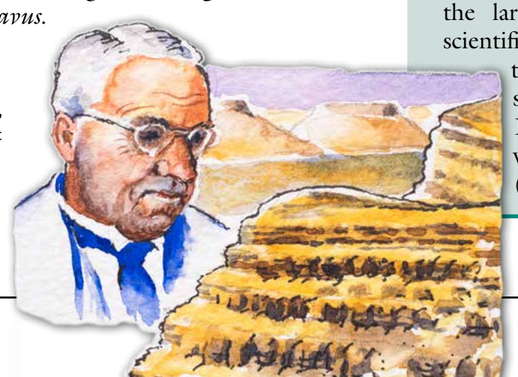
Most abundant were the dicynodonts—herbivores such as *Endothiodon* with two canines and a horny beak that they used for slicing and crushing plants.

There were also saber-toothed carnivorous therapsids called gorgonopsians. A typical example was *Lycaenops*, with its heavy skull, wide mouth, and massive canines.

Also common were the cynodonts, a group that included small- to medium-sized carnivores such as *Procynosuchus.*

Other therapsids included the dinocephalians, a group comprising bulky herbivores like *Moschops* and dog-sized carnivores like *Titanosuchus.*

Diapsid reptiles were also present, including the lizard-like *Youngina* and gliders such as *Coelurosauravus.*



▶ Robert Broom, the paleontologist who discovered many of the fossil reptiles of the Karoo Basin, South Africa.

FOSSIL REPTILES OF THE KAROO BASIN, SOUTH AFRICA

Large numbers of fossilized reptiles representing this extinct biome have been discovered in the Upper Permian sandstones and mudstones of the Karoo Basin in South Africa.

Robert Broom (1866-1951), a Scotsman who moved to South Africa at the turn of the twentieth century to practice medicine, made the largest collections. During his fifty-year scientific career, Broom named hundreds of fossil therapsids—including well-known types such as *Moschops* (in 1911), *Lycaenops* (in 1925), and *Procynosuchus* (in 1937—as well as other reptiles such as *Youngina* (in 1914).

◀ The magnificent rock exposures in the Karoo desert are a rich source of vertebrate fossils.

A *Scaphonyx.*
B *Aetosauroides.*
C *Saurosuchus.*
D *Herrerasaurus.*
E *Eodromaeus.*
F *Pisanosaurus.*
G *Chromogisaurus.*
H *Probainognathus.*
I *Chiniquodon.*
J *Chiniquodon.*

DINOSAURS I. TRIASSIC BIOME

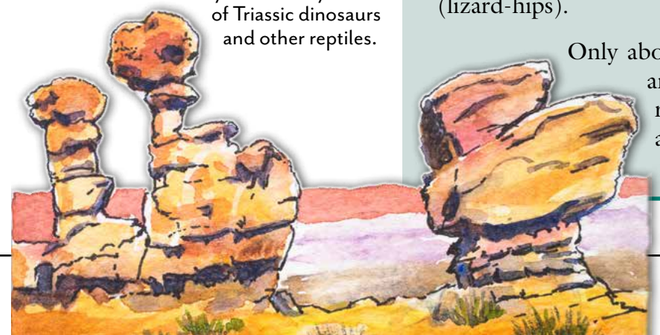
Large regions of the pre-Flood world must have been dominated by the extraordinary animals we call dinosaurs. In fact, it seems that there were at least three dinosaur biomes.

One of these biomes comprised the dinosaurs and associated creatures we find in Triassic rocks. Non-flowering gymnosperms dominated the flora, including conifers (such as *Protojuniperoxylon*). There were also horsetails and ferns (such as *Cladophlebis*).

The dinosaurs of the Triassic biome were mostly small, slender animals, including carnivores (such as *Herrerasaurus* and *Eodromaeus*) and plant-eaters (such as *Pisanosaurus* and *Chromogisaurus*).

But other kinds of reptiles were more numerous in this biome than the dinosaurs. There were the rhynchosaurs with their triangular skulls and sharp beaks; the aetosaurs with armored bodies, small heads, and upturned snouts; and the loricatans, crocodile-like in appearance but walking upright on four, long legs. Therapsids were also represented by small forms (such as *Probainognathus*), medium-sized forms (such as *Chiniquodon*) and large, bulky forms (such as *Ischigualastia*).

▼ Wind-sculpted rock formations in the Valle de la Luna (Valley of the Moon) in Ischigualasto Provincial Park, San Juan Province, northwestern Argentina. These rocks belong to the Ischigualasto Formation, which has yielded many fossils of Triassic dinosaurs and other reptiles.



DINOSAURS AND OTHER CREATURES OF ISCHIGUALASTO, ARGENTINA

Fossils representing this Triassic biome are preserved in the Ischigualasto Formation of the Valley of the Moon in northwestern Argentina.

Sparse dinosaur remains were discovered in this region in the 1950s, but our knowledge of these animals was greatly expanded when collecting resumed in the 1990s. The Ischigualasto dinosaurs include representatives of both main dinosaur subgroups: the ornithischians (bird-hips) and saurischians (lizard-hips).

Only about 10 percent of the vertebrate fossils in these rocks are dinosaurs. There are also fossils of many other reptiles, with the medium-sized rhynchosaur *Scaphonyx* accounting for more than half of the tetrapod remains in this formation.

DINOSAURS II. JURASSIC BIOME

Another biome hosted the dinosaurs and associated animals and plants that we find in Jurassic rocks. Conifers were the dominant trees in this biome, growing alongside mid-size plants such as ginkgos, cycads, tree ferns, and clubmosses. Small ground plants included horsetails and ferns (such as those belonging to the order Marattiales).

Giant sauropods like *Brachiosaurus* and *Apatosaurus* browsed the leaves from the tops of the tallest trees, while smaller ornithopods such as *Camptosaurus* and *Dryosaurus* browsed on the lower stems. Armored dinosaurs such as *Mymoorapelta* and *Stegosaurus* grazed on the small shrubs and ground plants.

The largest meat-eater in this biome was the theropod *Allosaurus*, but there were also smaller carnivores such as *Ceratosaurus*. The small, bird-like theropod *Ornitholestes* may have preyed on lizards and insects.

▶ The famous fossil wall at Dinosaur National Monument in Colorado, USA. About 1,500 dinosaur bones can be seen in the wall, which is part of the Jurassic Morrison Formation. The bones belong to *Allosaurus*, *Apatosaurus*, and *Stegosaurus*, among others.

Flying reptiles dominated the skies, including pterosaurs such as *Harpactognathus*. Scurrying around the feet of the dinosaurs were also small mammals. Some were burrowing animals, while others climbed trees. They all belonged to groups that are now extinct.

DINOSAURS AND OTHER CREATURES OF THE MORRISON FORMATION

The Morrison Formation is a widespread rock unit, extending for hundreds of miles across parts of seven American states: New Mexico, Oklahoma, Colorado, Utah, Montana, South Dakota, and Wyoming.

Hundreds of dinosaur skeletons have been excavated from these rocks since the days of the Great American Bone Wars, when Edward Drinker Cope (1840-1897) competed with Othniel Charles Marsh (1831-1899) for the best finds.

Many iconic dinosaurs are known from Morrison rocks, including meat-eaters such as *Allosaurus* and plant-eaters such as *Stegosaurus*. There are also fossils of many other animals, including lizards, turtles, crocodiles, mammals, fishes, and insects, as well as many diverse plants.

- A *Brachiosaurus*.
- B *Apatosaurus*.
- C *Camptosaurus*.
- D *Dryosaurus*.
- E *Stegosaurus*.
- F *Mymoorapelta*.
- G *Allosaurus*.
- H *Ceratosaurus*.
- I *Ornitholestes*.
- J *Harpactognathus*.
- K *Archaeopteryx*.
- L *Docodon*.
- M *Priacodon*.

DINOSAURS III. CRETACEOUS BIOME

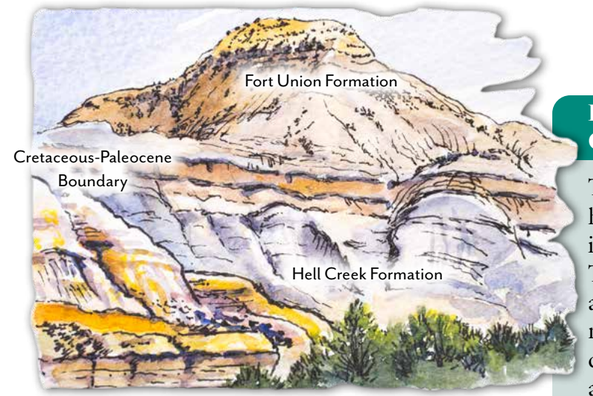
The dinosaurs and associated animals and plants that we find in Cretaceous rocks inhabited another biome.

Large trees included the seed-bearing angiosperms such as sycamores and magnolias. Mid-size plants included laurels, and there were small ground plants such as the fern *Dryopteris*.

Browsing and grazing on these plants were herbivores such as the hadrosaur *Edmontosaurus*, the horned dinosaur *Triceratops*, the armored *Ankylosaurus*, and the bone-headed *Pachycephalosaurus*.

The largest meat-eater in this biome was *Tyrannosaurus*, but there were smaller carnivores such as *Dromaeosaurus* and *Troodon*, both of which probably possessed a feathery covering.

Pterosaurs included true giants such as *Quetzalcoatlus*, with an estimated wingspan of 33 to 36 feet (10 to 11 meters). This extraordinary pterosaur was one of the largest flying animals ever to have lived. Small birds such as *Avisaurus* and small mammals such as *Alphadon* and *Mesodma* also inhabited this biome.

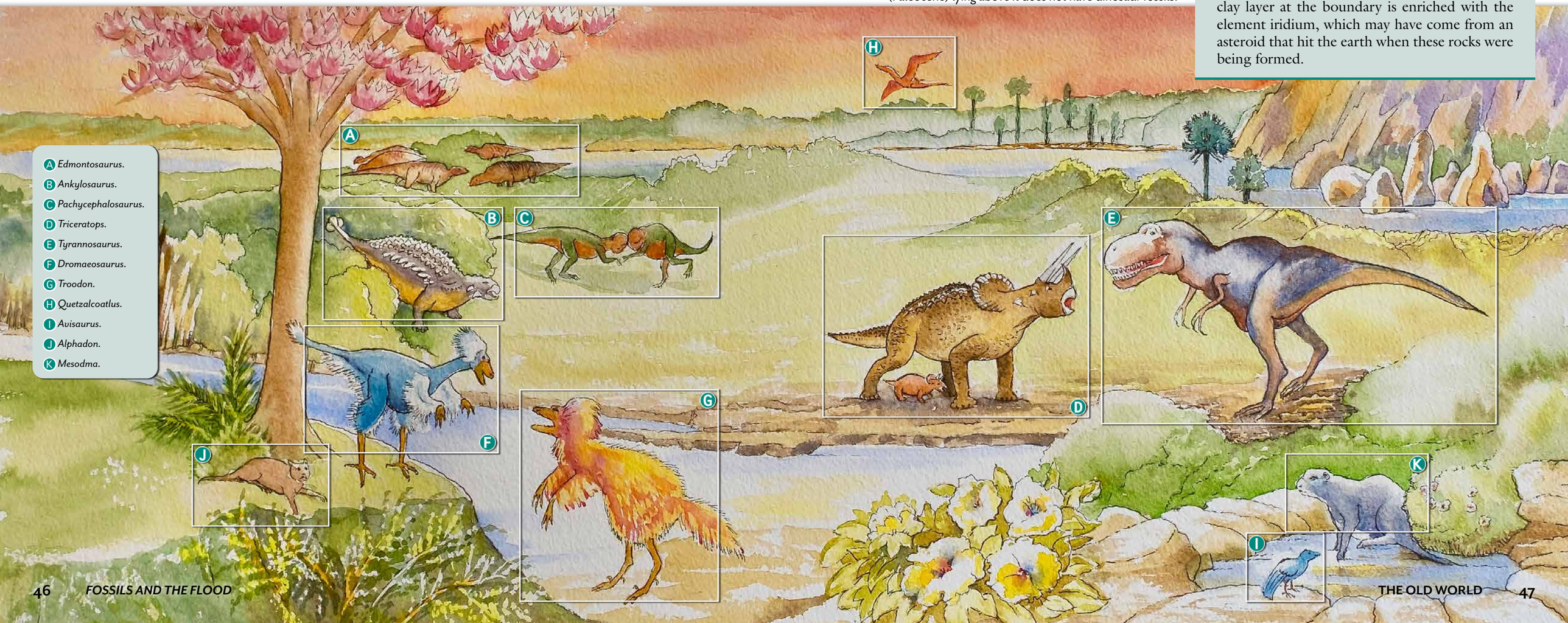


▲ The Cretaceous-Paleocene boundary in Makoshika State Park near Glendive, Montana, USA, is marked by a narrow band of iridium-enriched clay and carbonized plant material. The dinosaur-bearing Hell Creek Formation (Cretaceous) lies below the dark band; the Fort Union Formation (Paleocene) lying above it does not have dinosaur fossils.

DINOSAURS AND OTHER CREATURES OF THE HELL CREEK FORMATION

The Hell Creek Formation in Montana, USA, has yielded many fossil skeletons belonging to inhabitants of the Cretaceous dinosaur biome. These include dinosaurs and pterosaurs, but also crocodiles, lizards, turtles, frogs, fishes, and mammals. Among the most famous Hell Creek dinosaurs are the top predator, *Tyrannosaurus*, and the horned dinosaur, *Triceratops*.

Scientists have studied the Hell Creek Formation extensively because these rocks include the boundary that marks the last appearance of the dinosaurs in the fossil record. The thin clay layer at the boundary is enriched with the element iridium, which may have come from an asteroid that hit the earth when these rocks were being formed.



MARINE REPTILE BIOMES

The world before the Flood was also home to a greater diversity of marine reptiles than are living today. These animals may have inhabited the warm, shallow waters of inland seas closely associated with the dinosaur biomes of the Triassic, Jurassic, and Cretaceous.

Among the best known of these fossilized marine reptiles are the ichthyosaurs (fish lizards). They had streamlined bodies with front and rear paddles, and a deep tail fin. Their long, thin snouts were equipped with an array of sharp teeth, and they seem to have lived on a diet of fish and shellfish.

Another well-known group is the plesiosaurs (ribbon lizards). They had compact bodies and short tails but elongated necks. They probably used their paddles to swim with an underwater flying motion, darting out their long necks to catch fish and squid.

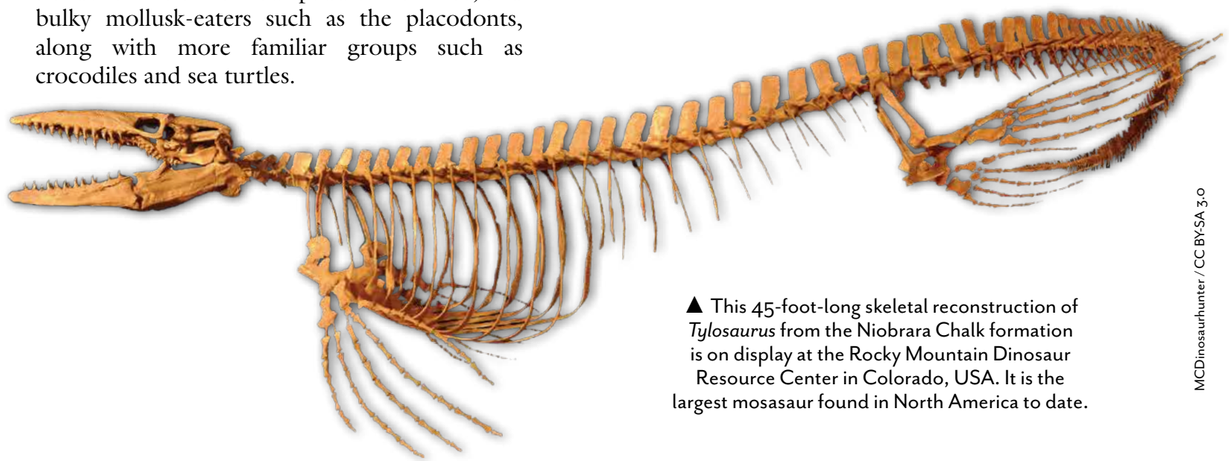
Perhaps most spectacular of all were the giant marine lizards called mosasaurs. These animals had long bodies, deep tails, and paddle-like limbs. Their wide jaws were lined with sharp, conical teeth, which they used to catch fish and crack open mollusk shells.

Other marine reptiles included the nothosaurs, slender animals with four paddle-like limbs, and bulky mollusk-eaters such as the placodonts, along with more familiar groups such as crocodiles and sea turtles.

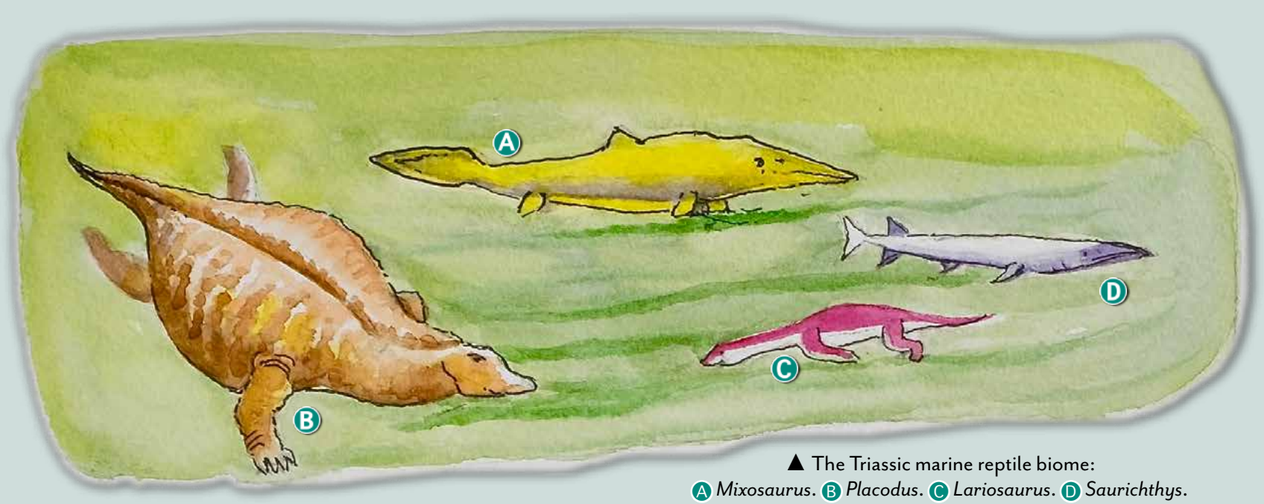
The Triassic marine reptile biome was home to ichthyosaurs (such as *Mixosaurus*), placodonts (such as *Placodus*), and nothosaurs (such as *Lariosaurus*). Also shown is the ray-finned fish, *Saurichthys*. This reconstruction is based on fossils from the Middle Triassic "Lower Reptile Bed" of the Guanling Formation in Guizhou Province, China.

The Jurassic marine reptile biome was inhabited by ichthyosaurs (such as *Stenopterygius*), plesiosaurs (such as *Plesiosaurus*), and crocodiles (such as *Steneosaurus*). Ammonites (such as *Dactylioceras*) and ray-finned fishes (such as *Lepidotes*) also swarmed in these warm waters. This reconstruction is based on fossils from the Lower Jurassic Posidonia Shale of Holzmaden, Germany.

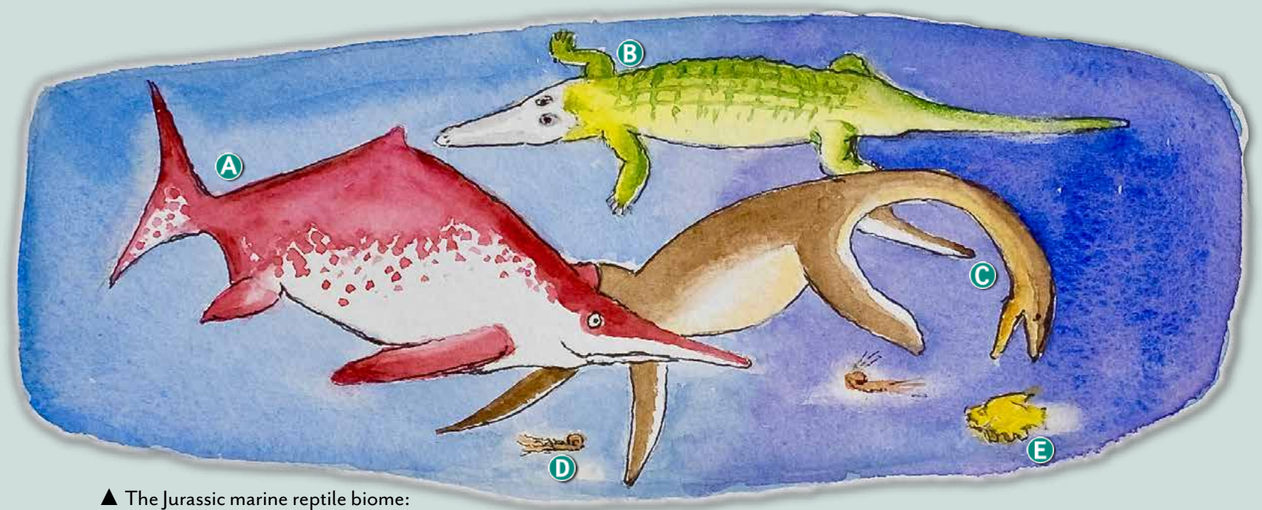
The Cretaceous marine reptile biome was populated by mosasaurs (such as *Tylosaurus*), plesiosaurs (such as *Elasmosaurus*), and sea turtles (such as *Archelon*). Also shown is *Squalicorax* (a shark), *Protosphyraena* (a swordfish), and *Pachyrhizodus* (a bony fish). This reconstruction is based on fossils from the Upper Cretaceous Niobrara Chalk of Kansas, USA.



▲ This 45-foot-long skeletal reconstruction of *Tylosaurus* from the Niobrara Chalk formation is on display at the Rocky Mountain Dinosaur Resource Center in Colorado, USA. It is the largest mosasaur found in North America to date.

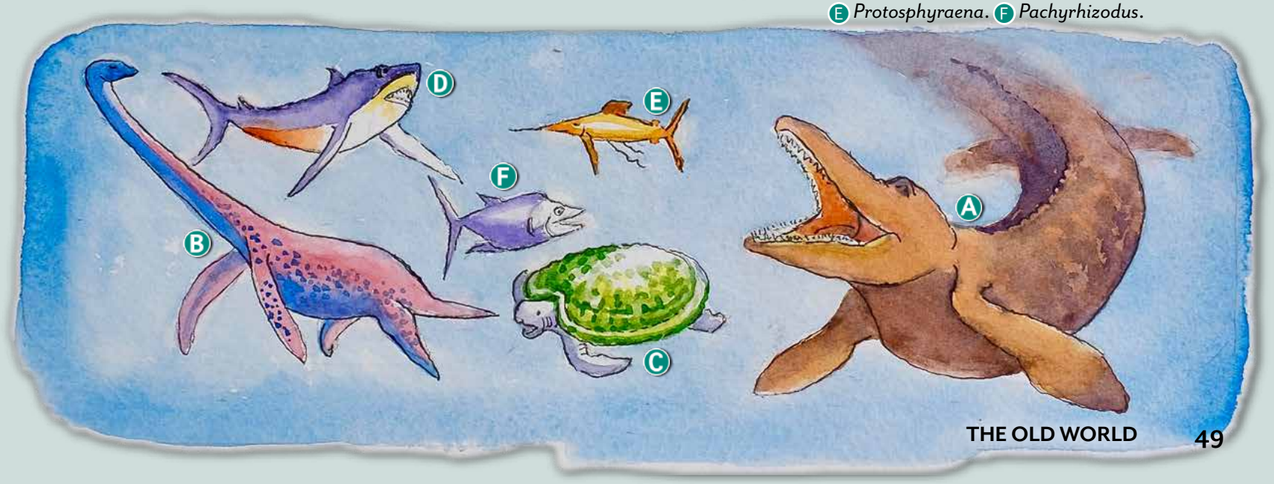


▲ The Triassic marine reptile biome:
A *Mixosaurus*. B *Placodus*. C *Lariosaurus*. D *Saurichthys*.



▲ The Jurassic marine reptile biome:
A *Stenopterygius*. B *Steneosaurus*. C *Plesiosaurus*.
D *Squalicorax*. E *Lepidotes*

▼ The Cretaceous marine reptile biome:
A *Tylosaurus*. B *Elasmosaurus*. C *Archelon*. D *Squalicorax*.
E *Protosphyraena*. F *Pachyrhizodus*.



EDEN AND ITS SURROUNDINGS

There must have been at least one other biome before the Flood—one in which most of the mammals and birds lived alongside humans. The dominant plants in this biome were probably angiosperms (flowering plants).

For reasons we will explore later, this biome seems to be entirely missing from Flood sediments. This means that we must speculate to a considerable degree about what this biome and its inhabitants were like.

We can get some clues about this biome from the Bible's description of the Garden of Eden and its surroundings. Genesis 2:10-14 tells us that a river ran out of Eden and split into four rivers that ran into four different countries. This suggests that Eden was at a higher elevation than the lands surrounding it.

Making the reasonable assumption that the humans were living in a biome centered around Eden, it seems likely that this was an upland ecosystem.

Furthermore, the river in Eden may have been fed by a spring bringing water from below the ground. Genesis 2:6 refers to a mist that came up to water the ground. Although the precise nature of this mist is not clear, the use of the same word in languages similar to biblical Hebrew suggests that it may have been a flowing spring of some kind.

Perhaps this biome was located right on top of one of the "fountains of the great deep" that broke open at the beginning of the Flood (Genesis 7:11).

We can also infer that humans living in this biome had an advanced culture. The Bible tells us that before the Flood, humans were farming arable crops and livestock (Genesis 4:2), building cities (Genesis 4:17), composing music, and working with metals (Genesis 4:19-22).

The next section of the book will look at the destruction of these biomes in the worldwide catastrophe of Noah's Flood.

This biome and its inhabitants were not preserved in Flood rocks, so we have reconstructed them here based on clues from the Bible and the earliest post-Flood fossil record:

- A Humans (based on early *Homo* from the Plio-Pleistocene).
- B Lemur (based on *Plesiadapis* from the Eocene).
- C Ape (based on *Aegyptopithecus* from the Eocene-Oligocene).
- D Raoellid (based on *Indohyus* from the Eocene).
- E Pantolestid (based on *Buxolestes* from the Eocene).
- F Mesonychid (based on *Dissacus* from the Paleocene-Eocene).
- G Dog (based on *Hesperocyon* from the Eocene-Oligocene).
- H Heron (based on *Zeltornis* from the Miocene).
- I Kingfisher (based on *Primobucco* from the Eocene).
- J Songbird (based on *Resoviaornis* from the Oligocene).
- K Chalicothere (based on *Schizotherium* from the Eocene-Oligocene).
- L Hawk (based on *Milvoides* from the Eocene).