How Plants and Animals Have Changed Through the Geologic Eras

Summary: If we could enter a time machine and travel millions of years back in time, what would we see? Would the plants and animals be much the same as those now on earth? Has God's creation stayed the same? Certainly not!

Fossils, which give us a sampling of the life forms we would be likely to find, demonstrate that the variety of living creatures today is vastly different than the types of creatures that lived when Paleozoic strata were being deposited. Most of today's common animals are not represented in fossils of that era, and most Paleozoic plants and animals are now extinct. Many of them are not even similar to anything living today. Biological variety has changed considerably through the eras.

Individual types of organisms are also different. The skeletons of modern fish, for example, are often considerably different than the fish fossils of the Mesozoic strata. A few types have remained much the same, but the morphology of most types has changed through the eras.[1] In this article, Dick Burky describes changes in plants and marine animals.

The geologic record gives us a fascinating glimpse into the history of the earth and the forms of life that have lived on it. This information is not available to us from any other source.

In previous articles we corrected two misconceptions about the geologic record. First, the geologic strata were not produced by catastrophic worldwide floods.[2] Rather, they were usually deposited over extended periods of time. The existence of long geologic time periods can be proven by mechanical, chemical and biological processes that occurred before, during and after the deposition of the strata.

Second, geologic strata actually lie on top of one another, and the layers indicate relative age — the bottom layers are much older than layers near the top. This is especially obvious in the Grand Canyon, where a large sequence of layers is exposed.

Radiometric dating techniques, which measure elapsed time based on the uniform rate of disintegration of radioactive elements, confirm that the time involved is very long. These methods also give quantitative estimates of the time involved.[3]

Different strata, different environments

We will now examine a few variations witnessed in living organisms from one geological time to subsequent times. As in the past article, we will use the

[1] Fish of the Mesozoic era were considerably different than fish that live today. But that does not mean that ancient forms *evolved* into modern forms. *Evolution*, as the word is commonly used, implies genetic connections through the eras and a gradual development caused by survival of the fittest. However, it cannot be proven that there has been any genetic connection between similar forms of different ages. The fossils reveal differences and similarities, but the fossils do not reveal whether or how one form is associated with similar forms of later eras. Evolution is an interpretation of the evidence. We reject that interpretation, but we cannot reject the evidence. Our beliefs lead us to interpret the evidence in a nonevolutionary way.

[2] Some layers of bedded rocks may have been deposited by floods, but certainly not the majority of strata.

[3] Radiometric estimates of age may seem to be simpler reference points than geologic formation names. However, all strata do not have rocks that lend themselves to radiometric dating and thus have to be dated by extrapolation from datable rocks that lie above or below them. To avoid the complexities and questions involved with radiometric dates I feel it is better and more straightforward to use the actual formation names. This allows the reader the tangible realization that he can consult a geologic map and find the actual body of rock strata being described. Though the multiplicity of names may make it seem more complex, it is really simpler. There are no theoretical or hypothetical adjustments that need to be made in fitting the facts to reality. Radiometric dating and the ages of the Colorado Plateau strata may be covered as a separate topic in a future article.

fossils found in strata of the Colorado Plateau as a basis for our discussion, since this area gives us a simple and direct correspondence between vertical sequence and chronological sequence.[4]

By comparing the plant and animal fossils of a sequence of geologic layers in the Colorado Plateau, we can get a picture of how plants and animals changed over the millions of years.

Individual strata are usually deposited in a single environment — for example, marine, desert, delta, swamp, etc.[5] The vast majority of fossils in each layer are from one type of environment. The earth, however, is made of many different environments, each containing a different mix of plants and animals. We cannot expect to find fossils of all animals alive on the earth at one time in any one strata.

In a stratum dominated by fossils of clams, for example, we would not expect to find fossils of mice, though it is of course remotely possible. If we are examining fossils deposited in an ancient desert, we do not expect to find ocean-dwelling animals.

Each stratum gives us only a geographically, environmentally and chronologically isolated segment of life on earth. It is only a partial picture of what was happening worldwide. This concept is simple enough, but sometimes we can forget it when we ask what type of organisms lived on earth when a certain stratum was deposited. Our knowledge is limited by the circumstances of the strata.[6] Fortunately, the Colorado Plateau strata contain enough of a variety of fossils to confirm the general pattern of plant and animal life throughout the geologic eras.

Fossil organisms found in Colorado Plateau strata

Figure 1, on the next page, lists the general type of fossils found in the strata of the Colorado Plateau. The names of the strata are on the left side of the chart. The larger geologic time periods to which they belong are also shown.[7] The list of organisms for each stratum is representative — certainly not exhaustive.

A close examination of Figure 1 reveals that the type of fossils found in succeeding strata indicates many changes in type of depositional environment. Ocean-living organisms are deposited in layers completely separate from those that occur in continental environments — environments that occur on land rather than in water.

Examples of continental environments are deserts with windblown sand and sediments, river floodplains and lake sediments. Of course, river deltas, lagoons and mud flats that border an ocean often contain a mixture of continental and marine fossils.

Separation of environments also explains why we can't expect to find a continuation of each line of organism in all the overlying strata. This separation of environments is additional evidence that geologic strata are not the result of one or two worldwide floods. Such floods would have mixed material from all environments and buried them together.

We will now more specifically examine the type of fossil organisms that are found in the strata.

Algae

Algae are the first life forms we encounter in the oldest, deepest strata of the Colorado Plateau. We do not necessarily find fossils of the actual algae — what we find are the limestone structures that algae build. These structures show little change with time. Throughout the geologic record, and continuing even today, algae are still depositing limestone in a manner similar to that found in the earliest rock strata in the bottom of the Grand Canyon.

This *lack* of significant change, which we also find in a few other plant and animal types, illustrates a dichotomy in the history of life on earth. Most fossil organisms were considerably different from their modern counterparts, or they became extinct with no modern counterparts. A few have changed hardly at all; they are known as "living fossils."

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[4] Thus we do not have to deal with the complicated issue of correlating disconnected strata in widely separated geographic areas.

[5] Some strata do contain mixed environments, such as those produced in river deltas, which contain both aquatic organisms and terrestrial organisms washed into the river.

[6] It is also good to remember that very few organisms are ever preserved as fossils. Most simply die and decay, and there is no enduring record of their existence.

[7] If there is a question of how we know these strata are in this order, please refer to the previous article, "An Overview of the Geologic Record," in the September-October 1990 *Reviews*.

FOSSIL ORGANISMS FOUND IN COLORADO PLATEAU STRATA

	GEOLOGIC FORMATIONS	FOSSILS
CENOZOIC	GLACIAL DEP.	BISON
	BROWN'S PARK	
	DUCHESNE RIVER	EARLY MAMMALS (CARNIVORES, HERBIVORES, RODENTS AND INSECTIVORES), FISH, TURTLES, CROCODILES, LIZARDS
	UINTA	
	GREEN RIVER	EARLY MAMMALS, FRESH WATER SNAILS AND CLAMS, MANY FISH, ALGAL LIMESTONE STRUCTURES, ABUNDANT FLY LARVA, INSECTS (MOSQUITOES, BEETLES, ANTS, FLIES, BEES), LIZARDS, TURTLES, CROCODILES, OSTRACODES, LEAVES
	COLTON	EARLY MAMMALS AND "HORSES" (PHENOCODUS, CORYPHODON, "EOHIPPUS")
	FLAGSTAFF	FRESH WATER SNAILS AND CLAMS
	NORTH HORN	UPPER STRATA - EARLY MAMMALS LOWER STRATA - LAST OF THE DINOSAURS
MESOZOIC	PRICE RIVER	
	BLACKHAWK	DINOSAUR TRACKS, COAL BEDS, LEAVES (FIG, WILLOW, SEQUOIA)
	STAR POINT	
	MANCOS	SNAILS, CLAMS, OYSTERS, SHARK TEETH, FISH SCALES, CEPHALOPODS, FORAMINIFERA, OSTRACODES, COAL BEDS
	DAKOTA	500+ SPECIES OF PLANTS, INCLUDING FIG, OAK, WILLOW, PALM, SASSAFRAS, POPLAR
	CEDAR MT.	PETRIFIED WOOD
	MORRISON	FIRST MAMMALS, MANY DINOSAURS, CROCODILES, TURTLES, SNAILS, FRESH WATER CLAMS
	SUMMERVILLE	
	CURTIS	CORAL, SQUID-LIKE ANIMALS
	ENTRADA	
	CARMEL	OYSTERS, CLAMS, SNAILS, CRINOIDS
	NAVAJO	DINOSAUR TRACKS
	KAYENTA	CLAMS, DINOSAUR TRACKS (RARE)
	MOENAVE	EARLY CROCODILES
	WINGATE	
	CHINLE	FIRST DINOSAURS, EXTINCT LARGE AMPHIBIANS AND REPTILES, EARLY BONY FISH, SNAILS, CLAMS, INSECTS, MANY PLANTS AND LARGE TREES
	MOENKOPI	EXTINCT AMPHIBIANS, COELACANTHS, SNAILS, CLAMS, SEA URCHINS, CEPHALOPODS, OSTRACODES
PALEOZOIC	KAIBAB	EARLY SHARKS, SNAILS, CLAMS, SPONGES, CORALS, SEA URCHINS, TRILOBITES, CRINOIDS, BRYZOANS, BRACHIOPODS, CEPHALOPODS, FORAMINIFERS, OSTRACODES
	TOROWEAP	
	COCONINO	ANIMAL TRACKS (20 VARIETIES), INSECT TRAILS —— NO ACTUAL FOSSILS FOUND
	HERMIT	PLANTS (SEED FERNS), ANIMAL TRACKS, INSECTS
	SUPAI	BARREN OF FOSSILS IN THE GRAND CANYON AREA
	REDWALL	SNAILS, CLAMS, EARLY SHARKS, CORAL, SEA CUCUMBERS, TRILOBITES, ALGAE, BRYOZOANS, BRACHIOPODS, CRINOIDS, BLASTOIDS, SPONGES, CEPHALOPODS, FORAMINIFERS, OSTRACODES
	TEMPLE BUTTE	PRIMITIVE ARMORED FISH, ALGAL LIMESTONE STRUCTURES
	MUAV	TRILOBITES, SNAILS, SPONGES, BRACHIOPODS (MARINE SHELLFISH, MOSTLY EXTINCT), EARLY CRUSTACEANS, CYSTOIDS
	BRIGHT ANGEL	
	TAPEATS	
PRECAMBRIAN	CHUAR GROUP	ALGAL LIMESTONE STRUCTURES, SOME FOSSILS OF UNCERTAIN IDENTITY
	DOX	
	SHINUMO	
	HAKATAI	
	BASS	ALGAL LIMESTONE STRUCTURES
	VISHNU	NO FOSSILS

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Figure 1. A general list of fossil organisms found in the strata of the Colorado Plateau. Careful comparison of the types of organisms found in each formation will indicate both depositional environment changes and long-term changes in the types of animals living in similar environments.

A few organisms even seem to degenerate and retrogress in design and function with time. The details of the story are far more complex than we may have hoped, yet there are some generalizations and major trends that are quite clear.

Trilobites

Near the bottom of Figure 1 we encounter a fossil almost everyone has heard of, the trilobite. Trilobites are marine bottom-dwellers that first show up in this area in the strata of the Tapeats Formation. They are found in most of the overlying marine layers until the top of the Kaibab Formation, which is the last time trilobite fossils are found, even though there are many overlying marine fossil layers.

Some creationists have stated that trilobites are found in deeper layers because of "density sorting" by flood waters. The idea is that trilobites were buried in lower layers because they are bottom dwellers and, being heavier than other animals, sank into the sediments of the flood waters faster than other organisms.

However, consider how many overlying strata contain fossil clams. Clam shells are far denser and heavier than trilobites. If the creationists' theory were valid, all the clams would be deposited with or below the trilobites. This is far from true, as we can see in Figure 1.

Clams occur throughout the strata, even in some near the top of the chart.[8] The creationists' density-sorting concept is completely invalid.

Figure 2 gives a sampling of a few of the many different types of trilobites.

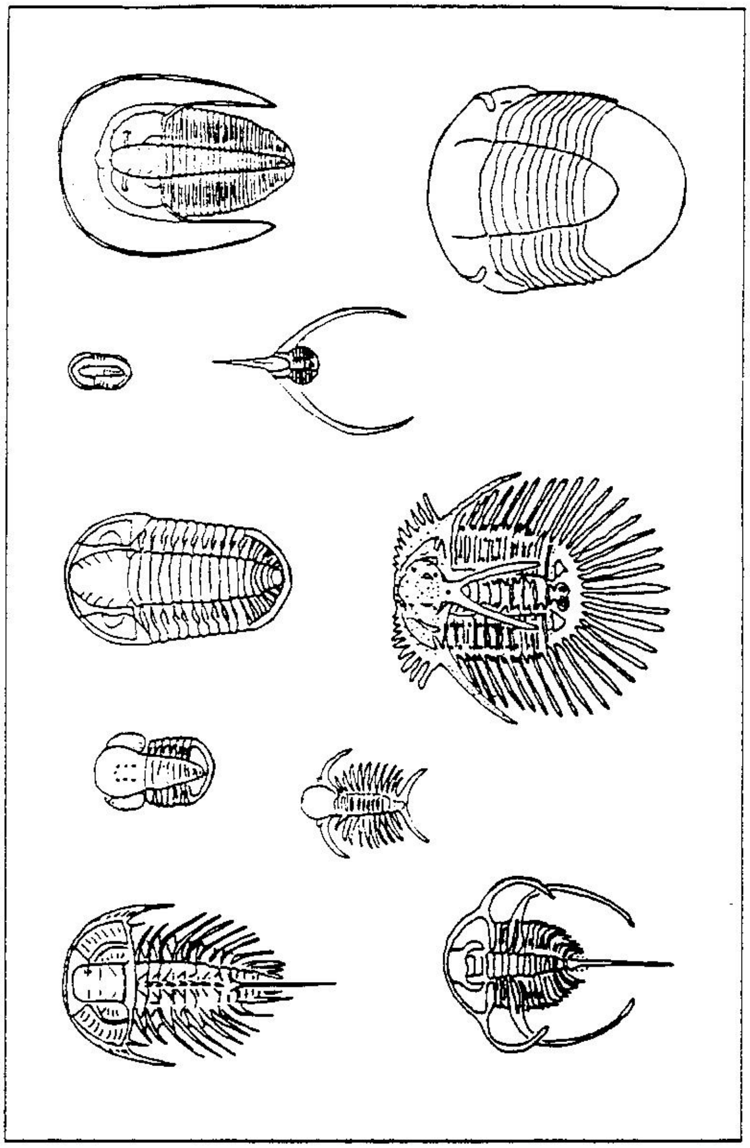

Figure 2. Trilobites. These are a few of the vast variety of trilobite fossils. Trilobites ranged in size from 1/4 inch up to 30 inches. (Redrawn from various sources; not to scale.)

Other marine life

Sea life has been fossilized in marine strata throughout the record. It is abundant in both variety and quantity.[9] Most modern forms of marine organisms are considerably different from the types found in the lower strata listed in Figure 1. Many of the early forms are long since extinct. Only two instructive examples of changes in marine animals will be men-

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[8] Rocks are even denser than clams. If the density-sorting concept were true, all the rocks would be deposited in the lowest strata. It is definitely not true.

[9] There are brachiopods (shellfish that look somewhat like a clam), pelecypods (clams), gastropods (snails), crinoids, sponges, corals, cephalopods (similar to the living *Nautilus* and squid), foraminiferans (one-celled animals with shells, usually microscopic), bryzoans, ostracodes, etc.

tioned: the brachiopod *Lingulella* and the ammonite group.[10]

The brachiopod *Lingulella* found in the Bright Angel Formation at the bottom of the Grand Canyon is quite similar to brachiopods (*Lingula*) that are currently dug for food along the Japanese coastline. This organism has changed very little in design throughout an incredibly long period of time.

But most types of organisms have changed substantially, if not dramatically, from the time they first occur in the fossil record.

An excellent example of rapid change is found in the ammonites, members of the cephalopod group. These marine organisms, similar to the modern *Nautilus,* looked much like giant snails. They lived in the oceans worldwide and were common during the time of the dinosaurs.[11]

The ammonites became prominent in the seas before the dinosaurs began to dominate the land. The whole group multiplied rapidly and spread widely before coming to an abrupt end along with the dinosaurs, suffering total extinction.

To my knowledge, the first stratigraphic level in the Colorado Plateau that contains ammonites is the Moenkopi Formation.[12] Ammonites are common in the Curtis Formation and are especially numerous in the Mancos.

Figure 3 shows a few of the many types of ammonites.

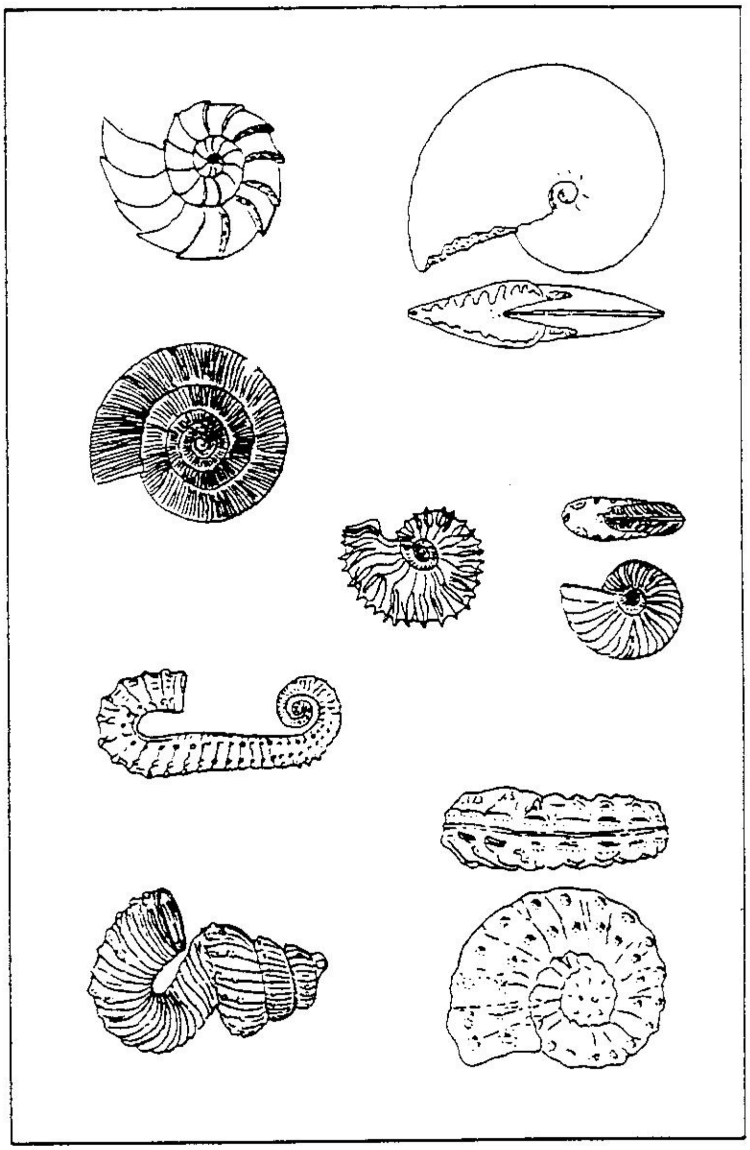

Figure 3. Ammonites. A few examples of typical and atypical (the partly "uncoiled" forms) ammonites from various geographical areas. (Redrawn from various sources; not to scale.)

Fossil plants

The fossil land plants show a considerable change as we progress upward through the strata of our study area. These changes are shown in Figure 4, on the next page.

The first significant land plants are encountered in the Supai Formation. Though the plant fossils in this formation are poorly preserved and fragmentary, they represent types of plants that are well preserved in abundance in the coal beds in other parts of the world.

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[10] Most marine fossils involve technical descriptions and obscure organisms that many readers do not know and may have difficulty relating to. It seems better to devote most of our time to examining the history of organisms that are more familiar to our readers.

[11] The ammonites ranged in size from a diameter of less than an inch up to 6 feet! They are grouped into more than 300 genera and thousands of species. One could spend a lifetime studying only the ammonites!

[12] They are known to occur in earlier strata elsewhere in the world.

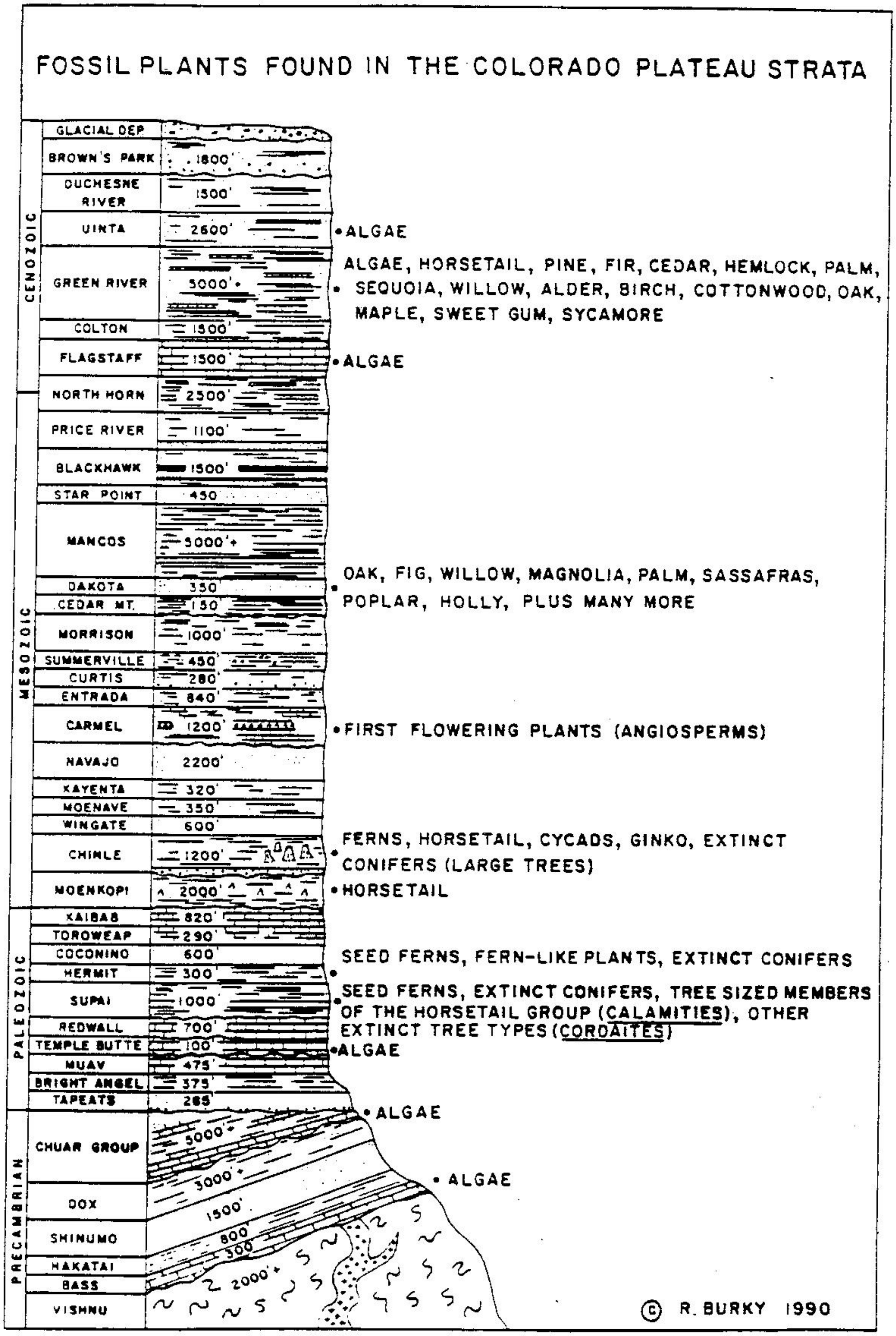

Figure 4. Fossil plants in the strata of the Colorado Plateau illustrate a dramatic change in the type of flora between earlier and later geologic time periods.

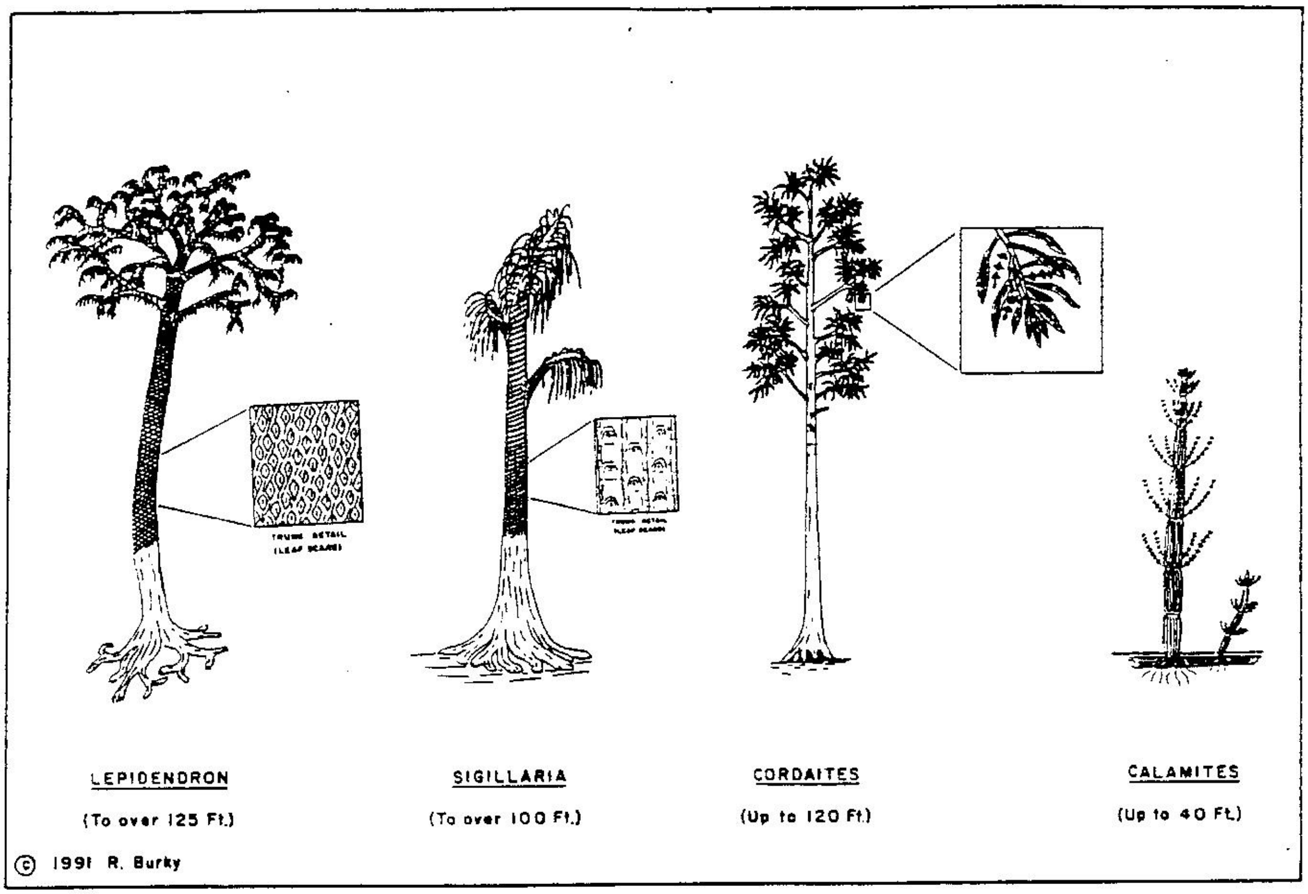

Figure 5. The four most common tree-sized plants in ancient coal beds worldwide. All are now extinct. The right two occur in the Supai Formation of the Colorado Plateau strata.

Figure 5 contains illustrations of four large plants that commonly occur in coal beds formed during a time roughly equivalent to the deposition of the Redwall and Supai Formations. In the Colorado Plateau, *Cordaites* and *Calamites* are found as fossils in the Supai Formation.

Notice how different all four plants are from any modern plants. Only *Calamites* is of a type represented by modern plants, the horsetails. Modern horsetails, however, grow only a few feet tall and have stems the size of a pencil. *Calamites* grew up to 40 feet tall and had a trunk nearly a foot in diameter. All these plants had large trunk cores made of pith, totally unlike the wood of modern trees.

The Hermit Formation contains a notable collection of fossil plants. These include fern-like plants, seed ferns and extinct conifers, but do not include *Cordaites* or *Calamites*. The conifers were "cone bearers," but they were not similar to the pines, firs and spruces we are familiar with today.

The flowering plants, the angiosperms, prevalent today, have never been found as fossils at this time, neither in the Supai, nor in the coal beds of equivalent age in the rest of the world.

In other geographic locations land plants are found as fossils much earlier than they are in the Colorado Plateau strata. Nearly all the previous strata in our study area are marine. We would not expect to find land plant fossils in a marine environment.

In the Moenkopi Formation are a few fossils of "horsetails" — plants much like the modern genus *Equisetum*, somewhat like the previously mentioned *Calamites*.[13] Horsetails are common fossils from this time forward.

The Chinle Formation contains abundant remains of fossil plants. Its strata are exposed in Petrified

[13] The modern horsetails are also known as scouring rushes because the pioneers in America used them to scour pots and pans. Their tough, abrasive stems are durable, which is why they are often found as fossils.

Forest National Park in Arizona. Petrified wood and remnants of other plants are found at many locations in the Chinle. Impressive huge logs preserved in the National Park represent several species of conifers that are similar to some obscure forms living today.

In all, 50 or more species of plants are found in the Chinle. These include fungi, conifers, ginkos (another ancient line with modern representatives), horsetails, cycads and others, but still *not* the flowering plants, the angiosperms.

Fossils of flowering plants, the angiosperms, are first found in a formation deposited about the same time as the Carmel Formation.[14] By the time of the Dakota Formation, angiosperms were abundant. Many trees and plants that you would recognize were present — such as oak, fig, willow, palm, sassafras, poplar and holly. During this time the dinosaurs were the most prevalent land animals and would continue to be for some time to come. Early mammals were present, but they were small in both size and number.

Plant fossils are found in many of the formations overlying the Dakota. They are abundant in the Blackhawk, where they form extensive, commercially exploited coal beds. The Green River Formation is especially well known for its fossil flora. These are predominately flowering plants. Many of them, perhaps most, we would recognize as modern plants.[15]

The Green River strata were deposited after the demise of the dinosaurs but still a very long time ago. Mammals were the prevalent land animals. However, these were not the type of mammals you and I are familiar with. They are types long since extinct.

I will briefly summarize what we have witnessed in the fossil algae and plants. Algae are the oldest; they lived throughout every level of the fossil record and continue to have living representatives thriving today.

The earliest land plants found in the Colorado Plateau strata are now extinct, though a few have similar types living today. A little later in the fossil record we find the living-fossil plants, including the ginkos, horsetails and cycads. However, these examples of long-lived types are the exceptions in the record, not the rule.

Angiosperms, the flowering plants, show up in the record during the later times of the dinosaurs. They soon become the dominant type of plant throughout the rest of the fossil record and in the modern landscape. There is a definite progression in the type and design of the flora as we move upward through the strata of the Colorado Plateau.

Changes observed in fossil fish

Another familiar group of organisms that clearly shows a significant pattern of change is the fish. To illustrate these changes, specific examples are shown in Figure 6, on the next page.

The first fossils of fish are found in the Temple Butte Formation, which lies fairly low in the Grand Canyon.[16] These fish are nothing like the kind you would pull out of a modern stream, lake or even the ocean. They belong to a class of fish known as placoderms or "armor skinned" fish.

The chief characteristic of this group is the bony armor plates that cover a major portion of their body, especially the head. They lack an internal bony skeleton, which is present in most modern fish. The placoderms' body support was more like that of an insect (having an exoskeleton) than like a modern fish. Their fins do not have bony spines for support. Their tails are decidedly asymmetrical.

There were many varieties of placoderms, but they were all extinct by the time the Redwall Formation was deposited.[17] The genus of the type found in the Temple Butte is *Bothriolepis;* an illustration is at the bottom of Figure 6.

Figure 7, on the page after the next, shows five other fish that lived about the same time as *Bothriolepis.* They are from other geographic areas, mostly Europe. These fish give a good feel for the type of

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[14] Some scientists feel they have found the earliest evidence of flowering plants in a formation in central Utah called the Arapien Shale. It was deposited about the same time as the Carmel Formation shown on our chart. Whether fossils of the first true angiosperms are in the Arapien Shale is not significant for us. What is significant is that they begin to show up as fossils *about* this time.

[15] The varieties found include pine, alder, fir, birch, cedar, hemlock, maple, sweet gum, sequoia, oak, sycamore, cottonwood, willow and many others.

[16] Fossils of these fish are found around the world in strata of similar age and position in the record. Notable localities for them are in Britain and eastern Canada.

[17] They have been extinct — based on radiometric dating — for nearly 300 million years.

design that was prevalent during that geologic period. We have absolutely nothing like these fish alive today.

Some fish fossils are in the Moenkopi Formation, but they are generally so poorly preserved that identification is difficult. However, the overlying Chinle provides a clearer picture of the freshwater fish of that time period, considerably later than the time the Temple Butte was deposited.

The fish of the Chinle are also illustrated in the center of Figure 6. Their design might be considered somewhat intermediate to modern fish. They had bony supports or "rays" in their fins to give them more strength. They had a bony skeleton, but most did not have a fully ossified backbone.

The scales were generally thicker and rhomboid in shape, more like those found in earlier fish. The scales were made of layers of bone, covered with a material like tooth enamel. The tail's exterior appearance was more symmetrical, but the internal bone structure was still asymmetrical. Earlier forms had functioning lungs; Chinle and later fish had air bladders. A fossil lungfish in the Chinle is quite similar to a modern living-fossil lungfish in Australia.

Another living-fossil fish found in the Chinle is the well-publicized coelacanth. It was thought to have been extinct since dinosaur times until a fishing boat brought one in from the waters east of Africa in the 1930s. Please keep in mind, though, that the living fossils are the exceptions, not the rule. They get more publicity because they are exceptional rather than ordinary. The majority of fish from the Chinle are now extinct, intermediate in design when compared to the earliest fish and modern fish.

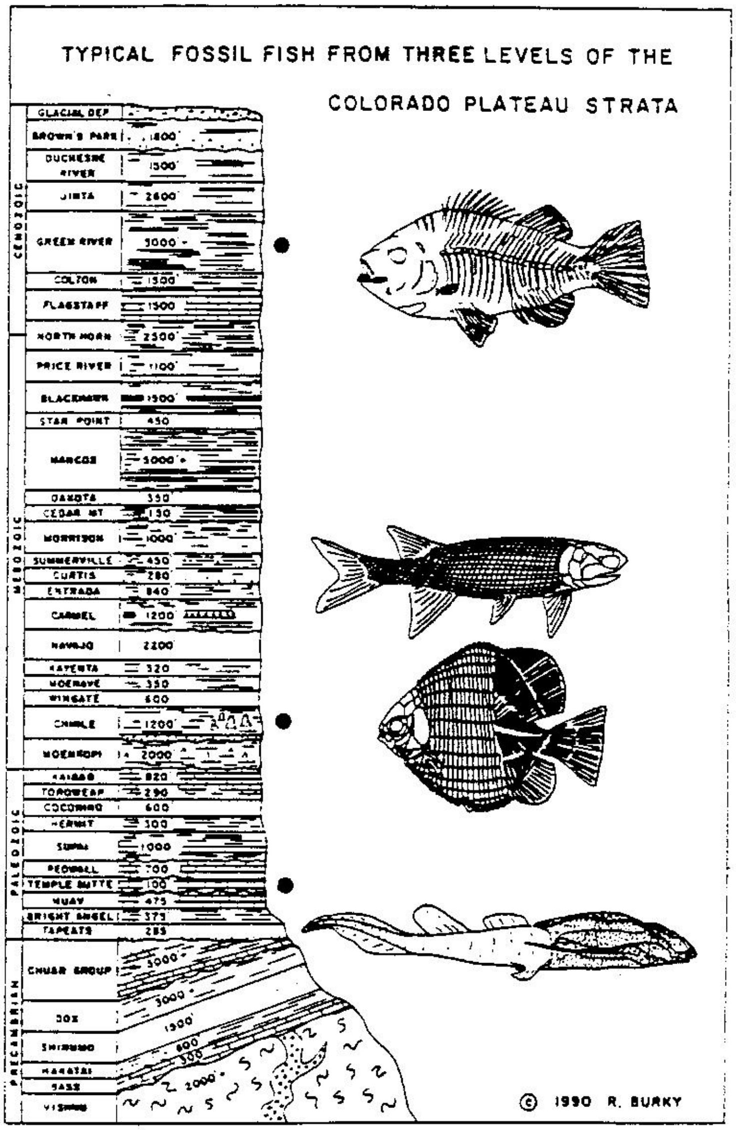

Figure 6. Typical fossil fish found at three stratigraphic levels. They are significantly different in design, representing primitive, intermediate and modern stages. The differences between these stages are explained in the text.

The Green River Formation, famous for its fossil fish, has fish that are quite modern in design and appearance. Their skeletons are fully ossified (composed fully of hard bone rather than being part of cartilage). Their scales are rounded in shape, made of a thin, light bony material. Their tails are symmetrical in both internal structure and exterior appearance. The fish illustrated near the top of Figure 6 is just one of many that could have been used as a sample to show the modern design typical of the fish of that time.

The history of fish is much more complex than shown in Figure 6. However, this sequence of forms represents the general changes that took place in the fish group. The fish fossils in the Colorado Plateau strata clearly reflect significant changes in design with time.

Summary

During the extensive time period taken to deposit the strata of the Colorado Plateau, life forms went through major changes.

In many cases that change was progressive in nature, as was shown by fish and plant fossils. In contrast to these, some few organisms, dubbed living fossils, experienced little or no change during the same time period. Their original design was one that remained viable and successful. Modern representatives of these organisms are alive today. Other organisms were simply allowed to go extinct and were eventually replaced with new organisms.

Changes in different types of organisms occurred throughout the geologic record, not just at a few junctures. The major changes made in the plants did not correspond in time period to the major changes in the fish or the land animals. The history is one of great complexity, not one of a few simplistic changes.

The next article will continue this topic. It will examine the changes that have occurred in the land animals. Then we will consider the possible meaning and importance this understanding gives us about how God has developed life forms we find on earth.

Richard Burky

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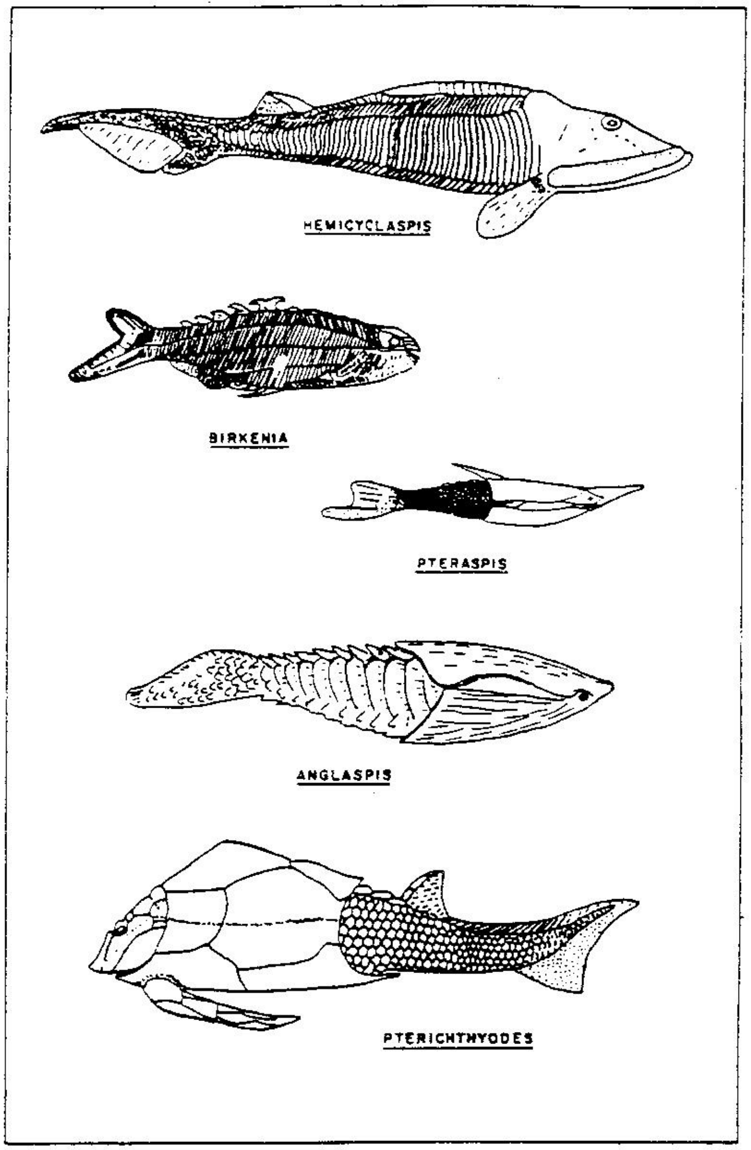

Figure 7. Early Fish. These fish were living in other parts of the world about the time the first fish appear in the Colorado Plateau strata. They range in size from two to eight inches. (Redrawn from various sources.)