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THE TRIASSIC PALEONTOLOGY OF GHOST RANCH

by

EDWIN H. COLBERT*

INTRODUCTION

Triassic fossils were scientifically recognized in northern New Mexico just a century ago when Edward Drinker Cope, the famous paleontologist and zoologist from Philadelphia, passed through this region in 1874 on a journey from Santa Fe to Tierra Amarilla. On this trip Cope picked up a few fossil reptilian bones in the vicinity of Gallina, where Upper Triassic sediments are exposed at the base of Cerro Blanco. In the hundred years since Cope's chance discovery various paleontologists have collected and studied Triassic fossils from northern New Mexico, to reveal a tetrapod assemblage of true significance for students dedicated to the study of organic evolution and the succession of vertebrate faunas during Mesozoic time. Much has been learned as a result of work during the past century on the Triassic vertebrates of the Southwest in general, and of New Mexico in particular. Much remains to be learned.

Three areas in northern New Mexico have yielded Triassic fossils: namely the slopes at the base of Cerro Blanco (already mentioned) a hogback immediately to the west of Capulin Mesa, as well as around the Mesa; the badlands at Ghost Ranch, and particularly the basal portions of the colorful cliffs which rise in spectacular splendor behind the ranch; and exposures in the vicinity of Lamy, to the south of Santa Fe. Our interest is in the first two of the areas listed, and especially in the sediments at Ghost Ranch.

COLLECTORS IN THE TRIASSIC

Cope's preliminary discoveries of 1874 have been mentioned. In 1881 David Baldwin, a professional collector, explored the Triassic beds around Capulin Mesa and at Ghost Ranch. At the time he was working for Cope (he had previously collected for Othniel Charles Marsh, Cope's bitter rival). And as a result of his efforts he obtained bones of a small Triassic dinosaur, described by Cope as *Coelophysis.*

Some 30 years later, in 1911, this region was explored jointly by Samuel Wendell Williston and Paul Miller of the University of Chicago, Ermin C. Case of the University of Michigan and Frederick von Huene of Tübingen University. However, the party was more concerned with the Permian vertebrates, to be found in the area near Coyote, than with Triassic fossils.

In the nineteen thirties the Triassic beds at Ghost Ranch were worked extensively by Charles Camp and Samuel Welles and their assistants, from the University of California at Berkeley. A fine series of phytosaurs was collected. During this time Llewellyn Price and Theodore White collected the armored thecodont reptile, *Typothorax,* for Harvard.

After the second world war E. H. Colbert and his associates opened a large quarry at Ghost Ranch, and excavated numerous articulated skeletons of the dinosaur, *Coelophysis.* This quarry has been subsequently worked.

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STRATIGRAPHIC RELATIONSHIPS

The Triassic in northern New Mexico, especially as it is exposed at Ghost Ranch and along the Rio Chama to the west, is composed of the Chinle Formation. The Chinle has been subdivided into several members, as follows:

	Petrified Forest Member
Chinle	Poleo Sandstone Member
Formation	Salitral Shale Tongue
	Agua Zarca Sandstone Member

These sediments, with a total thickness of 700 to 800 feet, are of continental origin. The Agua Zarca, up to 100 feet in thickness, consists of conglomeratic sandstones and siltstones. The Salitral, which also may be 100 feet thick, is a variegated shale with limestone concretions. The Poleo sandstone, a relatively thin member, no more than 60 feet in thickness, is nonetheless very resistant and topographically prominent. Most of the thickness of the Chinle Formation in this region is composed of the Petrified Forest Member, consisting of colorful red, brown and purple clays, siltstones and sandstones. These beds are made up, to a large degree, of intricately intertonguing lenses. (See also O'Sullivan, this issue, for a discussion of Triassic stratigraphy in the Ghost Ranch area.)

THE FOSSILS

Although fossils are known from the Agua Zarca, Poleo and Petrified Forest members, it is only in the last of these horizons that there is comprehensive paleontological evidence bearing upon the Late Triassic life of New Mexico. Fossil leaves and wood are locally common in the Agua Zarca, Poleo and Petrified Forest beds, with the ancient conifer, *Araucarioxylon* being perhaps the most characteristic plant. This is the tree so abundantly preserved in the Petrified Forest of Arizona, the type region for the Petrified Forest Member. *Araucarioxylon* is related to the modern arancarias, so typical of the Southern Hemisphere. The Poleo has yielded cycadeoids such as *Otozamites* and *Zamites,* and the cordaitalean, *Yuccites,* represented by strap-like leaves some two feet in length.

However, the bulk of the fossils in the Chinle Formation are found in the Petrified Forest Member. Besides plants there are fossil unionids—fresh-water clams—and fishes, amphibians and reptiles. The vertebrates are of particular significance, and to them we will now turn our attention.

THE CHINLE VERTEBRATES

The vertebrates of the Petrified Forest beds in northern New Mexico may be listed as follows.

Fishes—Ceratodus, a lungfish
Amphibians—Metoposaurus, a large labyrinthodont
Reptiles—Typothorax, a large, armored thecodont
Rutiodon, a large crocodile-like thecodont
Coelophysis, a saurischian dinosaur

Other fishes and reptiles are known from the Chinle Forma-

tion in Arizona and Utah and from the related Dockum beds in Texas and the Newark series in eastern North America, thus broadening our knowledge of Late Triassic life in North America. But our immediate concern is with the Upper Triassic vertebrates of northern New Mexico.

Fishes

The lungfish, *Ceratodus,* is represented by its very characteristic tooth-plates, which look something like combs with radiating ridges. These tooth plates show that the Triassic lungfish *Ceratodus* was closely related to the modern Australian lungfish, *Epiceratodus.* The Australian lungfish lives in rivers and lakes in Queensland. When the water inhabited by these modern lungfishes becomes stagnant during arid seasons, the lungfishes come to the surface to breathe air. There is every reason to think that the Triassic lungfishes led a similar mode of life, in a climate marked by seasonal periods of aridity.

Numerous primitive bony fishes are found in the Upper Triassic sediments in other parts of North America, and such fishes very likely inhabited the streams and lakes of Triassic New Mexico. But their fossils have not been found.

Amphibians

One amphibian is known from the Upper Triassic beds of New Mexico, as well as from other parts of the southwest. This is the gigantic labyrinthodont, *Metoposaurus,* the bones of which are among the most plentiful of Chinle fossils.

The labyrinthodont amphibians, so named because of the labyrinthine folds of the enamel in each tooth, were the first land-living vertebrates. They appeared at the end of Devonian times, and flourished from then until the end of the Triassic, when they became extinct. *Metoposaurus* was one of the last of the labyrinthodonts.

This was a giant among the amphibians, six to eight feet in length. The skull was inordinately large and remarkably flat, and was composed of heavy, dense bones, strongly corrugated on their upper surfaces. There were just five openings piercing the massive skull roof, the two nostrils, the two eyes and a median opening, the pineal (a sort of third "eye"), behind the eyes. The skull and the lower jaws were armed with numerous sharp, labyrinthine teeth, obviously well-adapted for catching fish. The shoulder girdle was also composed of heavy, corrugated bones (clavicles and interclavicle) but the rest of the skeleton was not so massively constructed. The vertebrae were short cylinders. The limbs were remarkably small and weak for so large an animal and there was obviously much cartilage in the skeleton.

It is doubtful whether *Metoposaurus* could walk on the land. Perhaps it could slither across mud flats. But it evidently lived a very successful life in the rivers and lakes of those days, where it existed in prodigious abundance.

Reptiles

Of the three Upper Triassic reptilian genera found in northern New Mexico, two, *Typothorax* and *Rutiodon,* are thecodonts, and one, *Coelophysis,* is a saurischian dinosaur. The thecodonts and dinosaurs are commonly grouped within a large subclass of reptiles known as archosaurs.

The archosaurs were and are advanced reptiles—in many respects representing the climax of reptilian evolution. The ancestral archosaurs were the thecodonts, essentially confined to the Triassic period. From the thecodonts there arose the two orders of dinosaurs, the Saurischia and Ornithischia, the flying reptiles or pterosaurs, and the crocodilians. The birds also had their origins from the thecodont reptiles, or perhaps from some of the dinosaurs.

The archosaurs anatomically were and are advanced reptiles, active and frequently aggressive. The skeleton generally shows adaptations for rapid and well-controlled movements; the skull commonly is lightly constructed, but very strong. The archosaurs were the rulers of Mesozoic continents, and the surviving crocodilians may be considered as very successful reptiles, giving way only in recent years to the onslaughts of Man, made terrifyingly lethal by modern firearms.

Typothorax was a large thecodont, eight or ten feet in length. It probably was an inoffensive herbivore, as indicated by the relatively small skull, short jaws, and weak teeth. It was completely encased by large, rectangular bony armor plates (these in life covered with horny sheaths), and such protection was necessary in a world inhabited by predatory carnivores.

Among these predators were the phytosaurs, of which the genus *Rutiodon* is typical. The phytosaurs were in effect the rulers of many lands during Late Triassic times. They lived before their cousins, the dinosaurs, had attained true giantism. In essence the phytosaurs were very similar to modern crocodiles in their adaptations, and obviously in their life style. They were large, (sometimes 20 to 30 feet in length), aquatic reptiles with elongated jaws armed with sharp teeth. Unlike the crocodiles, in which the nostrils are terminal, the phytosaurs had raised nostrils on top of the head, just in front of the eyes. And this was a most efficient breathing adaptation for such aquatic reptiles.

The dorsal nostrils in the phytosaurs are among many characters indicating that these Triassic reptiles were not ancestors, but rather predecessors of the crocodilians. The phytosaurs, very successful during Late Triassic times, became extinct, and then the crocodilians, evolving through the Jurassic to the present day, imitated the phytosaurs in a most uncanny way. It is a nice example of parallel evolution through time.

Coelophysis from Ghost Ranch was a small saurischian dinosaur belonging to the suborder Theropoda. (The theropods were the carnivorous dinosaurs, culminating during the Cretaceous period in the gigantic and well-known genus, *Tyrannosaurus).* This little theropod was about six to eight feet in length and was lightly built. The bones were hollow, like bird bones. *Coelophysis* walked on very bird-like hind limbs; the front limbs were small and served as grasping organs—like the fore-limbs of kangaroos. The body was pivoted at the pelvis and the tail was very long, to serve in part as a counter balance to the body. The neck was long and flexible; the skull was lightly built and the jaws were set with sharp, blade-like teeth.

Coelophysis obviously was a carnivore, but a carnivore that preyed upon small game. It must have been most agile, which would have been advantageous for the pursuit of small prey as well as for escape from the large, aggressive phytosaurs.

The quarry at Ghost Ranch has yielded numerous skeletons of *Coelophysis* of all ontogenetic ages—from newly hatched individuals to adults. Some of the adult skeletons contain within the rib cages the partial skeletons of juveniles—an indication that *Coelophysis* probably was prone to cannibalism, as indeed are some modern reptiles, such as crocodiles.

THE ECOLOGICAL PICTURE

Thus we have a glimpse, and only a glimpse, of life on the land in New Mexico during Late Triassic time. Our knowledge of the fauna is far from complete; there must have been a much greater variety of vertebrate life than is indicated by the incomplete sample now available.

Nonetheless the sample gives us some indication of Late Triassic ecology in this region. It was evidently a low-lying tropical land of many lakes and rivers. Coniferous forests covered the higher ground, while the edges of the waterways were fringed with ferns. There were times of rain and times of aridity.

Fishes lived in the lakes and streams, and were the prey of the large amphibians. The amphibians in turn were harassed by the giant phytosaurs—which also preyed upon the fishes. *Typothorax* wandered across higher ground, feeding upon plants. It also came down to the water, where its heavy armor offered some protection against the constantly aggressive phytosaurs. And on the high ground herds of *Coelophysis* ran across the land and through the undergrowth in search of small reptiles on which to feed. 177

CORRELATIONS

The combination of metoposaurs, phytosaurs and early theropod dinosaurs is characteristic of the Upper Triassic, not only in New Mexico but also in other parts of North America and in other continents as well. Indeed, metoposaurs and phytosaurs virtually identical with the Chinle forms are found in the Dockum beds of Texas, in the Popo Agie beds of Wyoming, in the Newark Series of the eastern seaboard, in the Keuper of central Germany and in the Maleri beds of peninsular India. Moreover, within recent years a small theropod dinosaur described as a new genus, *Syntarsus,* but remarkably like *Coelophysis,* has been found in the Forest Sandstone of Rhodesia, Africa.

So the several elements of the Chinle fauna represent far more than a local development of land-living animals. They are indeed part of a cosmopolitan fauna spread across a great ancient land mass. They offer paleontological evidence for a ligation between North America and Eurasia, before there was a North Atlantic Ocean, and furthermore, for the connection of a northern Laurasia to a southern Gondwanaland, of which Africa and peninsular India were components. They represent

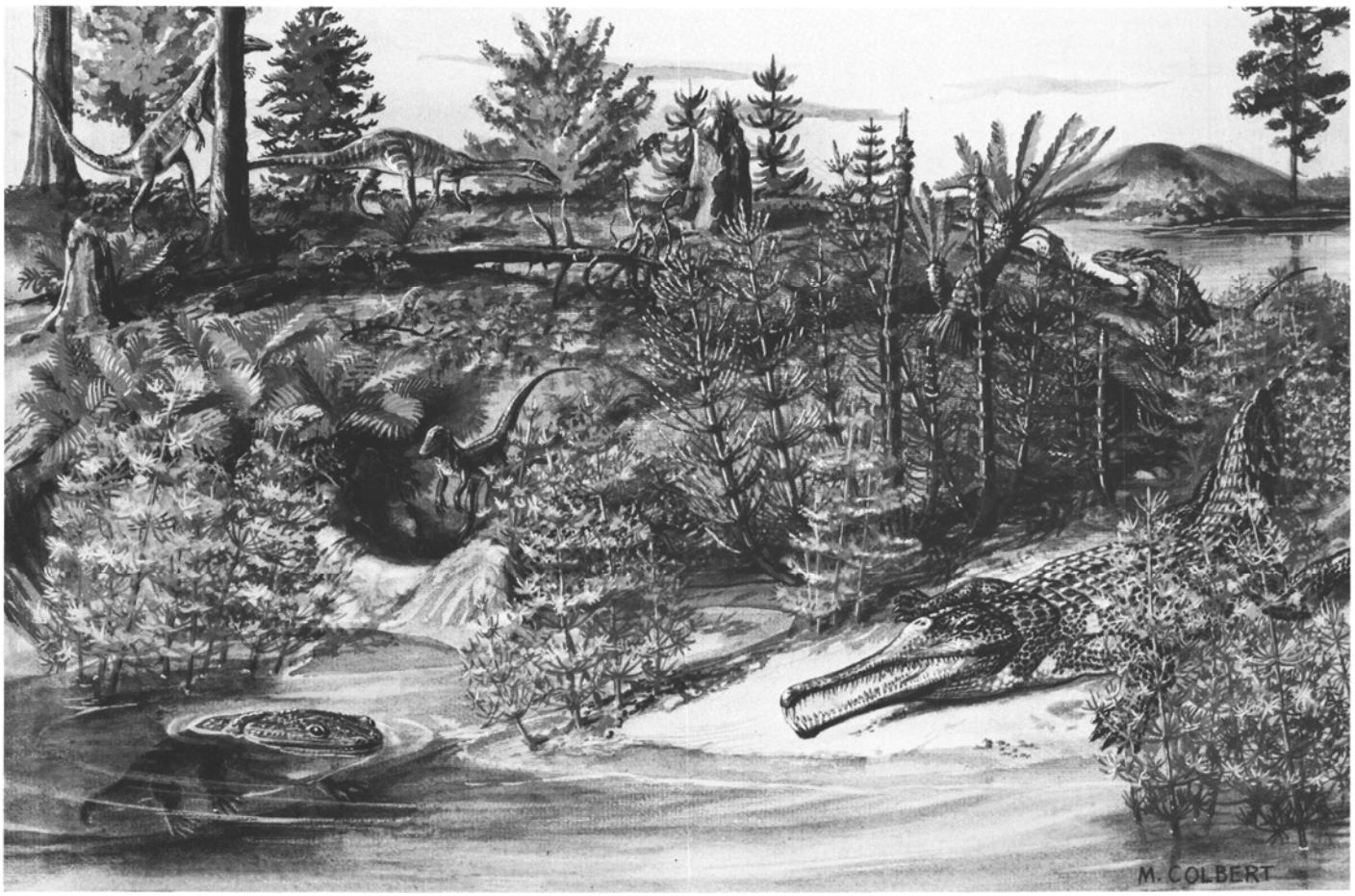

Figure 1. A Late Triassic scene in southwestern North America. The large conifers are Araucarioxylon. *In the foreground are giant horsetails,* Neocalamites, *and ferns. A gigantic phytosaur,* Rutiodon, *25 feet in length, is shown in the lower right portion of the picture; in the lower left is the labyrinthodont amphibian,* Metoposaurus. *Two theropod dinosaurs,* Coelophysis, *are seen in the upper left portion of the scene, while behind the phytosaur is an armored thecodont reptile. (The small reptile in the center of the picture is* Hesperosuchus, *a thecodont known from northern Arizona, but as yet not found in New Mexico). Illustration by Margaret Colbert. (From* The Age of Reptiles *by E. H. Colbert, London, Weidenfeld and Nicholson; and New York, W. W. Norton Company. Reproduced with permission of the publishers.)*

a mere fraction of what was once a wide-ranging association of terrestrial animals, living in a world of closely connected continents.

CONCLUSION

Thus, the Upper Triassic fossils of northern New Mexico have much to teach us. They show us what life was like in a small corner of the world, but beyond that, they show how this fragment of a faunal association can be linked to similar fragments in other lands, to afford us a glimpse of past life in a world far different from the world with which we are familiar.

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