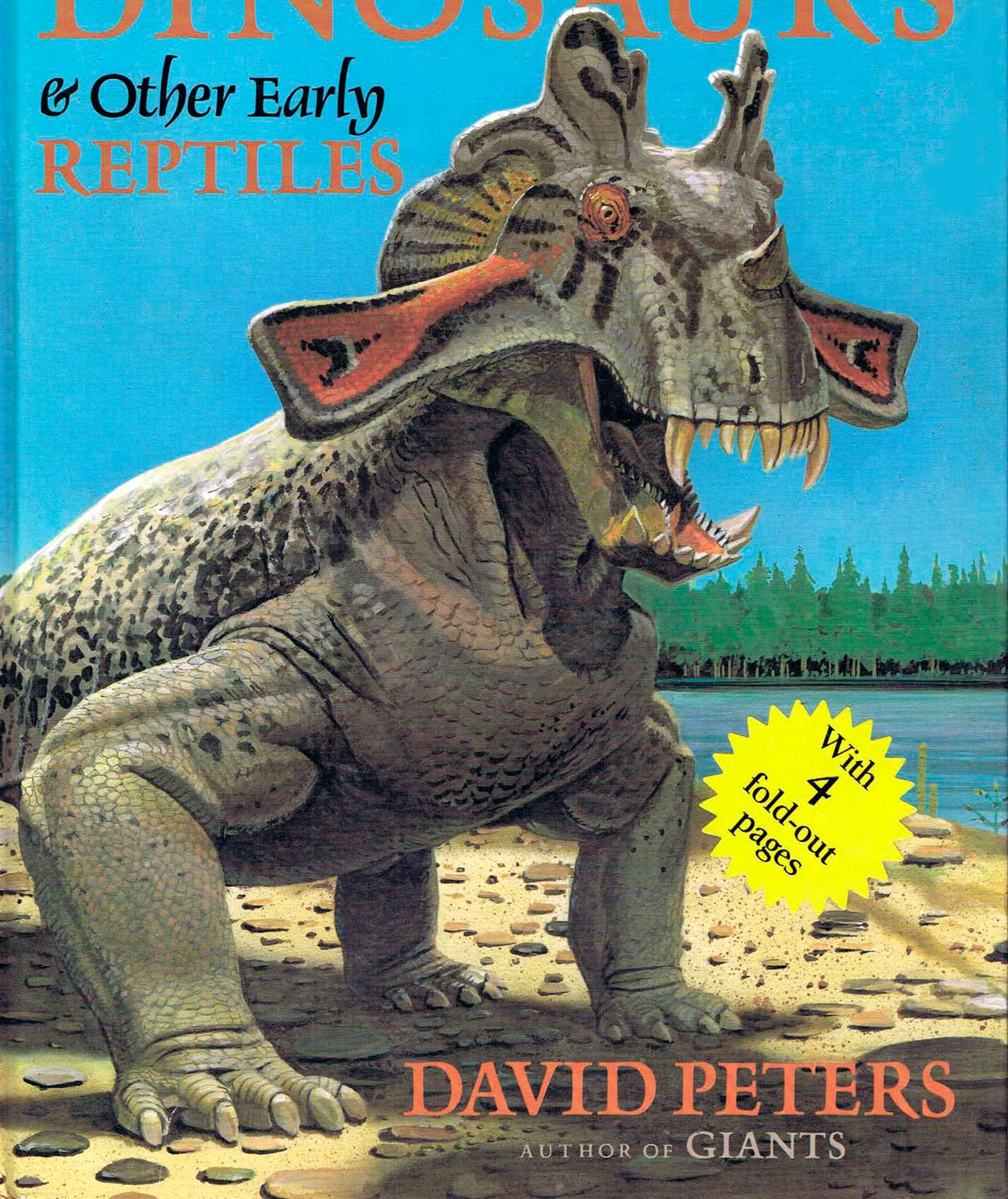
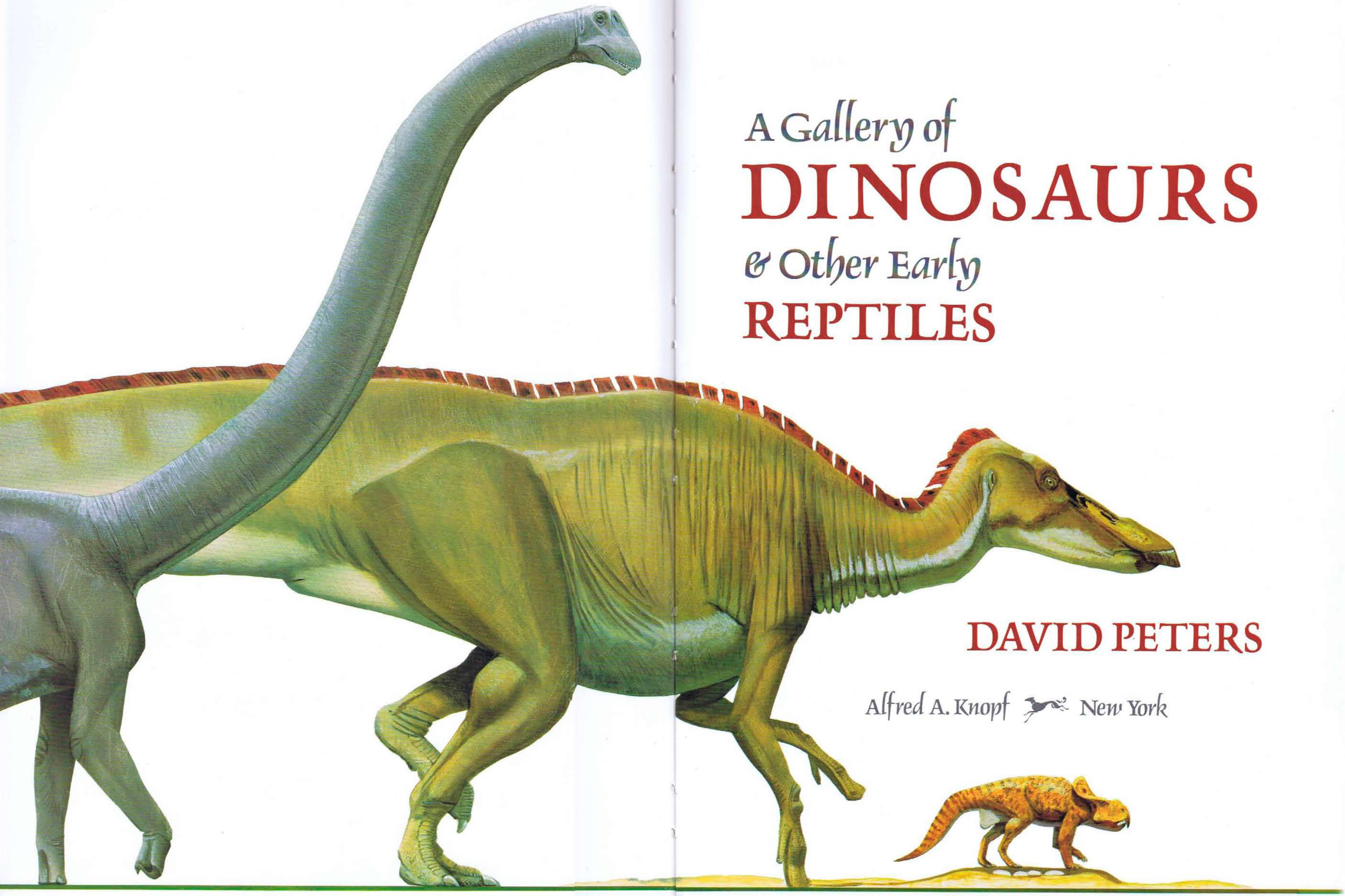
A Gallery of DINOSAURS & Other Early REPTILES



DAVID PETERS

AUTHOR OF GIANTS



A Gallery of

DINOSAURS

& Other Early

REPTILES

DAVID PETERS

Alfred A. Knopf New York

Dedicated to
my wife, Karen,
and my daughters, Stephanie and Ann,
who make coming upstairs
after a long day spent in the studio
such a joy

Sincere thanks are due the following, who either directly or indirectly contributed to this book:

The multitude of scientists who make discoveries in the field, in their labs, and in their cladograms, especially Dr. Kevin Padian, this book's scientific adviser.

The many artists/scientists who illustrate their findings so that nonscientists may understand, especially Mark Hallett, Greg Paul, Dr. Robert Bakker, Dr. Ken Carpenter, Doug Henderson, and Zdenek Burian.

The staff at Alfred A. Knopf, whose tireless efforts ultimately brought this book to print. Special thanks are due Jenny Fanelli, my editor, for her faith and guidance.

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Cover illustration: *Estemmenosuchus*

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Introduction

One hundred spectacular dinosaurs and other prehistoric reptiles march, fly, and swim through the pages of this book. Its portrait gallery format is designed for the casual, browsing reader who wants to know what these animals looked like, what sort of life they led, and how we know about them today. Though not intended to be a systematic introduction, the book relates the various family groups of reptiles to each other and includes some of the latest theories in this ever-changing field.

Dinosaurs dominate these pages, as they did the earth at one time, but they were by no means the only giant reptiles of long ago. The nondinosaurian reptiles, usually glossed over in most popular books, are given equal status here. Among the featured animals are the giants of each family along with a few smaller members and some other interesting varieties.

Clues to the Past

Fossils are the remains of prehistoric life, usually preserved in stone. We know about dinosaurs and such because we've found their fossil footprints, stomach contents, eggs, skin, and especially their bones and teeth. From these clues scientists can reconstruct not only an animal's size and shape but also the way it moved, what it ate, and how fast it grew.

The bones and teeth of most animals do not fossilize. Usually scavengers and bacteria destroy the remains. Occasionally, however, a carcass becomes buried under sediment (typically silt, sand, or volcanic dust) and is preserved long enough to form a fossil. In time, minerals seep through the sediment and convert the buried bones and teeth into stone. Although fossilization occurs only rarely, over millions of years it has happened often enough to give us an accurate picture of life in the past. A rich location can preserve many years' worth of living things within layer upon layer of rock.

The Evolution of Early Reptiles

Around 400 million years ago it seems there were predatory fish living in equatorial lakes that were poor in oxygen content and subject to periodic drought. These fish breathed with gills underwater and with simple lungs at the surface. They had two pairs of muscular fins and could have pulled themselves through the mud if their lakes evaporated and became too shallow to swim in. The fish were cold-blooded—their temperature rose and fell along with that of their surroundings.

Around 370 million years ago some descendants, known as amphibians, had sprawling limbs in place of fins. These cold-blooded animals walked like squirming fish and laid jellylike eggs in water. Hatchlings had gills and fins that disappeared as they matured.

Although most amphibians stayed in or near water, at least one small, agile, and scaly group lived continuously on land. Their young avoided the dangerous tadpole stage in the water and hatched fully formed on land. But there the eggs were in danger of drying out. When these animals began to lay eggs enveloped in a protective membrane and a hard or leathery shell, they became, by definition, reptiles.

About 300 million years ago dense, steamy tropical forests rose from certain swamps, while underwater, giant amphibians with huge gaping jaws waited for passing fish. Scurrying over fallen and decaying swamp-mired logs were the first reptiles. These small lizardlike creatures chased insects with rapid dashes and snapping jaws.

Aggressive, agile, and able to survive where no amphibian would venture, reptiles quickly evolved into a variety of scaly forms. From the start two main branches developed.

One branch, the synapsids, led by the pelycosaurs, developed a larger body size and larger jaws, which enabled them to eat larger prey such as other vertebrates. They and their descendants, the therapsids, dominated the scene for the next 50 million years. Some of these were the ancestors of all mammals.

The second main branch, the sauropsids, for the most part remained small and obscure lizardlike insect eaters while the pelycosaurs and therapsids reigned. Ultimately from among this second group emerged the lizards and their descendants, the snakes. As other sauropsids ventured into the earth's many different environments, some became fish-eating marine reptiles, some the plant-eating armored pareiasaurs, some the hard-shelled turtles, and some the long-legged archosaurs, or "ruling reptiles."

The Mesozoic Era, or Age of Reptiles, began about 245 million years ago with a catastrophe that cleared the earth of 95 percent of all the species that were living at the time. From among the few reptiles that survived, the archosaurs arose, ultimately to become the dominant animals on land. They had long jaws and big hind legs that made them well-suited for chasing prey. With a long tail acting as a counterbalance, some ran on their hind legs, which freed up their hands for grasping. From the early archosaurs arose the crocodiles, flying pterosaurs, and the most famous of all the prehistoric reptiles, the dinosaurs, or "terrible reptiles."

Like their ancestors, the amphibians, early reptiles had legs that swung out to the sides. They walked like fish out of water, with their undulating backbone doing most of the work. In contrast, dinosaurs had stiffened backbones and erect legs. Their limbs moved only forward and back beneath their bodies. More agile than any of their ancestors or contemporaries, they could probably run farther without tiring. Their legs acted like columns, able to support great weight with little strain.

Dinosaurs originated as small, two-legged, bird-like meat eaters, but rather quickly some turned to eating plants, became larger, and started walking on all fours again. Eventually there were many more plant eaters than predators. Birds arose from small meat-eating dinosaurs with long fingers and elaborate scales that became feathers.

Birds and mammals are "warm-blooded" in that they can create heat within their own bodies. Living reptiles are "cold-blooded" and are unable to do so. Since birds are warm-blooded and crocodiles (related to birds by way of early archosaurs) are not, when did the change take place? Were birdlike dinosaurs warm-blooded? Were *all* dinosaurs warm-blooded? This matter intrigues scientists today. But until a dinosaur has its temperature taken, the argument is not likely to be settled.

Dinosaurs are famous for having become extinct at the close of the Cretaceous Period, 66 million years ago. Actually they seem to have been in decline before then, with only a few species surviving until the very end. Extinction is a continuous process, and mass extinctions have occurred many times, according to the fossil record.

No one knows exactly what killed the last of the dinosaurs. One theory suggests that weather changes were responsible. At the beginning of the Mesozoic Era, when dinosaurs first arose, the continents were joined together into a supercontinent known as Pangaea ("all land"). Vast shallow inland seas and continental shelves moderated temperatures worldwide. As the Mesozoic Era went on, the continents drifted apart again, creating, among other things, the Atlantic Ocean. Changing currents and sea levels made the world's climate less stable. Ultimately half of all animal life, including all of the remaining dinosaurs, pterosaurs, and many forms of marine life, died out, unable to survive in their changing world.

Just as it began, the Mesozoic Era ended with a bang. The evidence suggests that one or more meteorites, several miles wide, hurtled toward the earth and exploded on impact, throwing millions of tons of dust into the atmosphere. This dust would have kept much of the sun's light from reaching the surface. Without enough light many plants would have withered. Without enough plants the giant plant eaters would have died, followed shortly by the giant meat eaters that preyed on them. Perhaps this visitor from space was the final blow that put an end to the reign of dinosaurs that had lasted 150 million years.

Not every reptile was killed during that catastrophe. Crocodiles, turtles, snakes, and lizards survived throughout the Cenozoic Era, or Age of Mammals, some growing as large or larger than their ancestors had during the previous age.

Mammals, birds, fish, and amphibians also survived. Mammals in particular flourished and became the dominant animals on earth. Today some mammals are advanced enough to build moon rockets. Others, such as the platypus and echidna, still lay eggs like reptiles.

Dinosaurs also left living descendants—birds. When you see a roadrunner, think of *Compsognathus* (page 30). When you see an ostrich, think of *Dromiceiomimus* (page 56). And when you eat chicken, pretend it's *Tyrannosaurus* (page 59).

In This Book

Of necessity, the largest creatures have been placed on the gatefold pages, and the others generally follow their proper chronological order, period by period. But some of the animals pictured together were not exact contemporaries of one another in place or time.

All the reptiles illustrated in this book are drawn to the same scale (1 inch = 22½ inches). This makes it easy to compare them with one another and with the 5-foot-tall young people included on every spread. Of course, no humans existed when any of these creatures lived. If you hold this book 18 inches from your eyes, the illustrations will seem the same size as the actual animals would when seen from a distance of about 34 feet.

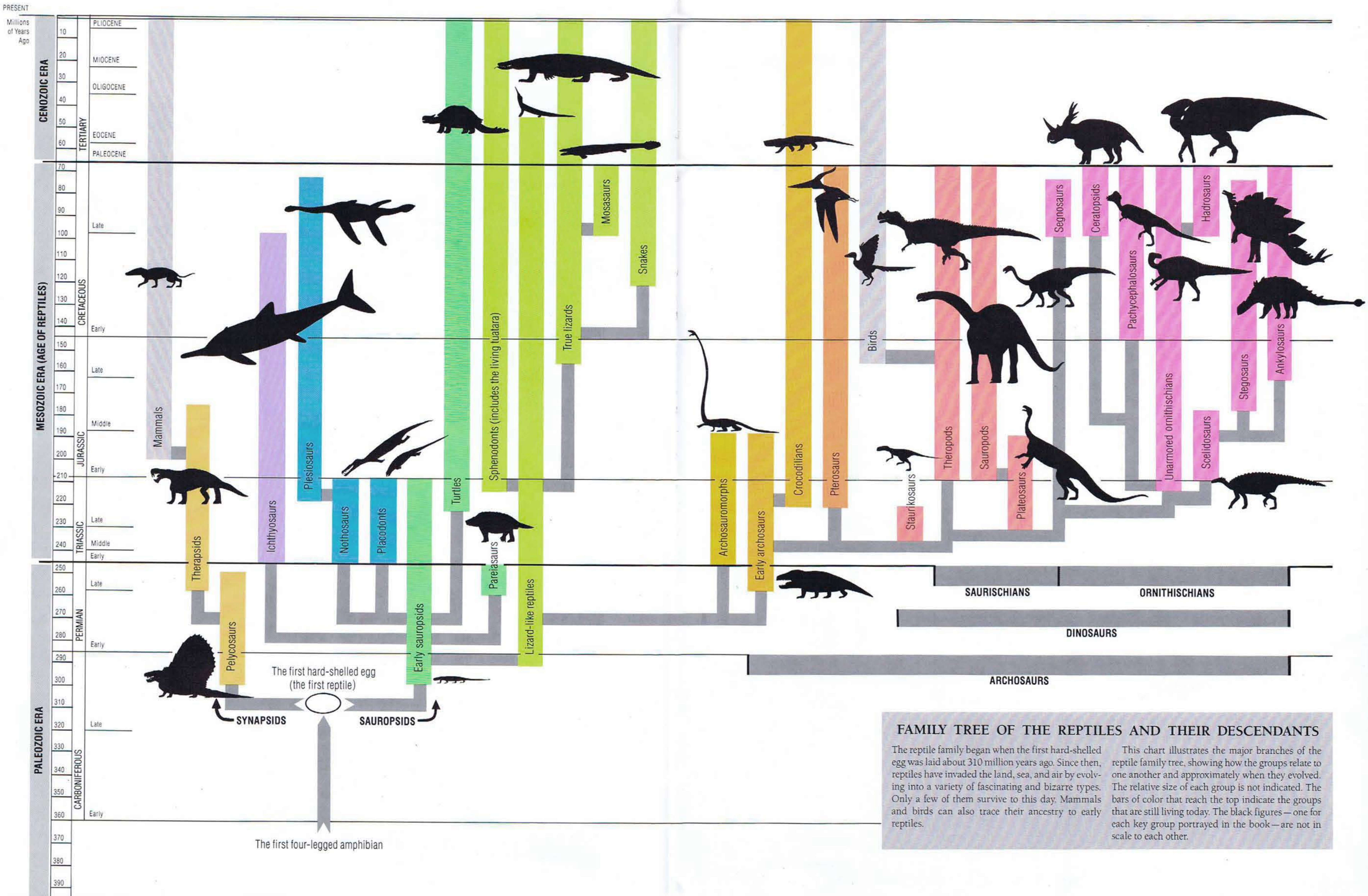
Since almost nothing is known about the coloring of prehistoric reptiles, the patterns and colors illustrated here are guesses. Most living reptiles are rather drab and inconspicuous. But most living birds are richly colored and perhaps their ancestors, the dinosaurs, were too.

The key facts about each animal in this book are summarized in the heading for its text entry, beginning with its scientific name, the pronunciation, and the meaning. *Saurus*, the Greek word for "lizard," is translated as "reptile" whenever the animal is not a true lizard.

The next line contains a list of the scientific categories into which scientists have traditionally grouped each animal in the class *Reptilia*, on the basis of shared characteristics. The list begins with the broadest category (here, usually the subclass or superorder) and ends with a category of closely related animals (here, usually suborder or family). All of the animals that belong to a category share certain features of the skeleton; the closer the relationship, the more the animals have in common. There is much uncertainty and disagreement in the scientific classification of early reptiles, so not all categories are given for every animal. The term *Dinosauria* is not part of the traditional listing, but has been included here before the two orders of dinosaurs, *Saurischia* and *Ornithischia*, because it is so familiar. Also nontraditional, in the entry for the bird-dinosaur *Archaeopteryx*, is the listing of *Aves* (birds) as an order of archosaurs rather than as a separate class.

The next line in the heading contains the period of time in which the animal lived and the location of its fossil find(s), followed by the length of the animal's fossil skeleton. In the case of flyers, the wingspread is given. "Est." means the length is estimated from partial remains. "Up to" means that many species are known, but only the largest is listed.

Currently some scientists prefer to call early reptiles "amniotes," a name that refers to the amniotic membrane, the protective tissue that develops around the embryo and yolk of all living reptiles, birds, and mammals. Instead of speaking of two branches of reptiles, they speak of two branches of amniotes: the synapsids, which include the ancestors of mammals and their kin, and the sauropsids, which include reptiles (snakes, lizards, dinosaurs, etc.) and birds. In this book, however, the term "reptile" will still be used for the early creatures in both the synapsid and sauropsid lines.



FAMILY TREE OF THE REPTILES AND THEIR DESCENDANTS

The reptile family began when the first hard-shelled egg was laid about 310 million years ago. Since then, reptiles have invaded the land, sea, and air by evolving into a variety of fascinating and bizarre types. Only a few of them survive to this day. Mammals and birds can also trace their ancestry to early reptiles.

This chart illustrates the major branches of the reptile family tree, showing how the groups relate to one another and approximately when they evolved. The relative size of each group is not indicated. The bars of color that reach the top indicate the groups that are still living today. The black figures — one for each key group portrayed in the book — are not in scale to each other.

Hylonomus

(hie-luh-NOE-muss)   "wood dweller"
Sauropsida • Captorhinida • Captorhinomorpha
Late Carboniferous • Nova Scotia • 1 foot long

Hylonomus was one of the earliest and most primitive of the reptiles. Its fossilized bones were found within the remains of a 300-million-year-old hollow tree fern stump.

The ancestors of reptiles were lizardlike amphibians, four-legged vertebrates that were probably scaly and laid jellylike eggs. Whichever one of them first began laying eggs enveloped in a protective membrane and a hard or leathery shell became the world's first reptile.

We do not know what kind of eggs *Hylonomus* laid. Nevertheless, certain features of its skeleton separate it from the lizardlike amphibians living at the same time. *Hylonomus* had a stronger backbone and more slender limb bones than its contemporaries. It was built for clambering over obstacles such as rocks and tree limbs, and seems to have been a more active hunting animal with better coordination. Instead of passively waiting for its victims to crawl or fly by, *Hylonomus* probably scampered after them in active pursuit. Although able to swim, it most likely remained primarily on dry land, where it was safer.

Most amphibians of the Late Carboniferous were probably as vocal as modern bullfrogs and spring peepers, but *Hylonomus* may have been silent. It seems to have lost the large eardrums that were so prominent above the jaw joint in its amphibian ancestors. Without these, *Hylonomus* was likely deaf to most sounds. As in all early reptiles, this area was filled in with bone and jaw muscles, giving *Hylonomus* a quicker bite for subduing insects and crawling invertebrates such as worms.

Early fish and amphibians had a double row of teeth: a row of many small ones along the margins of the jaws, and a row of a few large fangs descending from the roof of the mouth or palate. No reptile had these large palate fangs, although most, including *Hylonomus*, had smaller teeth hanging over their throat.

Archaeothyris

(ar-key-o-THIE-riss)   "ancient opening"
Synapsida • Pelycosauria • Ophiacodontidae
Late Carboniferous • Nova Scotia • 2 feet long

Archaeothyris's name refers to the synapsid opening, an opening in its skull above the jaw joint. This hole identifies it as a synapsid, the branch of reptiles from which all mammals, including humans, evolved. In humans this same synapsid opening remains as the space between the skull and the cheekbone. This opening gave *Archaeothyris* an early advantage, providing space for stronger jaw muscles.

Scaly, sprawling, lizardlike *Archaeothyris* was a contemporary of *Hylonomus* but grew to twice its size. Proportionally *Archaeothyris* had a larger head. Its bite was stronger but not quite as rapid. Perhaps *Archaeothyris* preferred larger prey than insects and dipped back into the swamp to find its food. *Archaeothyris*'s teeth came in a variety of sizes and were larger than those of insect-eating reptiles. The largest were stabbing canines that could have pierced the extra-thick bony scales of early fish, amphibians, and reptiles.

Like living lizards and snakes, no primitive reptiles had separate cavities for the mouth and nasal passages. The nasal passages entered the mouth directly behind the front teeth. A mouthful of food could have blocked the path of air to the lungs. *Archaeothyris*, however, had a high, narrow snout that provided a clear air passage over whatever was in its mouth.

Primitive reptiles, like all living reptiles, were cold-blooded. After a long, cool night, *Archaeothyris* would have had to sun itself until its body temperature warmed up. Horny scales prevented its skin from drying out in the heat.

All primitive reptiles and amphibians had a long, heavy tail as a counterweight to the body, making the backbone arch so that the belly could be lifted off the ground while walking.

Dimetrodon

(die-ME-truh-don)   "two-measure tooth"
Pelycosauria • Sphenacodontidae
Early Permian • Texas • up to 14 feet long (est.)

The earliest synapsids were the pelycosaurs, named for their bowl-shaped hips. The largest of the meat-eating pelycosaurs was *Dimetrodon*, the chief predator of its time. Its teeth were large and sharp, like knives. Its jaws were built to withstand the stresses of tearing off large chunks of flesh. The easy curve in its jawline gave this meat eater a natural grin. Living near water in an equatorial region visited by seasonal rains, *Dimetrodon* was one of the most common of all pelycosaurs.

As a cold-blooded reptile, *Dimetrodon* probably had a rather lazy, slow-motion lifestyle punctuated by rapid charges toward its prey. Living reptiles spend a great deal of time sunning themselves, and *Dimetrodon* was better equipped for this than any other reptile. Along its back stretched a sail of skin supported by long spines of bone arising from each of its vertebrae. This sail probably collected the rising sun's heat so well that *Dimetrodon* was able to warm up faster and get an earlier start than its sail-less prey. *Dimetrodon* could avoid overheating in the midafternoon sun simply by moving into the shade to let its sail cool off.

Edaphosaurus

(ee-daf-o-SOR-uss)   "base reptile"
Pelycosauria • Edaphosauria
Early Permian • Texas • up to 11 feet long

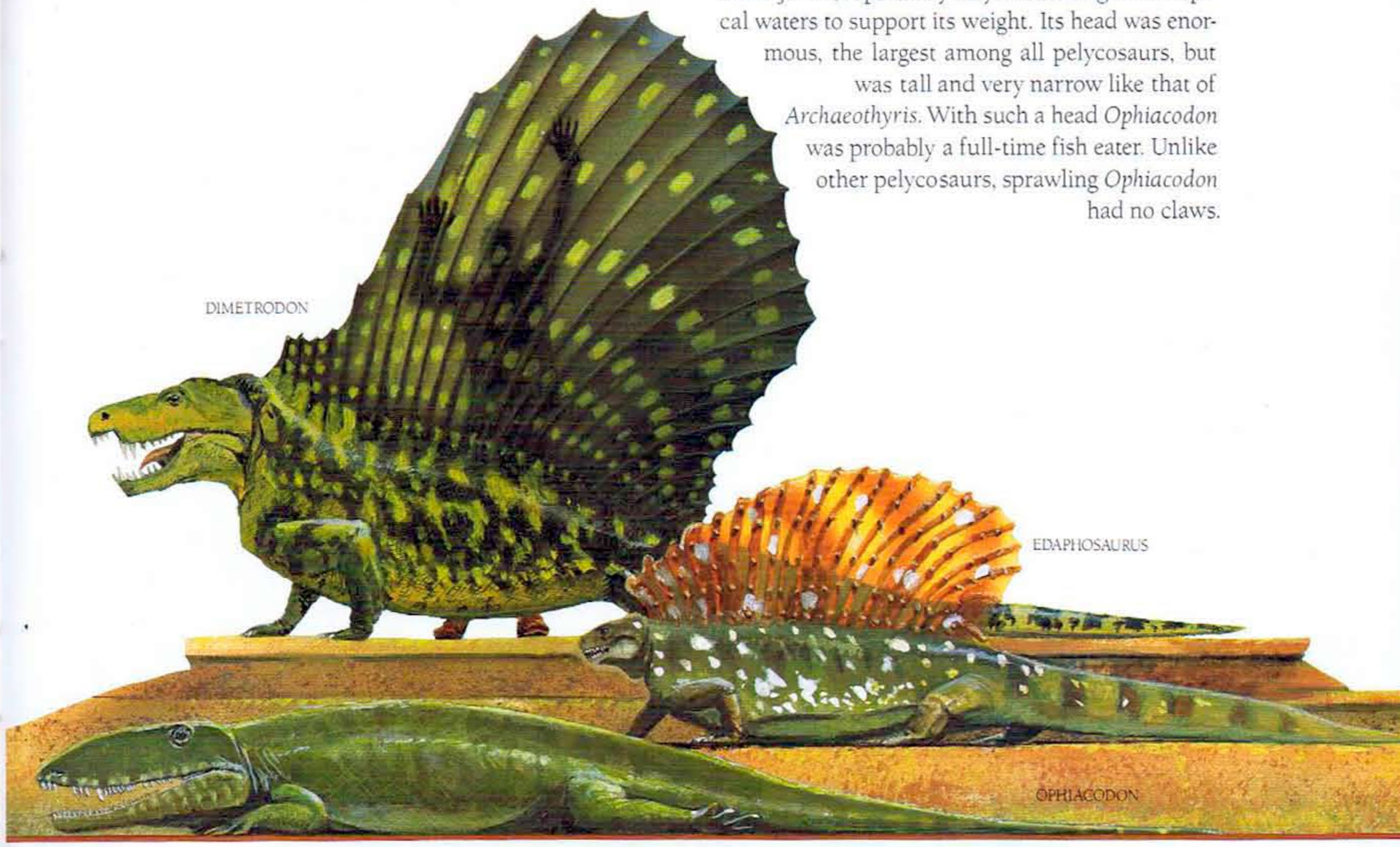
Edaphosaurus's teeth along the edge of its jaws were short, blunt, and all the same size. Similar teeth covered the roof of its mouth and the inner surfaces of its lower jaw. Such teeth show it ate soft plants. *Edaphosaurus* had a small but broad head, a large, rotund body, and short, stout, sprawling limbs. Plant eaters need a big belly because pound for pound, plants are less nutritious than meat, and plant eaters therefore need to eat more. Plants are also harder to digest. They stay in the belly longer because they have to ferment before digestion can take place.

Edaphosaur fin spines resembled the masts of a clipper ship, because they were decorated with many small crossbars. Perhaps these protected the sail tissue from damage.

Ophiacodon

(o-fee-AK-uh-don)   "snake tooth"
Pelycosauria • Ophiacodontidae
Late Carboniferous to Early Permian • New Mexico
up to 13 feet long

Ophiacodonts were the earliest pelycosaurs and the largest of these was *Ophiacodon* itself. Having weak ankle joints, it probably stayed submerged in tropical waters to support its weight. Its head was enormous, the largest among all pelycosaurs, but was tall and very narrow like that of *Archaeothyris*. With such a head *Ophiacodon* was probably a full-time fish eater. Unlike other pelycosaurs, sprawling *Ophiacodon* had no claws.



Cotylorhynchus

(kot-ee-loe-RIN-kuss) *"cup nose"*
Pelycosauria • Caseidae
Late Permian • Oklahoma • up to 13 feet long

Very few pelycosaurs survived into the Late Permian Period, but among those that did was tubby *Cotylorhynchus*. Perhaps its lack of a fin and its huge bulk of 620-plus pounds helped it retain body heat better than other pelycosaurs, which were suffering through cooler night temperatures while equatorial Oklahoma became increasingly arid. This blimplike plant eater was a member of the caseid family, the most diverse and widespread of the plant-eating pelycosaurs.

Huge *Cotylorhynchus* had a tiny head no bigger than that of its much smaller ancestors. As the caseids evolved, the head seems to have stayed the same size while the rest of the body ballooned. The nostrils, eyes, and brain, however, grew in proportion to the rest of the body, so they look extra-large in the tiny skull.

The long, blunt teeth of *Cotylorhynchus* were largest in front, decreasing toward the rear. The animal's front feet were larger than the rear feet and both sets were armed with the largest claws among pelycosaurs. Together these features suggest that *Cotylorhynchus* dug for roots.

Cotylorhynchus's spacious rib cage was twice as wide as it was high to enclose an extremely large gut. Burdened so, the animal must have moved as slowly as a giant turtle, but without the benefit of a shell for defense and support. Defenseless animals can survive only in the absence of predators, and with *Cotylorhynchus* this seems to have been the case. *Cotylorhynchus* often suffered from fractured ribs. Whether they cracked during fights or under the strain of its own resting bulk is not known.

Inostrancevia

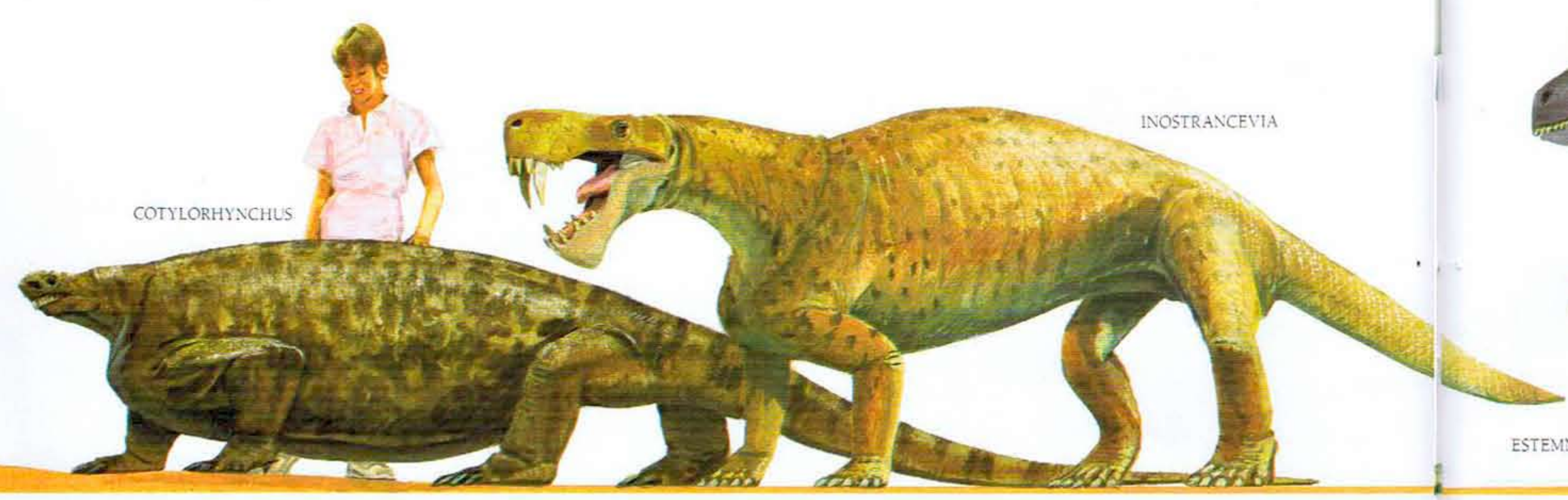
(in-os-tran-SEV-ee-ah) *[after Russian paleontologist Aleksandr Inostrancev]*
Therapsida • Gorgonopsia • Gorgonopsidae
Late Permian • Russia • 14 feet long

Just as the pelycosaurs were disappearing in what is now Europe and North America, their relatives, the therapsids, were appearing in Russia and South Africa. Therapsids descended from a sail-less relative of *Dimetrodon* (page 13).

Saber-toothed *Inostrancevia* was one of the largest of the meat-eating therapsids. With a head 2 feet long and fanglike canine teeth rivaling those of the dinosaur *Tyrannosaurus* (page 59), *Inostrancevia* was probably the chief predator of its day. Large jaw muscles drove those fangs deep into the flesh of its victims. Its prey would have included the likes of *Keratocephalus* and *Scutosaurus* (facing page).

Therapsid limbs, like those of living crocodilians, could vary between sprawling and semi-erect (think of a half-push-up). Although the elbows and knees still stuck out from the body, the feet were planted directly beneath these joints, not out beyond them as in pelycosaurs and lizards. This improvement meant that *Inostrancevia* kept its belly clear of the ground and could travel longer distances without tiring. The muscle tension used to maintain this posture generated heat, which raised *Inostrancevia*'s metabolism closer to warm-bloodedness. *Dimetrodon* warmed up only when the sun was out, but *Inostrancevia* could create at least some internal heat using its own muscles. In effect, it had a self-starting engine.

Like most therapsids, *Inostrancevia* had a shorter tail than any pelycosaur. Since its legs raised its belly off the ground, a heavy counterbalancing tail was no longer necessary.



Keratocephalus

(ker-ah-toe-SEF-uh-luss) *"horn-headed"*
Therapsida • Dinocephalia • Tapinocephalidae
Late Permian • South Africa • 10 feet long

About 250 million years before people imagined the unicorn, herds of a hippolike version of that fabled creature roamed the warm plains of the supercontinent of Pangaea on the Antarctic Circle. *Keratocephalus* had a short, stout, bony horn in the middle of its forehead. It was one of the dinocephalians (the "terrible-headed" ones), therapsids with notably thick skulls often topped by horns. *Keratocephalus* probably butted its head against rivals for mates or territory and also used its horn against predators.

Keratocephalus was a large, robust plant eater with a huge gut. Each upper front tooth had a step on its inner surface that provided a crushing table for the lower teeth to work against. The canine teeth were small and indistinguishable from the rest, unlike those of all other therapsids.

Estemmenosuchus

(eh-stem-men-uh-SOOK-uss)
"wreathed with a crown crocodile"
Therapsida • Dinocephalia • Titanosuchia
Late Permian • Russia • 7 feet long

With horns protruding in every direction, *Estemmenosuchus* had one of the most bizarre faces of all dinocephalians (see cover illustration). It probably used its bony head to push rivals away and charge at enemies. Its huge front teeth may have served the same purpose as those of a hippopotamus: to dredge up vast quantities of soft plants from shallow waters.

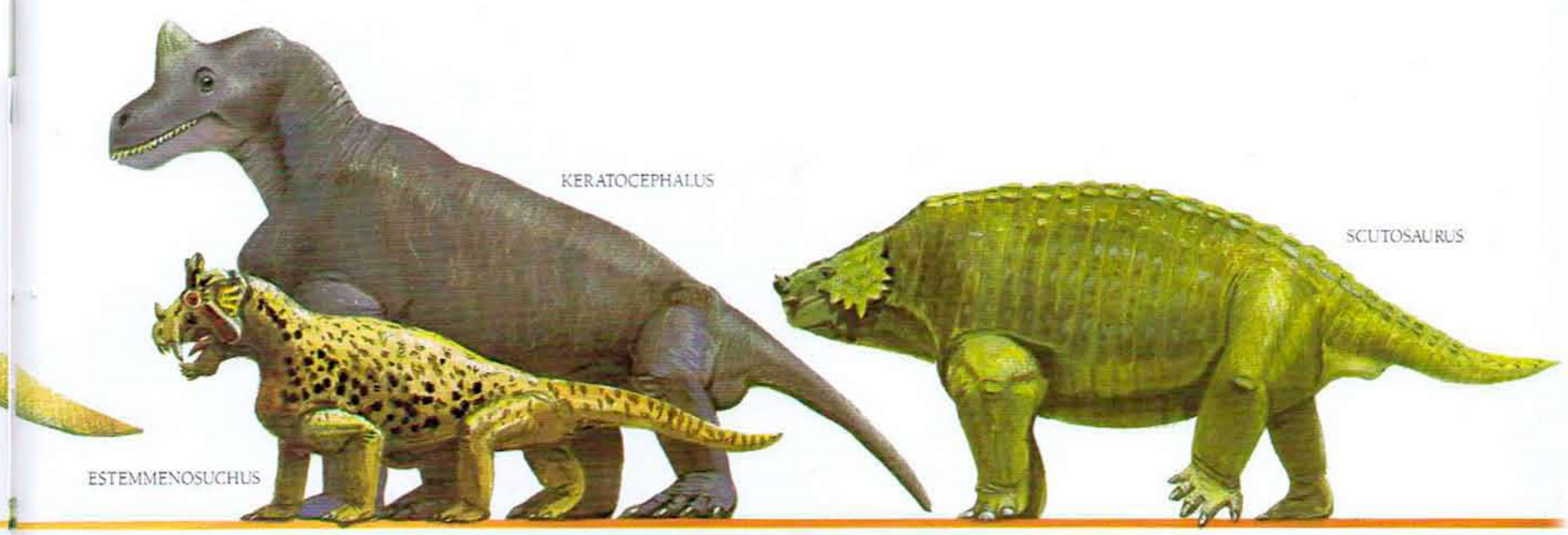
Scutosaurus

(SKEW-toe-sor-uss) *"plated reptile"*
Sauropsida • Pareiasauroidea • Pareiasauridae
Late Permian • Russia • 8 feet long

Scutosaurus was one of the largest pareiasaurs, bulky plant eaters that appeared only during the Late Permian. We don't know which reptiles were most closely related to them.

Scutosaurus had nearly erect hindquarters, yet its elbows continued to stick out to the sides. This rotund reptile defended itself against the attacks of predators with armor composed of numerous bony plates, known as scutes, embedded in the skin of its back. Today's crocodiles are likewise armored. *Scutosaurus* had a small, flat skull grotesquely ornamented and protected with wide, bumpy cheek plates. These grew so large that *Scutosaurus*'s eardrums faced the rear. Long, bony knobs decorated and protected the lower jaws as well.

This plant eater's teeth were shaped like coarsely serrated leaves on thick-stalked roots. They resembled the teeth of some living plant-eating lizards and many plant-eating dinosaurs. Multi-pointed teeth helped *Scutosaurus* shred vegetation so it could be digested faster.



Cynognathus

(sye-nog-NATH-uss) *"dog jaw"*
Therapsida • Cynodontia • Cynognathoidea
Early Triassic • South America, South Africa • 7 feet long

Cynodonts were the only predatory therapsids to survive the major extinction marking the end of the Permian Period. One of the largest of these was *Cynognathus*, an aggressive upland hunter. Its skull had both reptilian and mammalian features. Its brain was small, as in early reptiles, but its cheeks were wide-flaring, as in mammals. New jaw muscles that made chewing possible originated from these cheekbones. Most vertebrates swallow food whole. By chewing, *Cynognathus* could break down its food quicker and so hasten digestion and speed up its metabolism.

Like a mammal, *Cynognathus* had three kinds of teeth: nipping incisors, large stabbing canines, and multicusped cheek teeth for chewing. It also had a secondary palate, a shelf of bone that separated the nasal cavity from the mouth cavity, allowing *Cynognathus* to continue breathing even while chewing. Reptiles have three lower jawbones on each side, mammals only one. *Cynognathus* had three, but one was very large and mammal-like. It was only loosely connected to the other two tiny ones. These tiny bones served as hearing organs, as in mammals. One framed its eardrum.

Stahleckeria

(stah-leh-ker-REE-ah) *[after Dr. R. Stahlecker]*
Therapsida • Dicynodontia • Pristerodontia
Late Triassic • South America • 11 feet long

Stahleckeria was the largest of the dicynodonts, rotund, toothless therapsids with turtlelike beaks and enormous jaw muscles. These common plant eaters slid their jaws back and forth, rolling and crushing each wad of vegetation against the roof of their mouth. As plant-eating therapsids, dicynodonts were only distantly related to the cynodont branch leading toward the mammals.

Stahleckeria's beak was broader than that of other dicynodonts, and unlike others it had no tusks. A unique flat shield of bone at the rear of its skull protected its neck from attack.

Ancestors of Mammals

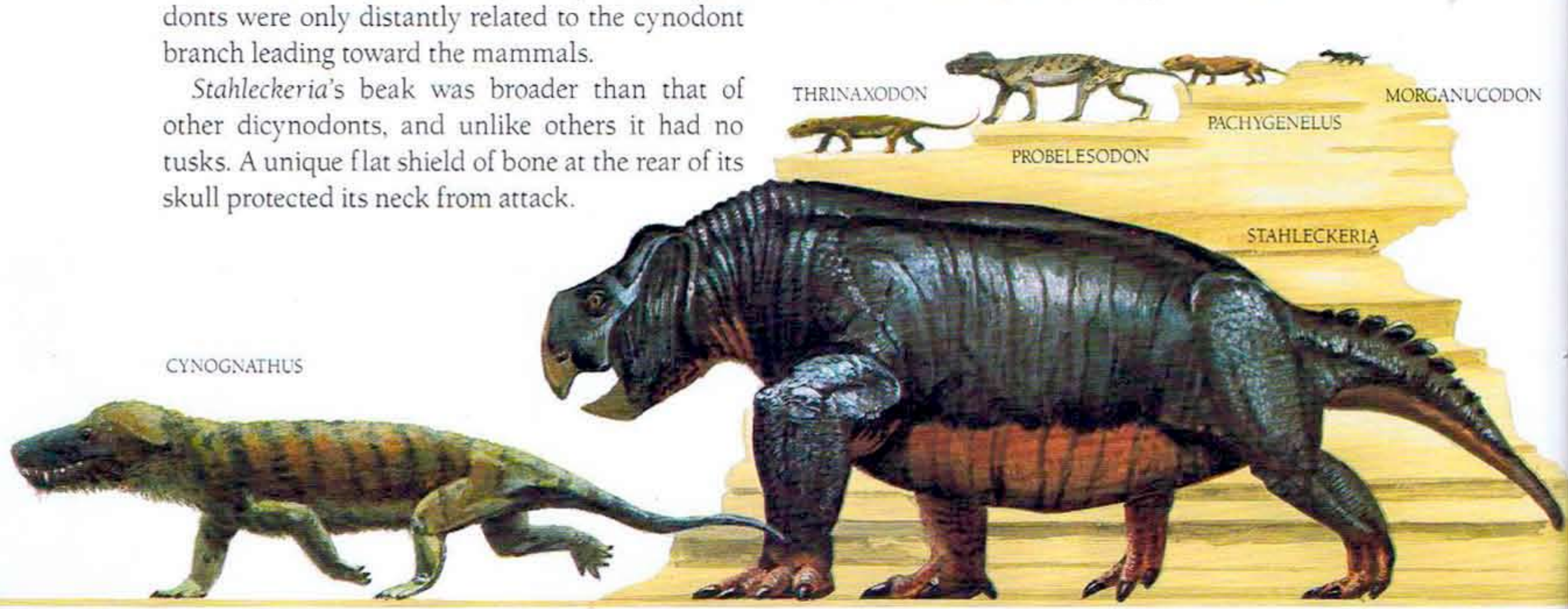
Increasingly mammalian cynodonts diminished in size through time, probably to avoid being seen and eaten by newly arriving archosaurs (page 18).

Twenty-inch-long *Thrinaxodon* of South Africa and Antarctica was one of the earliest cynodonts, living during the earliest part of the Triassic. Hair may have grown from between its scales. Tiny holes in *Thrinaxodon*'s snout allowed large blood vessels and nerves to pass through, probably to nourish and control sensitive whiskers (a type of hair). This clue suggests the presence of ordinary body hair as well.

Probelesodon, a 30-inch-long cynodont, lived during the Middle Triassic in South America. Its backbone undulated less than that of most therapsids and its hind legs were more erect.

Foot-long *Pachygenelus*, from the Late Triassic of Arizona and South Africa, was a weasel-like cynodont with teeth composed of superhard enamel. A mammal's adult teeth must be hard enough to last a lifetime, unlike those of a reptile, which are constantly being shed and replaced with new ones.

Less than 6 inches long, *Morganucodon* from the Early Jurassic of China and England was one of the earliest known mammals. It had a larger brain along with a more sensitive nose and ears than its cynodont ancestors. It may have looked like a fur-covered shrew with a scaly tail and without ear flaps. Still, it continued to lay eggs, as do the most primitive of today's mammals, the platypus and echidna. Unlike any reptile up to that time, its teeth were replaced only once, except the molars, which appeared only in adults and were never lost. All living animals with this pattern of tooth replacement are toothless as infants. If the infant *Morganucodon* was hatched without teeth, it could have found its only nourishment in milk from its mother, and only mammals produce milk.



Tanystropheus

(tan-ee-STROE-fee-uss) *"long vertebrae"*
Archosauromorpha • Protorosauria • Tanystropheidae
Middle Triassic • Switzerland • up to 35 feet long

In the Triassic Period, while some synapsids evolved toward mammals, the second main branch of reptiles, the sauropsids, developed into a wide variety of ever-larger types.

Tanystropheus was an extraordinarily proportioned sprawling protorosaur with a neck half as long as its entire body. Even hatchlings had extremely long necks. Any animal within the reach of this neck was immediately snapped up by *Tanystropheus* with lightning speed. A giraffe has only seven neck bones. *Tanystropheus* had twelve, nine of which were extremely elongated, making the neck rather inflexible. Neck ribs that were as much as five times longer may have served to snap the neck back like a fiberglass fishing rod after each strike.

Two-foot-long juveniles had three-pronged teeth for eating insects. Adults developed sharp, simple spikelike teeth for spearing fish. Adults could have swum at the surface snaring fish below or else parked themselves on the rocky seashore to dip into the surf.

As with many modern lizards, *Tanystropheus* could lose its tail and grow another. One fossil specimen has tail bones showing signs of having regrown and is the earliest known example of this phenomenon.

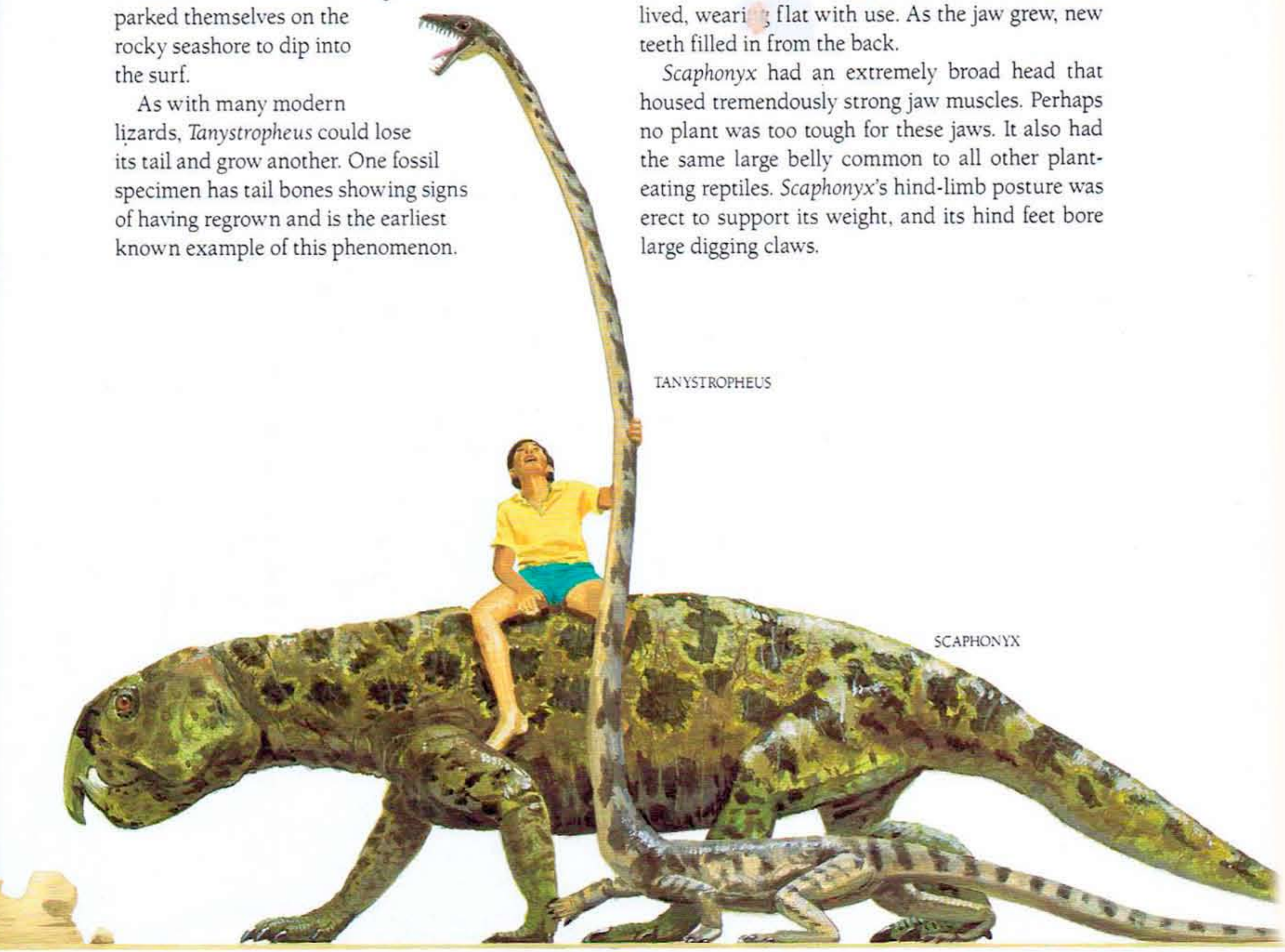
Scaphonyx

(skah-FON-iks) *"boat claw"*
Archosauromorpha • Rhynchosauria • Rhynchosauridae
Middle Triassic • Brazil, India, Argentina • up to 16 feet long

Scaphonyx was one of the largest and last of the beak-headed rhynchosaurs. Its ancestors resembled primitive sprawling lizards with slightly overhanging upper jaws. In *Scaphonyx* this feature became a pronounced beak unlike that of any other reptile. Two bony beak prongs descended from either side of the nostrils and met each other below the snout. When *Scaphonyx* closed its mouth, this upper beak was pinched in a groove between the twin tips of the lower jaws. In this way the beak could nip off plants or snap twigs and roots in half, like pruning shears.

Scaphonyx also had teeth like no other reptile's. In the upper jaw they were set in numerous rows on special pads divided by a groove. The lower teeth fit precisely into this groove to slice and munch plant material into little pieces. Most reptiles continually shed their old dead teeth and replace them with new ones. In *Scaphonyx*, as in modern rodents, the teeth continued growing as long as the animal lived, wearing flat with use. As the jaw grew, new teeth filled in from the back.

Scaphonyx had an extremely broad head that housed tremendously strong jaw muscles. Perhaps no plant was too tough for these jaws. It also had the same large belly common to all other plant-eating reptiles. *Scaphonyx*'s hind-limb posture was erect to support its weight, and its hind feet bore large digging claws.



Chasmatosaurus

(kaz-mah-toe-SOR-uss) "[skull] opening reptile"
Archosauria • Proterosuchia • Proterosuchidae
Early Triassic • South Africa • 9 feet long

Dinosaurs, pterosaurs (flying reptiles), crocodilians, and their ancestors and kin are collectively known as the archosaurs, a name that means "ruling reptiles." They were, for the most part, large predators that arose from small but long-legged insect-eating ancestors.

One of the earliest known archosaurs was *Chasmatosaurus*. This large, sprawling swamp dweller had a large but lightweight head and long jaws lined with sharp teeth. Its upper jaw was hook-shaped, perhaps to rip chunks of flesh from its victims, or it could have had some special use in catching fish. Small dicynodonts (page 16) shared its swamp and may have served as prey.

In contrast to swamp-dwelling crocodilians, which tuck in their small legs and sweep their broad tail from side to side while swimming, *Chasmatosaurus* probably swam with kicks of its large, sprawling hind legs, especially during the final lunge toward the victim after a successful underwater ambush.

Although the earliest of all reptiles were apparently deaf to most sounds, by the Triassic Period many reptiles, including *Chasmatosaurus*, had fragile sound-conducting ear bones sensitive enough to pick up a broad range of noises.

Erythrosuchus

(eh-rith-roe-SOOK-uss) "crimson crocodile"
Archosauria • Proterosuchia • Erythrosuchidae
Early Triassic • South Africa • 12 feet long

One of the largest four-legged meat eaters in the Early Triassic was the ferocious big-headed *Erythrosuchus*. Like *Chasmatosaurus*, it must have preyed on dicynodonts. The limbs of *Erythrosuchus* were semierect in posture, helping it get about on dry land.

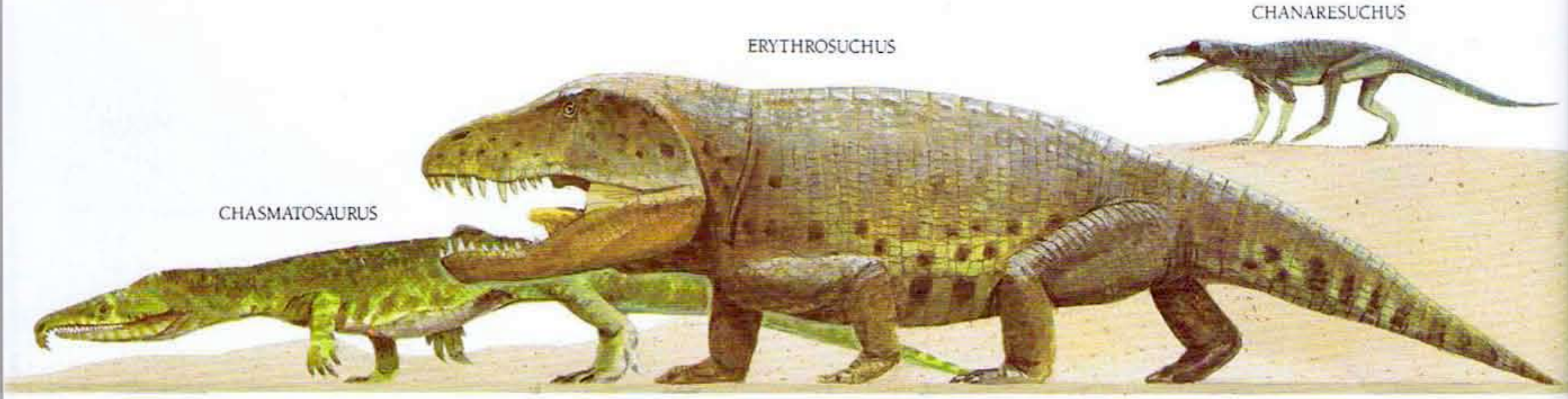
Erythrosuchus had two rows of scutes down the center of its back, a feature of other early archosaurs and crocodilians. Scutes are large scales with bony interiors that develop in the skin. They make a crocodile's back bumpy. Because they are firmly attached to the muscles and bones of the back, scutes help the long backbone support the body when it is held off the ground. Scutes also serve as armor, especially in smaller and younger animals.

A tall, narrow snout is a hallmark of many early archosaurs such as *Erythrosuchus*. This shape helped brace the lightweight jaws against the stresses of large struggling prey.

Chanaresuchus

(cha-nah-ray-SOOK-uss) "Chanares crocodile"
Archosauria • Proterosuchia • Proterochampsidae
Middle Triassic • Argentina • 4 feet long

With relatively long legs and a fairly erect posture, *Chanaresuchus* seems to have been adapted equally well to living both on land and in water. It lived near a large lake filled by seasonal rainfall that was a popular watering hole for many other types of reptiles. *Chanaresuchus*'s head was low and flat, with a long, narrow snout like that of a crocodile. Perhaps this early archosaur fished in the lake, then moved to higher ground to sun itself.



Desmatosuchus

(dez-ma-toe-SOOK-uss) "link crocodile"
Archosauria • Aetosauria • Stagonolepididae
Late Triassic • Arizona, Texas • 11 feet long

Aetosaurs were heavily armored early archosaurs that ate plants. *Desmatosuchus* was one of the largest of these, and it featured a fully erect stance. Its elbows and knees were tucked in at the sides, and its legs moved only in a forward-and-back arc. In addition to the heavy bony plates called scutes that covered its belly, back, and tail, *Desmatosuchus* had a lethal set of large, curved spikes just above its shoulders. Predators would have had a hard time getting through that tough hide, and would have been hurt by those spikes had they tried. Like other aetosaurs, *Desmatosuchus* had a bony, upturned, piglike snout that could have been used to uproot vegetation. It roamed in and around the dense stands of giant trees that would someday become the Petrified Forest.

Machaeroprosopus

(ma-kee-roe-PROS-uh-pus) "[snout like a] knife edge"
Archosauria • Phytosauria • Phytosauridae
Late Triassic • Arizona • 19 feet long

Machaeroprosopus was a phytosaur, an unfortunate misnomer that means "plant reptile." Phytosaurs did not eat plants. They looked like, and probably behaved like, living crocodiles, their distant relatives.

Like a crocodile, *Machaeroprosopus* could skulk along the surface of swamp waters and rivers, giving the appearance of a floating log, perhaps with just its nostrils and eyes poking above the water. The nostrils were not at the tip of its snout, as in crocodilians. Instead they were in a crest near the eyes. *Machaeroprosopus* was one of the largest phytosaurs. In contrast to most others, its teeth came in a variety of lengths, a feature that might have enabled it to more easily grab four-legged prey that came to the water's edge for a drink.

Proganochelys

(proe-gan-uh-KEL-eez) "before brightness turtle"
Testudinata • Chelonia • Proganochelydia
Late Triassic • Germany • 3 feet long

The secret of the turtle's success is its shell, which has provided protection from all sorts of predators throughout the ages. The earliest known turtle was *Proganochelys*, which had a shell much like that of any modern turtle. We know of no turtle ancestors that show us how this unusual mobile shelter made of bone and scales might have evolved.

Unlike most modern turtles, *Proganochelys* did not have the ability to withdraw its neck and tail beneath its shell. Instead, bony spikes protected these vulnerable areas. Along the edges of the shell additional sharp, bony plates, not found in modern turtles, protected its flanks.

Proganochelys was no doubt a slow-moving, rather passive plant and worm eater. Like all turtles, it may have been a good swimmer, too. In the water a variety of soft, slow-moving food was available. *Proganochelys* was one of the few turtles that had teeth, and these were only in the roof of its mouth. Along the edge of its jaws was a sharp horny beak that it used to hook and slice food. (See also *Meiolania*, page 61.)