

# Turtles

The timid, plodding tortoise has been the butt of jokes since the time of Aesop. And it is a comical reptile, with its burdensome shell, its awkward gait and its apparent stupidity. But turtles are not all awkward and slow; a pond turtle or even a giant sea turtle in its natural element is a creature of remarkable grace and speed. They apparently make use of celestial navigation: A box turtle, taken from its customary home range and deposited miles away, can find its way home—if it is a bright day. In cloudy or rainy weather, when the sun is invisible, it may become confused and lose its way. The sun or the stars may have some role in guiding the remarkable migrations every year of thousands of green sea turtles that leave their feeding grounds off the Cayman Islands to swim hundreds of miles across the Caribbean and deposit their eggs on the same beaches where they were born years before.

That clumsy-looking shell is actually a marvel of natural engineering and architecture. In the beginning of their evolution turtles were covered with scaly skin like other reptiles, but the scales eventually grew larger and into horny plates, and in the evolutionary process the plates fused together into carapaces, or upper shells, and plastrons, protecting the underbellies. These two shells were eventually joined at the turtle's sides, enclosing the animal in a bony armor, with holes for the feet, tail and head. Adjusting to its portable armor, the turtle's body was reorganized to comfortable dimensions and the shell became fused to the spine and some inner bone structure, leaving only the shoulder blades and the hip bones as movable joints. The turtle thus became the only land vertebrate in the world to wear part of its skeleton on the outside.

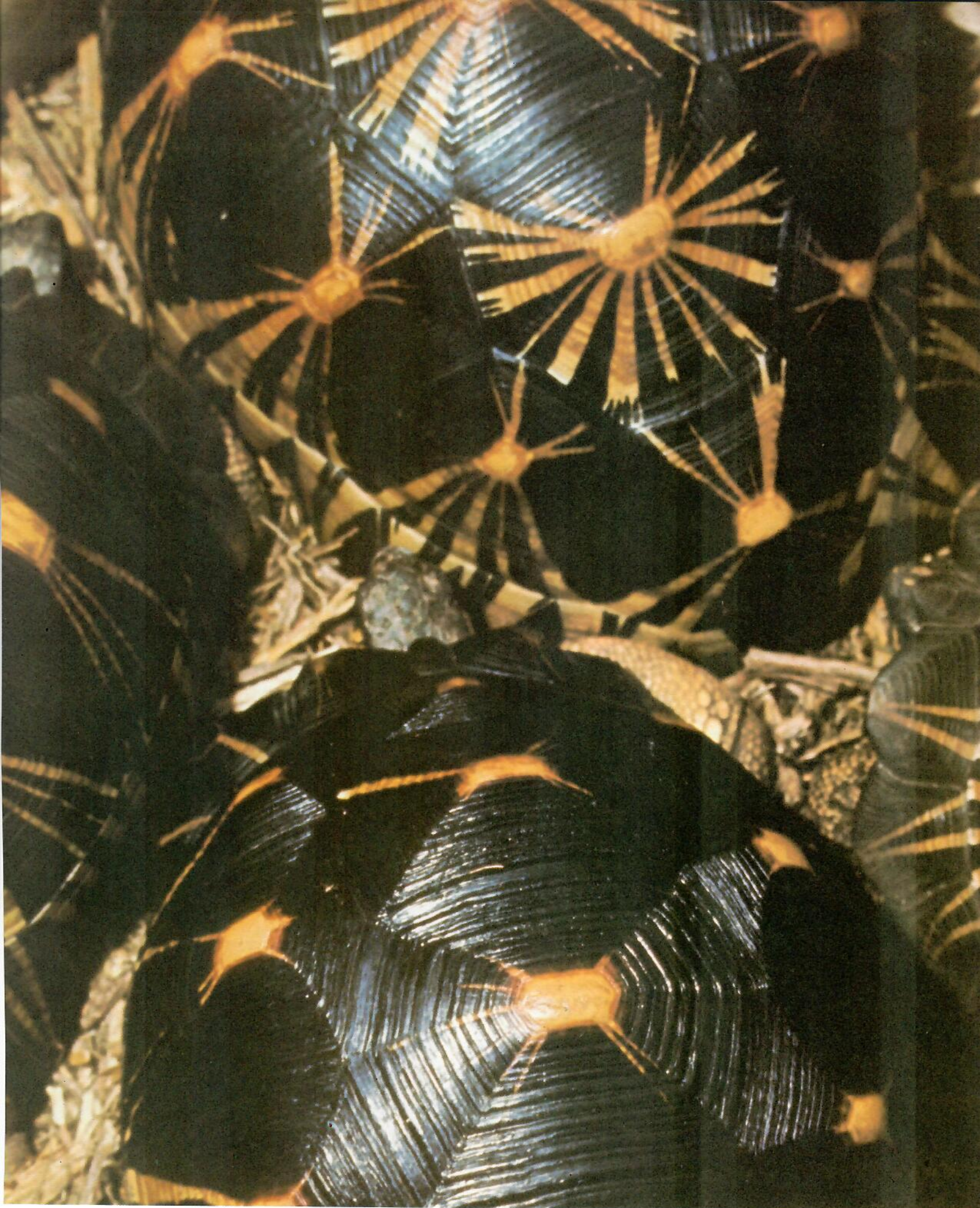
Early in the Mesozoic era turtles made certain refinements in their armor, adapting to their habitats. Those that returned to the water developed flattened, streamlined carapaces, and the claws of giant sea turtles evolved into flippers for easier navigation. Because they are more vulnerable to attack, the land turtles kept heavy, high-domed carapaces (opposite) and, in the case of the box turtles, hinged plastrons that enable them to retreat completely into the shell and snap shut. To carry those heavy turtle-ports around and to tear food apart, tortoises and pond turtles developed large, sturdy forelegs—webbed in the case of water turtles—and sharp claws.

Having achieved a design that inspired Roman legions to go into battle under a protective *Testudinaria*—a canopy

of upheld shields sloped to resemble a turtle's carapace—and later military engineers to design the Sherman tank, turtles seem content with their Model T and have not evolved to fill as many environmental niches as their cousins, the lizards and snakes. They look pretty much today as their ancestors did 150 million years ago. They are considered to be an order in decline precisely because they have failed to change with the times, and today there are just over 250 identified species, divided into 10 families. They include strictly terrestrial tortoises, such as the gopher and Galápagos tortoises; semiaquatic turtles, such as the painted and spotted turtles; aquatic turtles, such as the snapping and soft-shelled turtles; and the giants of the sea, such as the leatherback and hawksbill turtles. In general, the term *turtle* applies to the whole order and to water and oceangoing turtles, *tortoise* to land turtles and *terrapin* to those freshwater turtles that are edible.

An extremely durable animal, the turtle is believed to be the longest-lived creature on earth. Some turtles, especially the large tortoises, may attain an age of 200 years.

Turtles and their eggs have long been a food staple in many parts of the world, and men have brought many varieties to the verge of extinction. For centuries it was the common practice for ships on long voyages to stop at islands with large turtle populations and take aboard hundreds of live tortoises as a source of fresh meat in the weeks and months ahead. The island of Rodriguez, lying in the Indian Ocean athwart one of the main sea lanes to the Orient, once supported a vast population of giant tortoises. "Sometimes you may see two or three hundred of them in a flock," wrote an early explorer in 1691, "so that one may go above a hundred paces on their backs . . . without setting foot on the ground." So popular were the tortoises as food for seafarers that by 1800 not a single one was left on Rodriguez. The Galápagos Islands' tortoises were almost extinct by the end of the 19th century. Similar depredations have reduced the population of green turtles, esteemed as a soup base, to the point of endangerment, and have threatened the diamondback terrapin, a delicacy from the Atlantic coast, the gopher tortoise of the United States Southwest, a staple of Indian diets, and the river turtles of the Amazon and Orinoco river basins, slaughtered for their oily eggs and flesh. Even though conservationists have succeeded—through laws limiting harvests—in slowing the slaughter, these species are still slowly declining.

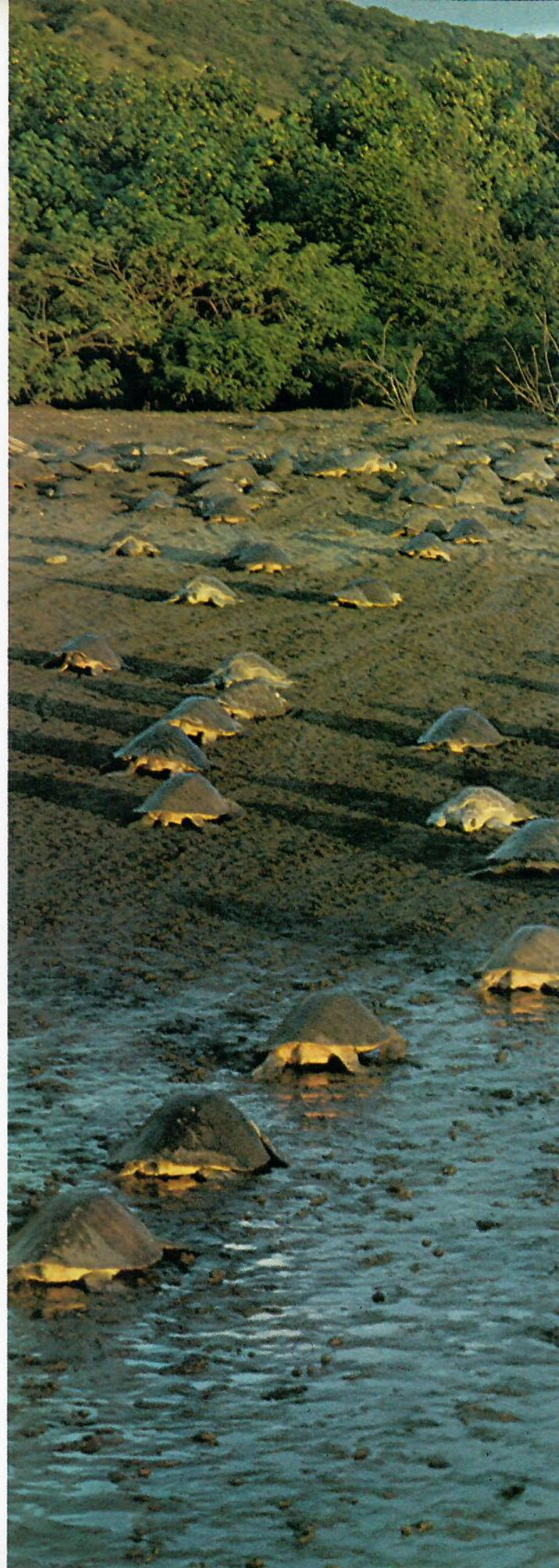




## The Ridleys' Riddle

The extraordinary homing instinct of sea turtles, like the Pacific ridleys pictured at right, has aroused the curiosity of such dissimilar groups as herpetologists and the United States Navy. What both would like to know, though for very different reasons, is how the ridleys navigate hundreds of miles of open ocean to find their way back to the very beaches on which they were born. For centuries the ridleys have made annual pilgrimages to the Costa Rican beach pictured here (there are seven such homing grounds known today—two beaches in Costa Rica and five in Mexico), swimming great distances to deposit their eggs in the sand at a mass nesting known as an *arribada*, or arrival. For many turtles it is their first contact with land since they were born. A female ridley may dig from three to five nests in the sand and leave as many as a hundred eggs in each. She returns to the sea after each nest of eggs is covered with sand, often copulating with the males that generally remain offshore (above), and ventures back later to leave more eggs to incubate in the warm sand.

*In violation of the usual sea turtle precaution of nesting only at night, the ridleys (right) swarm across the beach in broad daylight to go about their nest-digging chores. There are thought to be three arribadas each year, occurring unpredictably from April to June. Once a female has chosen and cleared a nesting site, she digs with a furious display of sand-slinging that leaves her exhausted, barely able to drag herself back to the sea.*







*After excavating the nest entirely with her rear flippers, so that she never really sees what she is doing, the female ridley (above) deposits her eggs in the nest. Once the hatchlings emerge, they are able to reach the surface only through sibling teamwork, and even then their difficulties have just begun. How they locate the ocean from behind the dunes or debris near their nests is a mystery, though it is thought that they instinctively head for the brighter sky over the ocean.*





The nests are emptied in a short time in a massive charge for the sea (left). To strike out singly would mean almost certain annihilation of the hatchlings. Even traveling en masse, few will reach their goal, and less than one percent will survive to adulthood. Ridley turtles may live for half a century in the open ocean, but their lives are never more threatened than in their first few minutes of existence. Of all the obstacles the hatchlings must contend with on their race to the sea—gulls, rock iguanas, ghost crabs and even the tropical heat, which their dark bodies absorb—none is a more skillful predator than the frigate bird (above). The frigate, which often feeds by catching flying fish in midair, is a relentlessly accurate hunter, and the hatchlings are not safe from it until they are in the water. Where the young turtles go when they do reach the ocean is yet another mystery. They begin what is called the “lost year,” for where they live, what they eat and how they survive no one knows.



## Soft-shelled Cousins

Some turtles, like the two pictured on these pages, have evolved without the horny plates that usually cover turtles' shells. The eastern spiny soft-shell (above) is a member of the world's most widespread genus of soft-shells, while the Fly River turtle (opposite) is one of the rarest of living turtles. The eastern spiny, named for the soft, pointed tubercles that rim the front of the adult's shell, grows to an average size of one foot. Like all soft-shells, it is nearly circular and almost flat and, as a result of this shape, shares

with others of its species the epithet "flapjack" turtle. The eastern spiny inhabits the muddy or sandy bottoms of slow-moving rivers and is an extremely active, almost exclusively aquatic creature. Unlike other turtles, which have tough, cartilaginous beaks, the Fly River turtles have fleshy lips and a snout that is drawn into a proboscis, which they use as a snorkel. But the fleshy lips are deceptive, for hidden beneath them are strong mandibles capable of mangling a hand if these irascible turtles are disturbed.

The New Guinea Fly River turtle (below) might aptly be described as a "non-missing link," for although its shell is covered only by a layer of skin, as in the true soft-shell turtles, it has more in common skeletally with the non-soft-shells. Its shell is about 18 inches long, and its limbs have developed into paddles with only two claws (true soft-shells have three). The Fly River turtle, the sole surviving species of the family Carettochelyidae, inhabits the Fly River drainage basin in southern New Guinea. Although enough specimens have reached museums to make a complete description possible, almost nothing is known of its habits in nature, though it is recognized as a powerful swimmer. Recently it was discovered to have migrated to rivers of northern Australia flowing into the Timor Sea.



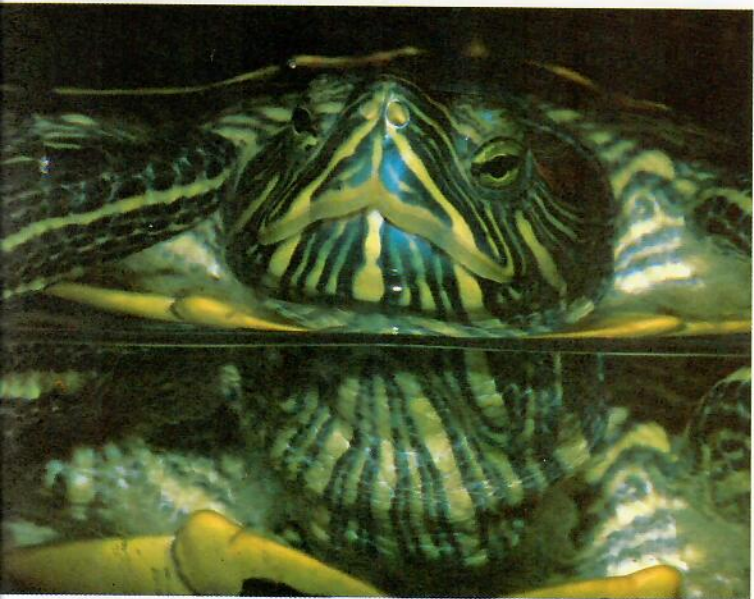


# Turtle Necks

While there is some color differentiation between male and female turtles of the same species, it is not nearly so pronounced as the dramatic differences of fur and plumage that distinguish the sexes in many mammals and birds. Minor variations in head and neck patterns and eye color, for example, may occur among males and females of the same species. And it is true that male turtles generally grow darker as they mature, losing much of their coloring. The gallery of glowering grumps on these two pages represents seven fairly common American turtles and demonstrates that, their evolutionary conservatism notwithstanding, turtles come in a curious—and not always conservative—array of colors.



Top row, from left: One of the most familiar turtles, the eastern box turtle—so named because a hinge on the plastron permits the shell to be closed into a tight box—is a gentle, terrestrial creature whose range extends from New England to Florida. The common snapping turtle (center) is a vicious animal with a large, ungainly head and a long tail similar in shape to an alligator's. A primarily aquatic species, it is a voracious feeder that will eat practically any animal matter. The painted turtle (right) is often observed basking in large numbers on half-submerged logs. While it is found throughout most of the United States, it is the most common pond turtle in the northeastern states.



Bottom row, left to right: The peninsula cooter is a large, high-domed pond turtle whose carapace length may reach 15 inches. The wood turtle (second from left), one of the most terrestrial turtles in the Northeast, is a fast mover and a capable climber. Because of the loss of its habitat, it has become scarce and is now protected in New York State and other areas. The red-eared turtle (third from left) has been sold in dime stores for years. Such sales were recently banned in many areas when it was found to be a carrier of salmonella, an intestinal disease. The most characteristic feature of the chicken turtle (far right), so-called because of the chickenlike flavor of its flesh, is its unusually long, striped neck.

# Lizards

The most successful and adaptable of all reptiles, lizards are found in every continent except Antarctica and have evolved into a fantastic variety of forms, colors and shapes. Lizards are at home in jungle treetops, burning deserts, rivers, tidelands, subarctic regions, grasslands—just about any habitat. They come in many sizes, from the tiny reef gecko, weighing a fraction of an ounce, to the 200-pound giant Komodo dragon of the Indonesian islands of Komodo and Flores. There are lizards like the *Draco*, or flying dragons, of Malaysia that glide through the air on winglike folds of skin and then furl themselves into something that resembles a shrunken leaf when they land on a tree. Other lizards, such as the “glass snake” and the blind worm lizards of the American West, have lost their legs through the course of evolution and are often mistaken for snakes or large worms. Some lizards can run erect on their hind feet, looking like miniature dinosaurs, and one—the green basilisk of Central America—can even scamper rapidly across the surface of water for short distances.

The ability to change color characterizes several lizards, notably the green anoles of the southeastern United States, sold as “chameleons” in circuses and pet stores, and the bizarre-looking true chameleons of Africa, Madagascar and Asia. Their repertory ranges from pale green to emerald to brown to gray and black. Both colors and patterns blend marvelously into whatever background they happen to encounter. But the master of color dynamics is the so-called bloodsucker of India, which gets its name from its habit of changing color during courtship or combat with rival males. It changes from a neutral brown to yellow, with cheeks, throat and neck turning a vivid scarlet. In other moods and situations the blushing bloodsucker—which does not suck blood at all but subsists on insects—can change itself into a whole rainbow of colors, from cinnamon-orange to jet black.

Only two lizards—the Gila monster of the southwestern United States (see page 69) and the Mexican beaded lizard—are venomous. The fat, lethargic Gila monster, with skin like Indian beadwork, has been captured and carried off to roadside menageries and individual collections in such numbers that the states of Arizona, California, Nevada, New Mexico and Utah have placed it under official protection to save it from extinction. Other large, non-venomous lizards, such as the monitors and especially the

Komodo dragon, are not known as man-killers but are quite capable of killing humans.

Most other lizards have neither poison nor great size as defenses and must rely on speed, camouflage or some special tricks to avoid predators. The portly chuckwalla of the southwestern United States and Mexico is able to inflate its body with air to twice its normal size. Under attack, it hides under a rocky ledge or in a crevice and inflates its body so that it is almost impossible to pull it out. But the Indians, who once savored the chickenlike flesh of the chuckwalla, learned to deflate the hapless creature with a pointed stick and drag it out. Chuckwallas, for their part, prefer flowers, and specifically brightly colored flowers, for food.

Skinks, which are common to all tropical and temperate regions of the earth, are among the most prolific families of lizards, with about 600 recognized species. With a few exceptions, they are recognizable by their glossy skins, and they run the gamut of lizard evolution, some with strong, well-developed legs, others with snakelike bodies and tiny, rudimentary limbs.

The majority of lizards are insectivorous and are important aids in keeping insect populations down. In tropical and subtropical countries the beautifully colored, large-eyed little geckos are welcomed into homes, where they relentlessly pursue flies, scorpions, mosquitoes and other pests. Endowed with remarkable fibrous footpads, geckos are able to scamper up a slippery wall or even across a ceiling on the trail of a fly.

The iguanids are one of the largest branches of the lizard tribe, ranging over the tropical and subtropical regions of the Americas and as far away as Madagascar and Fiji. They are a varied lot, remarkably adapted to their special environments. The rhinoceros iguana of Haiti (opposite) lives in an arid habitat, while the Galápagos marine iguana (overleaf) swims in the sea. The grotesque horned lizards—misnamed “horned toads”—look totally unlike their iguanid relatives, with flattened bodies and horny skin, an excellent desert camouflage and protection from predators. The horned lizard does resemble closely the Australian moloch, a completely unrelated lizard that evolved separately, halfway around the world, in an arid habitat that is almost identical to that of the horned lizard’s—a perfect example of parallel evolution and of the versatility of the lizards.

# Oceangoing Lizards

Of all the lizards, only the marine iguanas of the Galápagos Islands (left and below) are true creatures of the sea. They are equipped with flattened, paddlelike tails that effortlessly propel their five-foot-long bodies through the water. The sea is the marine iguanas' source of food, providing the algae and seaweed these herbivores eat. Because of their specialized diet the lizards have developed special nasal glands through which they excrete the excess salt they ingest. But even with these nautical adaptations, marine iguanas spend most of their time on land, sunning themselves on the volcanic rocks that border the sea and feeding only at low tide. Mating also takes place on land and is often marked by outbursts of aggression among males defending and disputing their territories and the harems of females that gather around them.



*Except at breeding time, marine iguanas are sociable animals. Herd members prefer to stay within 15 yards of shore, which often results in somewhat overcrowded conditions on the seaside cliffs (left). At low tide the lizards take to the sea (above), swimming easily, with only their dorsal crests and bumpy heads exposed.*



## Chromatic Chameleons

From their crested heads to their curling tails, chameleons are superbly constructed for life in the trees. Chameleons have opposable toes on all four feet, giving them firm footing on even the slimmest branches. Their usually long, thin tails are prehensile, providing a fifth grasping organ with which to climb slowly and steadily through their arboreal world. In addition, their unique eyes and tongue apparatus (see following pages) allow the lizards to zero in

with deadly accuracy on the grasshoppers and other insects they love to eat. Chameleons also have the ability to alter the color and pattern of their skin. These changes are dictated by variations in temperature and light and especially by the lizard's "emotional" state. Thus, the same chameleon will look different in daylight from the way it looks at night, different when it attacks from when it is being attacked.







## The Sure-footed Geckos

Geckos are a family of quite remarkable lizards. They are relatively small animals, the largest of which, the tokay of Asia (left), is 15 inches long. Geckos are the vocalists of the lizard world, with well-developed voices ranging from subdued chirps to loud-barks. Their feet usually end in enlarged toes that have lamellate, or scale-covered, soles (below). Most geckos are nocturnal animals—a factor in their ability to survive—with large, round, lidless eyes protected by a transparent membrane. These “contact lenses” are cleaned with a swipe of the lizards’ tongue. Geckos’ tails are autotomic and can be broken off at specific points by means of a muscle contraction. The wriggling of the discarded tail serves to distract an approaching enemy long enough to insure the gecko’s escape and a new, shorter tail grows in its place. Geckos also have the ability to slough off their skins in times of danger. Almost all geckos have these characteristics in some modified form to help them survive in terrain as diverse as deserts and rain forests.

*The Asiatic tokay, seen threatening an intruder above, is a plucky and persistent hunter, capable of subduing prey as large as a half-grown mouse. Like many other geckos, the tokay has scaled feet (right) lined with suction cups that are so tiny that they can adhere to the minutest irregularities on any smooth surface—even glass. The tokay moves by bending its broad toes backward, releasing the cups from the surface. With toes still flexed, it moves its foot to a new spot and presses the pads down again. When traversing rough terrain, such as the trunks of trees, geckos also employ the sharp claws at the tips of their toes.*





# A Cast of Colorful Characters

Many lizards, in addition to the true chameleons, have the ability to change color. Among them are the anoles, such as the Cuban knight anole (opposite), which are often mistakenly called chameleons. Fast-moving forest-dwellers, they lack the true chameleons' prehensile tails and opposable toes. Instead anoles have five clawed fingers and toes on each limb which enable them to climb securely through the trees. The agama lizard (below) and the racerunner lizard (right) exhibit some dazzling color displays. Their scales are made up of cells that contain a dark pigment called melanin and droplets of colored oil. When the melanin is concentrated at the center of the cell, light is reflected through the oil from the small spot of melanin, determining the animals' light color. But when the lizard is under stress or when there are changes in temperature and light, the melanin expands, screening out the color reflected through the oil and giving the animal a darker appearance.



In many lizard families it is the male that exhibits the most beautiful color changes. The brightly striped racerunner lizard (above) of Central and South America has a seasonal color repertoire. The males' coloring changes at breeding time and during disputes with other males over territory. The markings of the male agama lizard (left) of Africa and southwestern Asia are usually quite drab, but during the mating season he adopts the blue and purple blush that distinguishes him as a courting lizard.

# The Tuatara

When European settlers arrived in New Zealand in the early 19th century they found a lizardlike animal that the native Maoris called tuatara, or "spine bearer," for the spiny crest that runs down its neck and back and gives it a rather noble appearance. The reptile had no commercial value, either for its olive, yellow-spotted, pebble-dash skin or as a food, and scientists at first dismissed it as just another member of the multifarious lizard order, possibly an iguana. Later investigations by herpetologists disclosed that the tuatara (opposite) was no ordinary lizard but a very special creature indeed, the unique descendant of an ancient order of reptiles that goes back to the Age of Dinosaurs and was thought to be extinct for 180 million years. Through millions of years the tuatara had apparently not changed and yet somehow managed to escape extirpation on its remote South Pacific island home. It was, in short, a "living fossil," a creature that had hardly changed in nearly 180 million years. In genus, family and order, the tuatara is the last, and only, creature of its kind. Just why the curious animal escaped the fate of the rest of the members of its order is a mystery.

By the time the tuatara was recognized as the one-of-a-kind survivor it is, man had nearly completed the job that time and nature had overlooked. By 1850 there were no more tuataras on the two main islands of New Zealand: The sheep, goats, rats and other animals the settlers brought with them had wiped them out. Today these prehistoric relics live on only in some 23 windswept islets off the northeastern coast of New Zealand's North Island and in the Cook Strait, between the two main islands. Some 10,000 survive in their island fastnesses; but, rigidly protected by the New Zealand government, they seem to be holding their own, except on six islands where Polynesian rats have been introduced and prey on young tuataras. But, barring some sudden environmental change, they should continue to live.

Their survival depends completely on an undisturbed way of life. The tuatara shares its islands with swarms of seabirds. The birds live in burrows, and tuataras, though perfectly capable of digging their own holes, often move in with

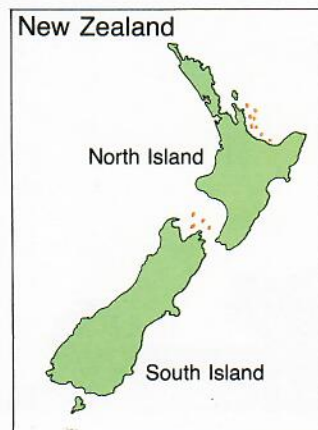
the birds. The rooming arrangements are usually amiable, although the primitive reptiles will sometimes eat the birds' eggs or nestlings or drive the original burrowers away. They seem to be loners, often grumpy by nature. The seabirds will occasionally eat a young tuatara. Perhaps as a natural means of self-preservation, tuataras are nocturnal, emerging from their holes at dusk, when the birds are in their burrows. Tuataras hunt the large, wingless crickets known as wetas, as well as the beetles, snails and geckos that are their principal food.

Tuataras differ uniquely from lizards and other reptiles in the structure of their skulls and bones. Another distinctive characteristic is a third eyelid, a translucent "window wiper" that sweeps across the surface of the lens from the inner corner while the two conventional eyelids are open. A third, or "parietal," eye is socketed in the top of the tuatara's head, clearly visible in younger animals but covered over with thickening skin as the tuatara ages. The third eye is unable to perceive images but is sensitive to heat and light and probably functions as a kind of thermostat, alerting the tuatara to get out of the hot sunlight. Tuataras have a much greater functional ability in cold weather than other reptiles. They are active when the temperatures are as low as 45 degrees F. but are most comfortable when the reading is about 52 degrees.

Adult male tuataras weigh over two pounds and grow to a length of more than two feet; females are slightly smaller. In the New Zealand summer (November to February) the female lays a clutch of eight to 15 parchment-shelled eggs in a shallow hole, usually some distance from her own

burrow, on a sun-warmed hillside. The eggs do not hatch for 13 to 15 months, the longest incubation period of any reptile, although they are ready to hatch by the beginning of the second summer. Instead, they go through a period of aestivation (summer dormancy) for several months before the young tuataras break out of their shells. Neither parent pays the slightest attention to the young, and the babies are on their own from birth.

*The tuatara formerly ranged over both main islands of New Zealand (green) but has been reduced to a sprinkling of offshore islets (red).*







# Caecilians

In 1920, during a specimen-collecting expedition to the Philippine island of Basilan, Edward H. Taylor, the American herpetologist, found a legless, wriggling creature underneath a log. After a perfunctory inspection he decided that it was just another earthworm and dropped it on the ground. To his surprise, the animal moved off, not in the characteristic concertina fashion of worms but in a very deliberate, serpentine wriggle, exactly like a slow-moving snake. Picking it up again, he examined the animal more closely and decided that he had discovered neither a snake nor a worm but a hitherto unknown species of caecilian. And what, one may properly ask, is a caecilian? It is not a native of Sicily but "the worm with a backbone," one of the least-known vertebrates on earth. Many herpetologists know it only from books and pictures, and only a few thoroughgoing scientific studies of caecilians have been made. Most laymen have never heard of the animal. And yet it is one of three surviving orders of amphibians that have lived on the earth longer than any other land creatures, the cousin of the familiar frogs and salamanders.

Physically, caecilians cannot be called handsome creatures. Their size ranges from four inches to four and one half feet and their color varies from charcoal-gray to pink. Their elongated bodies are segmented in circular or semicircular folds called annuli, but these have no function in moving, as the segments of an inchworm or a caterpillar do. They are the only amphibians that have a scattering of rudimentary scales. Although a few species are aquatic, most caecilians spend their lives in burrows in moist ground and under leaves, rocks, rotten logs and debris, searching for the worms and insects they feed on. They venture out on the surface of the ground at night, but the slightest glimmer of light drives them back to the darkness of their subterranean world.

Because they live in darkness, adult caecilians have little or no need for vision, and as a consequence their eyes are either very small and almost functionless or even overgrown by skin. Their sense of hearing is not very keen, either, and caecilians rely instead on small moving feelers or tentacles that sprout from their heads, near the eyes or nostrils, as they grow to adulthood, and on an excellent sense of smell. One African species has eyes on the tips of the tentacles. Their heads are important as burrowing instruments, so caecilian skulls are heavily boned and compact, and their muzzles often protrude belligerently. Although all caecilians have teeth, few are harmful to anything larger than a beetle or grub. The Indians of the Oax-

aca region of Mexico are unconvinced, though. They firmly believe that the metlopils, or Lafrentz caecilians, which they sometimes turn up with their plows are deadly poisonous and savage biters, and they give them a wide berth.

There are over 150 recognized species of caecilians, in four families, located in tropical and subtropical parts of the Americas, Africa, Asia and the Indonesian and Philippine archipelagoes.

Herpetologists believe that there are many undiscovered species of caecilians in areas of Sumatra and South America that have been poorly explored or unexplored zoologically. Those species that are known are still being named and classified, and there is much disagreement among herpetologists about their descriptions and characteristics. Until 1879 caecilians were classified as reptiles, described as a separate order of "pseudosnakes."

Courting almost certainly takes place when the caecilians come to the surface of the ground in the darkness of night; the breeding seasons are after the annual monsoons, or rainy seasons. Though most caecilians are oviparous, six species give birth to live young, small replicas of their parents that are nursed through the larval stage within the mother's body with a special uterine milk.

Egg-laying caecilians usually produce a clutch of about two dozen eggs, which they gather together in bunches in damp burrows near running streams. During incubation the mothers coil protectively around the eggs to guard them from burrowing snakes and legless lizards, which, because of their ability to follow them into their burrows, are the caecilians' principal enemies. As they incubate the eggs become annealed together and gradually absorb water from the damp earth, until they double in size. When they hatch, young caecilians are four times as large as the newly laid eggs.

Hatchlings have frilly, scarlet external gills, which they quickly lose. They go, nevertheless, to the water near their birthplace and begin a lengthy aquatic stage before metamorphosing into strictly terrestrial adults. During their watery larval phase young caecilians have large eyes and a tailfin, which gradually deteriorate as their tentacles develop and their skin changes texture. Nineteen aquatic caecilians of South America have only one functional lung; all others become bound to the land in adulthood. However, like all amphibians, they require considerable moisture in order to survive in their forest or riverbank habitats. They are, in fact, so completely terrestrial that if they are forced to stay in the water, they drown.





# Introduction

*by Richard Oulahan*



DURING AN ECLIPSE OF THE MOON IN 1972, Cambodian soldiers stationed in Phnom Penh killed two of their comrades and wounded 83 others when they fired thousands of rounds of ammunition and tracer bullets into the night sky. The fusillade was not an act of war or rebellion; the troops were simply warning the moon that it was being eaten by a snake. According to ancient Khmer legend, the sky is inhabited by an enormous serpent, an evil brother of the sun and moon that attempts to devour its celestial brethren from time to time, and it is the duty of humans during an eclipse to make as much racket as possible in order to alert the sun or moon so that they can escape the dreadful snake's attack. The soldiers in Phnom Penh were simply doing what their parents had taught them to do in early childhood.

That such mythic beliefs persist in an age when men have walked on the moon is not surprising. Humans have been in awe of reptiles and amphibians and have attributed magical powers to them throughout recorded history, simply because they are so different from the other creatures of the earth. They inspire either fear and revulsion or awe and admiration that often escalate to religious worship. However, such reactions are neither inborn nor instinctive. A very young American child will show no fear on his first encounter with a snake, but his older brother will have been taught that a snake is a dangerous, loathsome creature, to be avoided or killed. At the same time, youngsters in certain tribes of Africa and India are taught that the awesome python is sacred, to be respected and worshiped as a god.

It is true that some amphibians and reptiles are potentially dangerous: snakes with venom that can kill in a matter of minutes or coils that can crush the life out of an animal as large as a deer, crocodiles capable of amputating a leg or swallowing a child, turtles that can snap off fingers or toes, even poisonous lizards, frogs and salamanders. But, as with so many kinds of animals, the truly dangerous ones are a minority that give the others a bad name. While most reptiles and amphibians are harmless creatures, all are useful to mankind and the earth in keeping the balance of nature.

Still, man has reacted with panic and dread ever since his first encounter with a yawning croc or a writhing snake in some primeval forest millions of years ago. This has given rise to the greatest body of legends and tall tales to surround any group in the animal kingdom. Almost without exception the stories are untrue. There is, for example, no such thing as a hoopsnake that grasps its tail in its mouth and turns itself into a rolling wheel. Glass snakes (which are actually legless lizards) cannot fragment and then miraculously reassemble their bodies. Salamanders are not impervious to fire, and no one ever got warts from handling a toad. Snakes are not slimy, and mother snakes do not protect their babies by holding them in their mouths when danger threatens (although mother crocodiles do carry their young from the nest to the water gently cradled in their mouths). And St. Patrick, remarkable man though he undoubtedly was, did not drive all the snakes out of Ireland. Before snakes could get there from their southern places of origin, the Emerald Isle became detached from the European continent. England became an island in a later period of geologic upheavals, and three kinds of serpentine



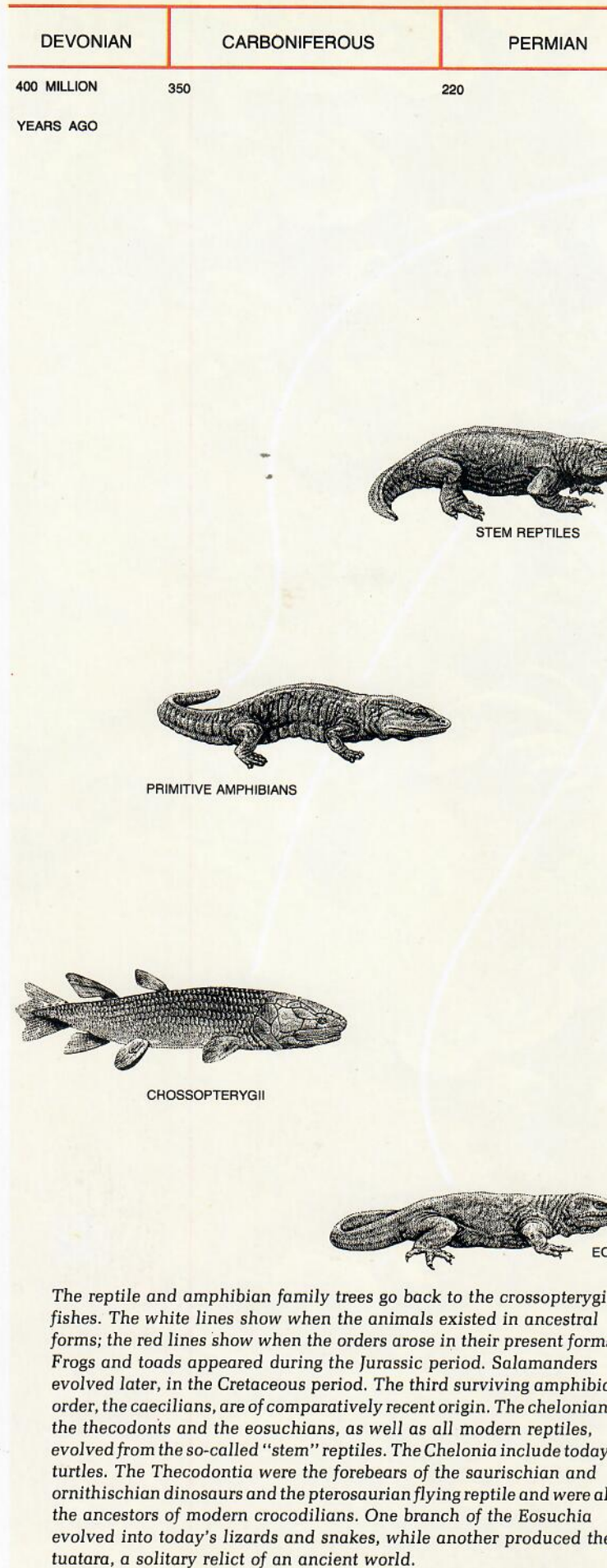


invaders were part of the English scene before it separated from the mother continent.

Reptiles—the word is of Latin origin meaning “to creep”—have been worshiped as gods or supernatural creatures with magical powers like that Cambodian flying snake since the beginning of recorded time. The ancient Egyptians considered the Nile crocodile divine and built a holy city, Crocodilopolis, in its honor. The Aztecs revered Quetzalcoatl, the plumed serpent, as “the master of life.” Aphrodite, the Greek goddess of love and beauty, had a sea turtle as an adviser, and across the world Benzai-Teu, the Japanese goddess of learning, eloquence and conjugal bliss, was depicted with a tortoise as her constant companion. The imperial Chinese dragon is believed to be a crocodile.

Ophiolotry, the worship of snakes, is by no means a dead religion. It is still practiced in Punjab and the Malabar Coast in India, and, on the Malaysian island of Penang, the Temple of the Snake is a famous tourist attraction. There, hundreds of snakes, many of them deadly poisonous, lie draped over altars, rafters and shrubbery by day and come down at night reputedly to consume the offerings left by the faithful when the stupor-inducing incense wafts away. In equatorial Africa the python is regarded as sacred, and men have been burned alive for accidentally killing one of the giant constrictors. The natives of Madagascar believe that the spirits of dead nobles enter the bodies of boas, and whenever a large snake is found after the burial of a prince, it is hailed with great joy and venerated and indulged for the rest of its days. Rattlesnakes are used in the religious dances of the Hopi Indians of the southwestern United States and in the rites of fundamentalist Christian sects of the rural South—occasionally with fatal effects on the handlers.

Although most humans have not turned to reptile worship, mankind does owe a certain debt to these primitive animals. Without reptiles and amphibians there would be no human race as we know it today. The amphibians were the first creatures to emerge from the sea, the first to breathe through true lungs, the first to crawl about on legs. Their immediate descendants, the reptiles, including the dinosaurs, were



The reptile and amphibian family trees go back to the chosopterygii fishes. The white lines show when the animals existed in ancestral forms; the red lines show when the orders arose in their present forms. Frogs and toads appeared during the Jurassic period. Salamanders evolved later, in the Cretaceous period. The third surviving amphibian order, the caecilians, are of comparatively recent origin. The chelonians, the thecodonts and the eosuchians, as well as all modern reptiles, evolved from the so-called “stem” reptiles. The Chelonians include today’s turtles. The Thecodontia were the forebears of the saurischian and ornithischian dinosaurs and the pterosaurian flying reptile and were also the ancestors of modern crocodilians. One branch of the Eosuchia evolved into today’s lizards and snakes, while another produced the tuatara, a solitary relict of an ancient world.

TRIASSIC

JURASSIC

CRETACEOUS

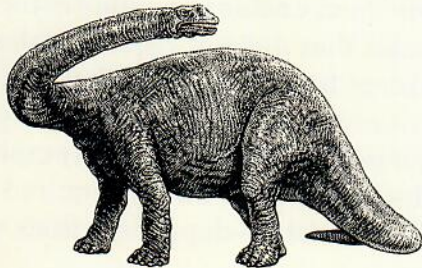
TERTIARY - RECENT

180

135

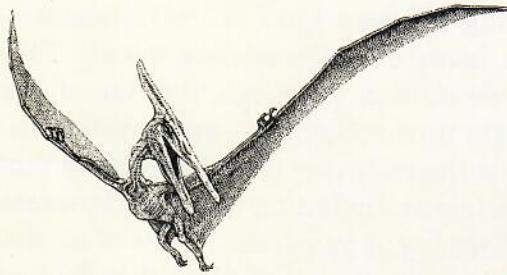
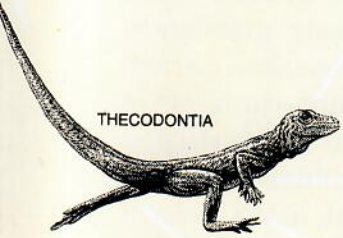
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CHELONIA

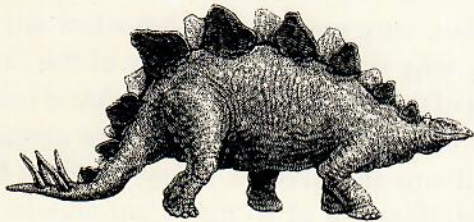


SAURISCHIA

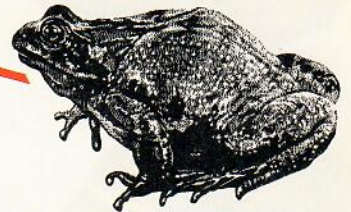
THECODONTIA



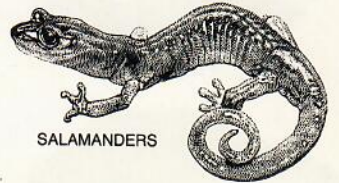
PTEROSAURIA



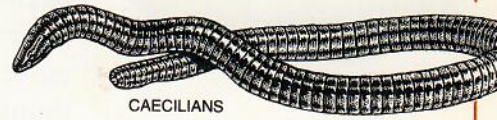
ORNITHISCHIA



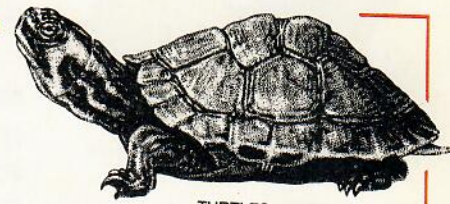
FROGS AND TOADS



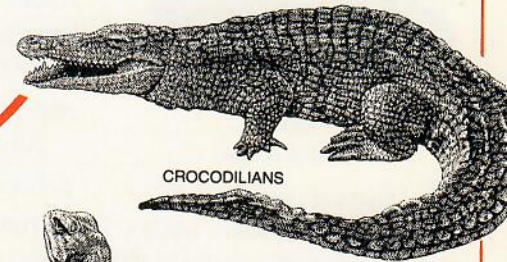
SALAMANDERS



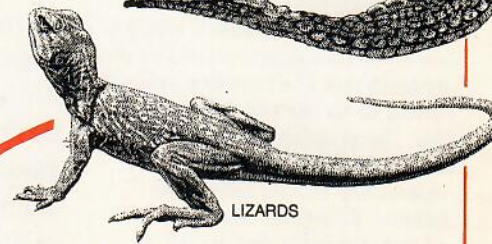
CAECILIANS



TURTLES



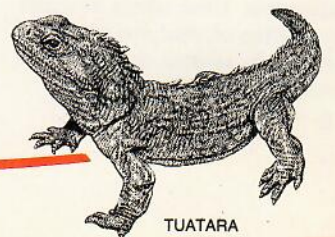
CROCODYLIANS



LIZARDS



SNAKES



TUATARA

AMPHIBIANS

REPTILES



Toad



Frog



Lizard



Snake  
Smooth scales



Snake  
Keeled scales

As the ancestors of today's reptiles and amphibians spent more time on dry land, they had to evolve ways of cutting down their bodies' water loss. The skins of modern reptiles and amphibians (above) reflect adaptations to their terrestrial habitats. Both frogs and toads have epidermal glands that secrete a mucus that helps prevent them from drying out. Most toads have skins covered with wartlike protuberances, while frogs are generally smooth, soft and moist. Lizards and snakes evolved a horny epidermal covering that slows down evaporation. These plates, or scales, may overlap or abut one another; they may be smooth or have a keel down the center.

the first vertebrates to live entirely on the land. Every living land animal of today—all the birds of the air, every warm-blooded mammal, including man—is descended from those pioneering amphibians and reptiles.

Until 80 million years ago the reptiles were the dominant animals of the planet, like Quetzalcoatl "the masters of the earth." The Age of Reptiles lasted a full 120 million years, and before that, in the late Devonian period (300 to 350 million years ago), the ancestral amphibians were the only living creatures, other than fishes and insects, that evolved separately—sluggish animals that plodded from pool to pool in the steaming swamps, feeding on the insects that hovered overhead.

Unlike the so-called warm-blooded mammals that followed them, the reptiles remained "cold-blooded" in that their body temperatures were governed by the temperature of their habitat, which made them unable to tolerate extremes of cold or heat. They developed protective scales that did not require moisture, as the naked skin of amphibians does, and except for snakes and other legless reptiles their limbs evolved into a different positioning off the belly, enabling reptiles to move more efficiently on land. The major point of departure from amphibious life, though, was the evolution of a tough-shelled egg, which required no watery hatchery and enabled reptiles to leave their moisture-dependent pasts and become the first completely terrestrial creatures.

Reptiles flourished and dominated the earth for at least 120 million years, adapting to every kind of environment—swamps, deserts, forests, grasslands, rivers, lakes, even the sea and the air. Then, at the end of the Cretaceous period, some 80 million years ago, the Age of Reptiles came to an abrupt—in terms of geologic time reckoning—and mysterious end. The story is told in the striated rocks of the early part of that period. In those rocks hundreds of different kinds of reptile fossils, including those of dinosaurs, have been found. But, in the rocks of later Cretaceous years, the fossils of all the dinosaurs and four-fifths of the other reptiles, including all of those that flew, completely disappeared.

What caused this dramatic and abrupt extinction? Scientists have theorized and debated the question ever since they learned to interpret the riddles of the Cretaceous rocks, without reaching a completely satisfactory explanation. If a flaming supernova scorched the earth, killing all the dinosaurs and most reptiles by radiation, as some have suggested, then why were there even a few survivors? If their bigness doomed the dinosaurs, why did small members of the family also perish? A sudden cooling or warming of the earth's temperature could indeed have accounted for the so-called "time of dying," but it would just as certainly have exterminated the reptiles and amphibians that live on today to refute that argument. And to attribute the sudden obliteration of so many animals to a natural catastrophe is to invite two unanswerable questions: 1) Why was it selective? and 2) Why was it not recorded in the telltale Cretaceous rocks?

The true cause of the great extirpation will probably never be known, but it must be counted one of the major events in the story of the earth. The end of the Age of Reptiles left great voids in the terrestrial parts of the earth, to be filled by warm-blooded animals in the beginning of the present Age of Mammals.

What remains of the dinosaurs are fossilized bones and eggs in museums. The rest of the reptiles are not much better off: Of 16 orders known to have roamed the earth, only four have survived. Three of these—the turtles, the crocodilians and the lonely tuatara—are in decline, with just 250 species of turtles, 21 crocodilians and a single order of tuatara surviving. Only the fourth order, which includes both lizards and snakes, has continued to proliferate and adapt to a changing world. Snakes, in fact, are the newest suborder of reptiles, descended from the lizards, with a genesis in the early Cretaceous period, when the Age of Reptiles was flourishing. Together the snakes and lizards consists of over 4,700 species, by far the largest, most modern branch of the reptile class.

Given a reasonable chance, the reptiles might continue to live on indefinitely. But they share the planet with man, and man in a few hundred years has visited on them a second “time of dying.” Wholesale slaughter of reptiles for their beautifully patterned skins and shells, and for their flesh and eggs, along with the systematic destruction of their environments, have kept the scaly creatures in a steady decline. Some species, such as the great green turtle of the high seas and the unique tuatara, have been so reduced in numbers that they are now belatedly protected animals, teetering on the brink of extinction and surviving only by the sufferance of man.

The more primitive amphibians have fared no better. Through the attrition of the ages and the encroachments of mankind on their humid habitats they have been reduced to just three orders—the frogs and toads, the salamanders and the snakelike caecilians. The rare sirens, two-legged amphibians, are sometimes classified as a separate fourth order, but most herpetologists place them in the salamander order. As the name *amphibian*—“double life” in Greek—implies, they must live in an environment with access to both water and land, and that limitation alone has kept them from developing as successfully as their reptilian kin. And man’s relentless development of the land has cut back the living space of amphibians to an alarming degree. In one particularly dramatic example, the entire world of the Santa Cruz long-toed salamander has now shrunk to an area the size of a racetrack. As if that were not enough, amphibians are preyed on quite as relentlessly as any other animal. In 1971 nine tons of leopard frogs were shipped out of Manitoba for use in United States and Canadian laboratories and schools—some 216,000 frogs, at a rate of 50 to 55 cents a pound. A worthy contribution to science, perhaps, but with that kind of depredation, the springtime choruses of the frogs may soon be just a memory.

If the unhappy day comes when the last reptiles and amphibians have departed this earth, it may be a day of reckoning. These creatures are of inestimable value to mankind and other animals for their role in keeping the delicate balance of nature. They are formidable consumers of insects, rodents and other pests. In South America, enlightened planters do not harm snakes in their canefields that control the plagues of rats, and any knowledgeable Midwest farmer knows that an insect-gorged toad is a valuable commodity to him. So, on that silent spring day when the last snakes and frogs and lizards disappear forever and the Age of Insects begins, man himself may not be far behind.



Wild, Wild World of Animals

# Reptiles & Amphibians



Snakes · Turtles · Lizards · Crocodilians  
Tuatara · Salamanders · Frogs · Toads

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