The Tao of the Alligator and the Crocodile

Ancient Animals in a Modern World

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ISBN Number 978-0-9858688-7-1

How doth the little crocodile
Improve his shining tail
And pour the waters of the Nile
On every golden scale!

How cheerfully he seems to grin
How neatly spreads his claws
And welcomes little fishes in
With gently smiling jaws!

Lewis Carroll from *Alice in Wonderland*

Family Gavialdae

Gavialis gangeticus Gharial

Chapter One

The Dawn of Reptiles

The Big Boys Come Out to Play

Crocodiles Make Their Entrance

The Mesozoic (from "meso" meaning middle and "oic" referring to animals) Era includes three geologic periods: the Triassic, named in 1834 by Fredrich Von Albertini for the three distinct layers of red beds (the Bunter, Muschelkalk and Keuper) capped by chalk followed by black shale (245-208 million years ago), Jurassic (208-146 million years ago), and Cretaceous (derived form the Latin "Creta" meaning chalk (146-65 million years ago). It was during this time that the world's fauna changed dramatically and drastically from what had been seen in the Paleozoic Era.

Flying reptiles and birds first appeared during the Mesozoic Era. The Jurassic and Cretaceous Periods saw crustal plates collide and generate large qualities of molten rock that rose up and formed what is now the Sierra Nevada mountain range in California and the Rocky Mountains. The Appalachian Mountains, at that time as high as the Rocky Mountains were also created.

On land dinosaurs were the ruling animals while enormous marine reptiles populated and dominated the world's oceans. During much of this period world climate was temperate and equatorial and shallow seas covered low-lying land masses. There were no ice caps not even in the polar regions that were not moist and temperate. By the end of the Cretacious period the dinosaurs had become extinct. Some of their fossilized remains have been found in Montana and New Mexico.

At the beginning of the Mesozoic Era of the earth's land was contained in a single continent called Pangaea (All Earth) which fractured into Laurasia in the north and Gondwanaland in the south.

North America broke away from the northwest coast of Africa and the Atlantic Ocean forming the Gulf of Mexico. Over time South America, India and Antarctica broke away from Africa and assumed the positions they occupy today.

During the Mesozoic Era there were several derivations of marine reptiles. In contrast with the mammals who presumably developed from some collective forerunner of reptiles early in the Triassic Period, many more types of reptiles, having accomplished an existence on land, reverted to the seas. Aquatic adaption (marine, estuarine or freshwater) is a common event among reptiles because of their low metabolic rate, facility to accept anoxia and low body temperatures, and easy ability to utilize to their best advantage fermentative metabolism for muscle activity. Perhaps most important it does not require large structural or physiological changes. Moreover reptiles move with an inherently sinuous motility that is easily adaptable to swimming.

It is not surprising that reptiles liked the seas. And still do.

Although today's crocodilians are for the most part large reptiles adapted to a semi-aquatic existence, it wasn't always like way.

The alligator's, caiman and crocodile's early predecessors (Crocodylomorphia) were called archosaurs and they were typically reptilian in their scaly integument and ectothermic (cold-blooded) metabolism, maternal care of their young, and four-chambered heart. The archosauria (meaning ruling reptiles) was comprised of dinosaurs, pterosaurs and the thecondotians which may have been a precursor to modern crocodiles. The name thocondota refers to teeth set into jaw sockets as opposed to being fused to the sides of the jaw as is typical of other reptiles.

During the late Triassic and early Jurassic Periods these animals were primarily diminutive, graceful, energetic, terrestrial forms. The earliest known crocodilian-like reptiles among the archosaurs are the sphenosuchians whose fossil remains have been found in rocks dating to the late Triassic period, approximately 230 million years ago. After thriving for forty to fifty million years, almost as long as

the age of mammals, these animals died out either thorough competition with small theropod dinosaurs or perhaps through a mass extinction.

The surviving crocodilians were much larger animals, more like the alligators, caiman and crocodiles of today but they were also mostly marine. These animals were called protosuchians. Suchia is a common ending of words relating to crocodiles, coming from the Latin Sobek, a crocodile god of ancient Egypt.

Later in the Jurassic Period these primarily salt water preferring animals invaded fresh water and swamp environments as large, semi-aquatic predators. It was in this form that they were most successful.

The basic crocodilian design has changed very little in the last 200 million years. Crocodilians existed in the Cretacious Period. However, they had major marine competitors such as sharks and other predatory fish. Obviously a shark can swim faster than a crocodilian and if the two are competing for the same food source the crocodilian will always lose.

That's why as time progressed crocodilians became less of a strictly marine animal and more of a semi-aquatic predator. Arguably this is the one adaption that has allowed them to survive for more than 200 hundred million years. Everything else was in place and this one kink in the evolutionary line quite possibly saved them from extinction.

During the Triassic Period rainfall on earth increased, the oceans rose and lush, tropical vegetation covered much of the earth's surface. Conifers, giant club moss, and tree ferns ruled the timberlands and marshlands. Much of North America was under water during the Triassic Period. It was a time of vast change when strange creatures walked the earth. Animals began to take on different characteristics.

The polyphletics that included turtles, lizards and alligators fertilized their eggs internally and encased their young in a tough membrane that protected the embryo, the larval stage occurred inside

the egg and when they hatched they were miniature adults.

These in turn gave rise to the thecodonts that included dinosaurs, crocodile-like reptiles called phytosaurs and birds. The phytosaurs had four short legs, a long snout, and differentiated teeth. There's a model of one on display at Dinosaur State Park in Rocky Hill, Connecticut in the United States and it has the thick body of an alligator or crocodile and a long, narrow snout. Crocodilian history is relatively well-known because their marshy habitat promotes fossilization.

Another discovery near Cheshire, Connecticut revealed the fossilized remains of a Mesozoic crocodile that walked upright on four legs not with its legs splayed out as with modern crocodiles. The position enabled the crocodile to literally gallop, probably attaining speeds greater than fifteen miles per hour. The fossil closely resembles remains found in Scotland more than one hundred years ago. Giant crocodile fossils have also been discovered in the Aguja Formation in the Big Bend National Park, Texas. Reaching lengths of between forty to fifty feet and armed with six-inch long teeth, these Triassic Period monsters were ambush hunters, lying submerged near shore and capturing enormous dinosaurs as they rummaged amid the flora of Big Bend's antediluvian marshes.

Phytosaurs (meaning plant lizards, an inaccurate description) flourished during the late Triassic Period 222 to 215 million years ago. They are not considered dinosaurs but semi-aquatic thecondont, archosaurian reptiles. Their body armor was much thicker than modern day crocodilians. Heavy bony plates even covered their throat and their stomachs were supported by a separate set of abdominal ribs. Measuring up to sixteen feet in length and possessing a long slender snout (ideal for catching fast prey) full of weak but razor sharp teeth designed for holding and positioning but not shearing they resembled Gharials which are also called Gavials and were the dominant predators in lakes, rivers and swamps during their time. They differed from present crocodilians in several ways. It is possible they built nests and protected their young.

Most had tusk-like teeth that jutted from the curved upper and lower jaws. Reasons for these

highly specialized teeth remain somewhat speculative. Some scientists contend they were used to spear fast-moving fish, other say they were used for probing for prey and some think they were used in combat.

Their nostrils were high on their heads just in front of their eyes and they did not have a double palate that enables modern crocodiles, caiman and alligators to breathe despite having a mouthful of water. Their high nostrils gave them that capability. They could move in a semi-erect stance on land but did not drag their tails.

Although primarily fish eaters they would attack and kill any small animal that came within striking distance near the water's edge. Like the dinosaurs they were victims of the mass K-T extinction that occurred at the end of the Triassic Period. Although they had a physical resemblance to modern crocodilians, they are only distantly related. Phytosaurs were the pioneers that paved the way for present crocodiles, caiman, alligators and gharials.

The tropical Tethys Sea formed between the supercontinents of Gondwanaland in the south and Laurasia in the north and became home to a distinctive congregation of marine reptiles who were mainly coastal and shallow water dwellers. It was the beginning of the Mesozoic Era and exciting things were happening. Pangaea altered global climate and ocean circulation. Mass extinctions were common and the survivors of these catastrophic events spread and recolonized.
Evolve or die.

The first birds, Archaeopteryx whose spines extended into bony tails just like reptile tails, made their appearance and reptiles increased their chances of survival because their desiccation resistant eggs allowed them to move away from the water. Mystriosuchus, a crocodile-like reptile was one of many types that prowled the fresh and salt waters of the earth, filling empty niches on land and in water. Amphibians also flourished.

The most successful group was the Squamata whose members include iguanas, geckos and

chameleons. It was a good time to be a reptile. The environment was perfect and the unbeatable evolutionary hand they had been dealt was being played out perfectly.

The word Jurassic often triggers images of giant four and two-legged dinosaurs running amok through forests of giant ferns and conifers and usually this is true although many animals portrayed in the film *Jurassic Park* flourished a little later during the last portion of the Mesozoic Era, the Cretaceous Period. Nevertheless, it's a fair representation.

The name Jurassic derives from the Jure Mountains that border France and Switzerland. In 1795 Alexander von Humbolt characterized the limestone formations as Jura Limestone and in 1839 Leopold von Buch designated the rocks the Jurassic System and the name stuck. The dinosaurs at this time were quite different from those found in the Triassic Period. Diversification ran rampant often having deleterious effects upon individual species.

The ocean levels rose and flooded large portions of the continent. The climate was hot and humid like a giant greenhouse. Modern sharks began to appear and semi-aquatic, fish eating alligators and crocodiles were plentiful and eclectic. Some of them were true giants and they fed on the dinosaurs that ventured into water.

The Cretaceous Period (named for the extensive chalk beds found in Upper Cretaceous in Great Britain and adjacent continental Europe) saw more changes some of which were subtle while others were blatant.

For the dinosaurs the end of their reign as the predominant species on earth had come. They had flourished for millions of years evolving into animals that stir the imagination to this day. Nevertheless, when the end came, it came with a bang not a whimper as an asteroid collision. Never to be seen again, their fossil remains fascinate and tantalize.

Flowering plants now ruled the earth's flora and greatly modified its ecology in elemental ways. The plants that depended on birds, insects and small mammals for pollination brought them into

mutually dependent co-evolutionary alliances with these animals. The possibilities were infinite and many of them were exploited to the fullest.

Although there are no significant gaps in the fossil record leading to today's alligators, their development in America is well-documented. The earliest Tertiary remains in North America date back to the Palaecocene epoch, around fifty-seven million years ago. In North Dakota, a small alligatorine, with a short and rather pointed snout, was unearthed. Known as *Wannaganosuchus*, it was evidently well-protected by scutes. Another Palaecocene find is that of *Ceratosuchus*, from Colorado. This alligatorine had strange head armaments, in the form of triangular horns, which resulted from an enlargement of the squamosal bones located at the back of the skull, behind the eyes. The function of these horns is unclear.

Some opinions hold that during the succeeding Eocene epoch, there were at least four different genera of alligatorine present in North America. These include *Allognathosuchus* a relatively small species growing up to 9.75 feet in length. Its remains have also been found in Europe, where alligators were quite widespread at this stage. The unusually flattened and large rear teeth of the alligatorine, coupled with its powerful jaws, suggested it may have preyed on turtles and shellfish.

While *Allognathosuchus* appears to have played no part in the development of contemporary alligators, it is possible that its descendants gave rise to the South American genus *Eocaiman*. These alligatorines are assumed to have been part of the ancestral line leading to contemporary caiman.

The most likely Eocene genus involved in the subsequent evolution of the various North American forms of alligator is *Procaimanoidea*. Its remains have been unearthed in Wyoming and in Utah. Again, its dentition suggests that it fed on food which had to be crushed before swallowing. The head was also enlarged.

Some experts posit that the fourth alligatorine genus known from the Eocene epoch in North America was *Diplocynodon* but it seems to have a rather brief history, occurring in the United

Kingdom about forty-seven million years ago. In contrast across the Atlantic and in Europe, it survived as recently as three and a half million years ago, and its remains have been found over a wide area, from Spain to Bulgaria. This alligatorine is characterized by the presence of a double pair of caniniform teeth in the upper jaw.

Following the close of the Eocene epoch, the first member of the contemporary genus *Alligator* appeared during the succeeding Oligocene epoch, which lasted for fourteen million years. Christened *Alligator prenasalis* it lived in the vicinity of present-day South Dakota. This was a broad-headed alligatorine, which was to play a critical role in the development of subsequent North American alligators.

Many experts concur that three distinct species had evolved from *Alligator prenasalis* by Miocene times. The most specialized of these was undoubtedly *Alligator mcgrewi*, which has been discovered in the Marseland formation of Nebraska. It was characterized by an extremely broad head and a short snout, and attained a size of about six and a half feet. This species had died out by the end of the Miocene, five million years ago, and left no obvious descendants.

In contrast, *Alligator thomsoni*, which was contemporaneous with *Alligator mcgrewi* in Nebraska, appears to have continued to influence the alligator lineage down to the present day. Another broad-snouted species, it thrived in the north-west of the United States at a time when the climate in the area was much milder than it is today. From here *Alligator thomsoni* was able to cross the land bridge in the region of the Bering Strait to reach Asia. On this continent it became established as the predecessor of the Chinese alligator.

Many authorities hold that in North America, the direct descendant of *Alligator thomosi*, which appeared during the Pliocene in Nebraska, was *Alligator mefferdi*. This form had become isolated from the eastern population of alligators as the Rocky Mountains formed and created a dry area in their wake. In due course *Alligator mefferdi* was to die out, and so this particular evolutionary line came to

an end in the United States.

It was to be *Alligator olseni*, which was known to have occurred in Florida during the Miocene epoch, that led to the present-day American alligator (*Alligator mississippiensis*). Yet *Alligator olseni* was a relatively small species in comparison, which rarely grew beyond eight feet in overall length. Its range may have extended over a much wider area of the eastern United States but there is a lack of fossil evidence to confirm this possibility.

Traces of a succeeding Pliocene alligator have also been found in Florida. It seems likely that this was indistinguishable from *Alligator mississippiensis*, which means that this species could have evolved up to five million years ago.

As we skim over these millions of years of evolution one lasting impression remains with us, fixed in our memory. Very quietly and subtly alligators, caiman and crocodiles slowly climbed up the evolutionary ladder making critical adaptions at crucial times. In doing so they found a niche for themselves that dovetailed perfectly into a radically changing environment and habitat.
A few tiny missteps over the eons and their fate would have been drastically altered. Somehow, for reasons that are both clear and obscure they didn't. In doing so, in making those momentous modifications at the precise moments that were absolutely necessary they secured the place they have occupied ever since.

Timing is everything.

As man evolved with agonizing slowness from ape-skulled *Australopithecus anamensis* to flat-nosed *Australoputhecus afarensis* to human-jawed *Australopithecus africanus* to large brow-ridged *Australopithecus robustus* to starting to talk *Homo habilis* to tool, weapon and fire using *Homo erectus* to rounded skull *Homo sapiens archaic* to receding foreheaded *Homo sapiens neanderthalensis* to modern *Homo sapiens sapiens* they would have seen crocodiles.

And they wouldn't have been the dainty six to eighteen footers that can be observed today in

many parts of the world.

Thirty-five million years ago they would have seen the fifty-foot *Deinosuchus riograndenis* armed with over a hundred teeth, forty-five million years ago perhaps they would have raided crocodile nests for eggs, an excellent source of protein, in what is now Glen Rose, Texas.

Eighty million years ago they would have had to take special care to avoid thirty-foot-long crocodiles that plied every existing swamp and river patiently lying in wait for an opportunity to ambush the thirsty or unwary. One hundred million years ago in what is now New Mexico crocodiles swept their toes on the bottom of a shallow sea cruising the shoreline with only eyes and nostrils showing.

One hundred and ten million years ago forty-foot-long *Sarcosuchus imperator* (flesh-eating crocodile emperor) was the top predator in the many rivers that flowed through the lush plains of what is now Niger. Weighing 18,000 pounds, it preyed on dinosaurs and one of its haunts was Gadoufaou (the place where camels fear to tread). The dog-like *Araripesuchus* also lived in the rivers and was capable of inflicting a nasty, often fatal bite.

As he slowly developed and progressed over millions of years early man would have seen countless numbers of his own kind eaten alive by monster crocodiles. There are far better and less painful ways to die.

And man would have been terrified and he would have remembered.

Just as we do.