

## Examrace

# Competitive Exams: Evolution Time Scale: Dinosaurs

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## The Dinosaurs

The Dinosaurs (or "terrible reptiles" ), the monarchs of the land and the swamps, are the central and outstanding family of the Mesozoic reptiles. As the name implies, this group includes most of the colossal animals, such as the Diplodocus, which the illustrated magazine has made familiar to most people. Fortunately the assiduous research of American geologists and their great skill and patience in restoring the dead forms enable us to form a very fair picture of this family of medieval giants and its remarkable ramifications.

The Diapsid reptiles of the Permian had evolved a group with horny, parrot-like beaks, the Rhyncocephalia (or "beak-headed" reptiles), of which the tuatara of New Zealand is a lingering representative. New Zealand seems to have been cut off from the southern continent at the close of the Permian or beginning of the Triassic, and so preserved for us that very interesting relic of Permian life. From some primitive level of this group, it is generally believed, the great Dinosaurs arose. Two different orders seem to have arisen independently, or diverged rapidly from each other, in different parts of the world. One group seems to have evolved on the "lost Atlantis," the land between Western Europe and America, whence they spread westward to America, eastward over Europe, and southward to the continent which still united Africa and Australia. We find their remains in all these regions. Another stock is believed to have arisen in America.

Both these groups seem to have been. More or less biped, rearing themselves on large and powerful hind limbs, and (in some cases, at least) probably using their small front limbs to hold or grasp their food. The first group was carnivorous, the second herbivorous; and, as the reptiles of the first group had four or five toes on each foot, they are known as the Theropods (or "beast-footed" ), while those of the second order, which had three toes, are called the Ornithopods (or "bird-footed" ). Each of them then gave birth to an order of quadrupeds. In the spreading waters and rich swamps of the later Triassic some of the Theropods were attracted to return to an amphibious life, and became the vast, sprawling, ponderous Sauropods, the giants in a world of giants. On the other hand, a branch of the vegetarian Ornithopods developed heavy armour, for defence against the carnivores, and became, under the burden of its weight, the quadrupedal and monstrous Stegosauria and Ceratopsia. Taking this instructive general view of the spread of the Dinosaurs as the best interpretation of the material we have, we may now glance at each of the orders in succession.

## The Theropods

The Theropods varied considerably in size and agility. The Compsognathus was a small, active, rabbit-like creature, standing about two feet high on its hind limbs, while the Megalosaurus stretched to a length of thirty feet, and had huge jaws armed with rows of formidable teeth. The Ceratosaur, a seventeen-foot-long reptile, had hollow bones, and we find this combination of lightness and strength in several members of the group. In many respects the group points more or less significantly toward the birds. The brain is relatively large, the neck long, and the fore limbs might be used for grasping, but had apparently ceased to serve as legs. Many of the Theropods were evidently leaping reptiles, like colossal kangaroos, twenty or more feet in length when they were erect. It is the general belief that the bird began its career as a leaping reptile, and the feathers, or expanded scales, on the front limbs helped at first to increase the leap. Some recent authorities hold, however, that the ancestor of the bird was an arboreal reptile.

To the order of the Sauropods belong most of the monsters whose discovery has attracted general attention in recent years. Feeding on vegetal matter in the luscious swamps, and having their vast bulk lightened by their aquatic life, they soon attained the most formidable proportions. The admirer of the enormous skeleton of Diplodocus (which ran to eighty feet) in the British Museum must wonder how even such massive limbs could sustain the mountain of flesh that must have covered those bones. It probably did not walk so firmly as the skeleton suggests, but sprawled in the swamps or swam like a hippopotamus. But the Diplodocus is neither the largest nor heaviest of its family. The Brontosaur, though only sixty feet long, probably weighed twenty tons. We have its footprints in the rocks to-day, each impression measuring about a square yard.

Generally, it is the huge thigh-bones of these monsters that have survived, and give us an idea of their size. The largest living elephant has a femur scarcely four feet long, but the femur of the Atlantosaur measures more than seventy inches, and the femur of the Brachiosaur more than eighty. Many of these Dinosaurs must have measured more than a hundred feet from the tip of the snout to the end of the tail, and stood about thirty feet high from the ground. The European Sauropods did not, apparently, reach the size of their American cousins--so early did the inferiority of Europe begin--but our Ceteosaur seems to have been about fifty feet long and ten feet in height. Its thigh-bone was sixty-four inches long and twenty-seven inches in circumference at the shaft. And in this order of reptiles, it must be remembered, the bones are solid.

## **The Sauropods**

To complete the picture of the Sauropods, we must add that the whole class is characterised by the extraordinary smallness of the brain. The twenty-ton Brontosaur had a brain no larger than that of a new-born human infant. Quite commonly the brain of one of these enormous animals is no larger than a man's fist. It is true that, as far as the muscular and sexual labour was concerned, the brain was supplemented by a great enlargement of the spinal cord in the sacral region (at the top of the thighs). This inferior "brain" was from ten to twenty times as large as the brain in the skull. It would, however, be fully occupied with the movement of the

monstrous limbs and tail, and the sex-life, and does not add in the least to the "mental" power of the Sauropods. They were stupid, sluggish, unwieldy creatures, swollen parasites upon a luxuriant vegetation, and we shall easily understand their disappearance at the end of the Mesozoic Era, when the age of brawn will yield to an age of brain.

The next order of the Dinosaurs is that of the biped vegetarians, the Ornithopods, which gradually became heavily armoured and quadrupedal. The familiar Iguanodon is the chief representative of this order in Europe. Walking on its three-toed hind limbs, its head would be fourteen or fifteen feet from the ground. The front part of its jaws was toothless and covered with horn. It had, in fact, a kind of beak, and it also approached the primitive bird in the structure of its pelvis and in having five toes on its small front limbs. Some of the Ornithopods, such as the Laosaur, were small (three or four feet in height) and active, but many of the American specimens attained a great size. The Camptosaur, which was closely related to the Iguanodon in structure, was thirty feet from the snout to the end of the tail, and the head probably stood eighteen feet from the ground. One of the last great representatives of the group in America, the Trachodon, about thirty feet in length, had a most extraordinary head. It was about three and a half feet in length, and had no less than 2000 teeth lining the mouth cavity. It is conjectured that it fed on vegetation containing a large proportion of silica.

In the course of the Jurassic, as we saw, a branch of these biped, bird-footed vegetarians developed heavy armour, and returned to the quadrupedal habit. We find them both in Europe and America, and must suppose that the highway across the North Atlantic still existed.

## **The Stegosaur**

The Stegosaur is one of the most singular and most familiar representatives of the group in the Jurassic. It ran to a length of thirty feet, and had a row of bony plates, from two to three feet in height, standing up vertically along the ridge of its back, while its tail was armed with formidable spikes. The Scelidosaur, an earlier and smaller (twelve-foot) specimen, also had spines and bony plates to protect it. The Polacanthus and Ankylosaur developed a most effective armour-plating over the rear. As we regard their powerful armour, we seem to see the fierce-toothed Theropods springing from the rear upon the poor-mouthed vegetarians. The carnivores selected the vegetarians, and fitted them to survive. Before the end of the Mesozoic, in fact, the Ornithopods became aggressive as well as armoured. The Triceratops had not only an enormous skull with a great ridged collar round the neck, but a sharp beak, a stout horn on the nose, and two large and sharp horns on the top of the head. We will see something later of the development of horns. The skulls of members of the Ceratops family sometimes measured eight feet from the snout to the ridge of the collar. They were, however, sluggish and stupid monsters, with smaller brains even than the Sauropods.

Such, in broad outline, was the singular and powerful family of the Mesozoic Dinosaurs. Further geological research in all parts of the world will, no doubt, increase our knowledge of them, until we can fully understand them as a great family throwing out special branches to meet the different conditions of the crowded Jurassic age. Even now they afford a most

interesting page in the story of evolution, and their total disappearance from the face of the earth in the next geological period will not be unintelligible. We turn from them to the remaining orders of the Jurassic reptiles.

In the popular mind, perhaps, the Ichthyosaur and Plesiosaur are the typical representatives of that extinct race. The two animals, however, belong to very different branches of the reptile world, and are by no means the most formidable of the Mesozoic reptiles. Many orders of the land reptiles sent a branch into the waters in an age which, we saw, was predominantly one of water-surface. The Ichthyosauria ( "fish-reptiles" ) and Thalattosauria ( "sea-reptiles" ) invaded the waters at their first expansion in the later Triassic. The latter groups soon became extinct, but the former continued for some millions of years, and became remarkably adapted to marine life, like the whale at a later period.

The Ichthyosaur of the Jurassic is a remarkably fish-like animal. Its long tapering frame--sometimes forty feet in length, but generally less than half that length--ends in a dip of the vertebral column and an expansion of the flesh into a strong tail-fin. The terminal bones of the limbs depart more and more from the quadruped type, until at last they are merely rows of circular bony plates embedded in the broad paddle into which the limb has been converted. The head is drawn out, sometimes to a length of five feet, and the long narrow jaws are set with two formidable rows of teeth; one specimen has about two hundred teeth. In some genera the teeth degenerate in the course of time, but this merely indicates a change of diet. One fossilised Ichthyosaur of the weaker-toothed variety has been found with the remains of two hundred Belemnites in its stomach. It is a flash of light on the fierce struggle and carnage which some recent writers have vainly striven to attenuate. The eyes, again, which may in the larger animals be fifteen inches in diameter, are protected by a circle of radiating bony plates. In fine, the discovery of young developed skeletons inside the adult frames has taught us that the Ichthyosaur had become viviparous, like the mammal. Cutting its last connection with the land, on which it originated it ceased to lay eggs, and developed the young within its body.

## The Ichthyosaur

The Ichthyosaur came of the reptile group which we have called the Diapsids. The Plesiosaur seems to belong to the Synapsid branch. In the earlier Mesozoic we find partially aquatic representatives of the line, like the Nothosaur, and in the later Plesiosaur the adaptation to a marine life is complete. The skin has lost its scales, and the front limbs are developed into powerful paddles, sometimes six feet in length. The neck is drawn out until, in some specimens, it is found to consist of seventy-six vertebrae: The longest neck in the animal world. It is now doubted, however, if the neck was very flexible, and, as the jaws were imperfectly joined, the common picture of the Plesiosaur darting its snake-like neck in all directions to seize its prey is probably wrong. It seems to have lived on small food, and been itself a rich diet to the larger carnivores. We find it in all the seas of the Mesozoic world, varying in length from six to forty feet, but it is one of the sluggish and unwieldy forms that are destined to perish in the coming crisis.

The last, and perhaps the most interesting, of the doomed monsters of the Mesozoic was the Pterosaur, or "flying reptile." It is not surprising that in the fierce struggle which is reflected in the arms and armour of the great reptiles, a branch of the family escaped into the upper region. We have seen that there were leaping reptiles with hollow bones, and although the intermediate forms are missing, there is little doubt that the Pterosaur developed from one or more of these leaping Deinosaur. As it is at first small, when it appears in the early Jurassic--it is disputed in the late Triassic--it probably came from a small and agile Deinosaur, hunted by the carnivores, which relied on its leaping powers for escape. A flapperlike broadening of the fore limbs would help to lengthen the leap, and we must suppose that this membrane increased until the animal could sail through the air, like the flying-fish, and eventually sustain its weight in the air. The wing is, of course, not a feathery frame, as in the bird, but a special skin spreading between the fore limb and the side of the body. In the bat this skin is supported by four elongated fingers of the hand, but in the Pterosaur the fifth (or fourth) finger alone--which is enormously elongated and strengthened--forms its outer frame. It is as if, in flying experiments, a man were to have a web of silk stretching from his arm and an extension of his little finger to the side of his body.

From the small early specimens in the early Jurassic the flying reptiles grow larger and larger until the time of their extinction in the stresses of the Chalk upheaval. Small Pterosaurs continue throughout the period, but from these bat-like creatures we rise until we come to such dragons as the American Pteranodon, with a stretch of twenty-two feet between its extended wings and jaws about four feet long. There were long-tailed Pterosaurs (Ramphorhynchus), sometimes with a rudder-like expansion of the end of the tail, and short-tailed Pterosaurs (Pterodactyl), with compact bodies and keeled breasts, like the bird. In the earlier part of the period they all have the heavy jaws and numerous teeth of the reptile, with four or five well-developed fingers on the front limbs. In the course of time they lose the teeth--an advantage in the distribution of the weight of the body while flying--and develop horny beaks. In the gradual shaping of the breast-bone and head, also, they illustrate the evolution of the bird-form.

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