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B.Sc Part II Paper III

E. Content for students of Patliputra University

Topic - origin and evolution of Amphibia

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Q. Give an account of origin and evolution of Amphibia.

Ans. Amphibians are a transitional group; they are neither fully aquatic nor fully terrestrial, but show a sort of compromise of the two environments. The amphibians are undoubtedly the most primitive land vertebrates. But they are chained to the water. At least for reproduction they should return to water.

Time of origin of amphibians : The first amphibians evolved during the Devonian period of Paleozoic era about 325 million years ago. The Rhipidistian crossopterygian fishes are considered to be the ancestors of amphibians. The Rhipidistian is on the direct line towards the early amphibians.

Ancestors of amphibians : To trace the direct line of evolution from fishes to land living vertebrates, it is necessary to consider the crossopterygian fishes. The crossopterygian fishes are choanate fishes with lobe fins. The crossopterygians had well developed internal nostrils. Their nasal passages as in the higher land living vertebrates, went direct from the external nostrils through the internal nostrils into the mouth or pharynx. The teeth of the crossopterygians are of the labyrinthodont type i.e., the enamel has number of infoldings.

The bone arrangement in the paired fins of crossopterygian could form the starting point for the evolution of the pentadactyl limb land living animals. The fins had a single proximal bone which can be compared with the humerus in the forelimb and the fumer in the hind limb of vertebrates. The next two bones of the fish fin can be compared with the radius and ulna of the fore-limb and the tibia and the fibula of the hind limb in the land living vertebrates. Thus the early crossopterygian fishes had the characters that we might expect in the ancestors of land living animals.

Rhipidistian Crossopterygians : During the Devonian period crossopterygians evolved in two lines, one being represented by the sub-order Rhipidistia the other by the sub-order coelocanthini. The coelocanthini are not on the 'main line' towards the evolution of amphibians. But the Rhipidistians are on the 'main line' towards the evolution of amphibian. The Eusthenopteron is a typical genus of Rhipidistians. These fishes were on direct line towards the early amphibians. Eusthenopteron was an elongated carnivorous fish which had a skull pattern similar to the skull pattern of early amphibians. In the Eusthenopteron the paired fins possessed skeletal elements that could be compared with the pentadactyl limb. It was indeed but a short step from Eusthenopteron to a land living vertebrate.

Appearance of the amphibians : During the Devonian period some of the crossopterygian fishes come out of the water on to the land. The Eusthenopterons were the Crossopterygians which ventured on the land to which environment they were only partly adopted. It was indeed as bold step by these animals. Once they were in the new environment they soon evolved into the amphibians.

According to Prof. A. S. Romer two factors compelled the crossopterygians out of the water on to the land—

1. The desire for more water that brought about the first excursions of crossopterygians away from their river and lake environment into the land. During the Devonian period there was excessive drought and this forced the crossopterygians to seek new fresh water pools in which they could continue to live. So they struggled out on the dry ground to reach the water that was necessary for this survival.

2. The second factor could have been the search for food on the land.

The special problems of living on land when some crossopterygian fishes ventured out of the water on to the land at the end of the Devonian period the back boned animals entered a completely new course of evolutionary development. For the first time the vertebrates were invading a new environment very different from the one in which they had lived for millions of years.

Problem of respiration : One of the important problems faced by the early amphibians was respiration. The fish ordinarily obtains oxygen from the water by means of gills, whereas the land living vertebrates obtain oxygen from the air by means of lungs. But the crossopterygian fishes which were the direct ancestors of amphibians had well developed lungs. So the early amphibians had lesser problem of breathing air.

Problem of desiccation Another problem to confront the first land living vertebrates was desiccation or drying up. This is no problem for a fish which is continually bathed in water but to a land living animal this is a severe problem. The early amphibians like ichthyostegids never went far away from water and frequently returned to water. Further many early amphibians retained the scales of their fish ancestors. The early amphibians of the Permian period developed tough skin which prevented evaporation from the skin.

Problem of gravity : To an animal living on the land, gravity is a powerful factor influencing much of the structure and the life of the individual. The first amphibians developed a strong backbone and strong limbs to withstand gravity. Powerful girdles developed at two points in the vertebral column.

Problem of locomotion : The early terrestrial vertebrates became adopted to a new method of locomotion where the limbs and feet are important. The paired appendages (fore and hind limbs) became the chief locomotor organs.

Problem of reproduction : Fishes commonly deposit their unprotected eggs in the water, where they hatch. Land living animals must either go back to the water to reproduce or they must develop methods for protecting the eggs on the land. Though the amphibians developed many terrestrial adaptations they never solved the problem of reproduction. So the amphibians have to return to water for laying their eggs. So it is rightly pointed out that the amphibians are chained of water.

Early amphibians : The early amphibians gradually developed the basic design for life on the land.

The early amphibians include the Ichthyostegids, the labyrinthodont amphibians like Anthracosaurs, Rachitomes and Sterospondyls. Another group of aberrant amphibians namely the Lepospondyls can also be grouped under early amphibians.

Modern amphibians (Lissamphibia) : The modern amphibians like Anurans, Apoda and Urodela grouped under Lissamphibia.

Previously the Anurans (frogs and toads) were considered as the direct descendents of the labyrinthodonts. The Salamanders (Urodelestailed amphibians) and Apoda (Limbleless amphibians) were regarded as the descendents of the Lepospondyls. The modern view is to group the living amphibians under Lissamphibia based on many characters shared by them (Colbert, 1969). Though the modern amphibian share many similar characters, the frogs and toads differ from the salamanders and apodans.

The anurans (frogs and toads) appeared during the Triassic times. The earlier anurans were Triadobatrachus. They showed many modern anurans characters like reduction in the skull bones, and elongated ilium in the pelvic girdle. But they still had tail and ribs. During the jurrassic period there was a sudden change from Triadobatrachus to the modern type of frog. The change that occured during the conversion of Triadobatrachus into modern frogs includes the complete suppression of tail in the adult, elongation of hind legs, elongation of bones of the ankle for leaping and strengthening of the shallder girdle to take up the shock of landing. Thus the modern anurans evolved during the Triassic times.

The first urodeles are known from cretaceous sediments. The urodeles are water living amphibians and some modern forms like the axolott retain larval characters and are neotonous.

The apodan amphibians are a rather degenerate group in which the limbs are completely suppressed. They are vermiform, burrowing amphibian distributed in the tropics. They might have evolved from Lysorophus. Lysorophus, like the modern apodans was small and worm like with a peculiar skull.