

B.Sc. Honours - Part - II

Paper - III A

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Origin and Evolution of Amphibia

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The most-spectacular event in the phylogenetic history of vertebrates is the emergence of Amphibia (Tetrapoda) from piscine ancestors. The event took place nearly 300 million years ago in the background of the dry and arid Devonian period. The close anatomical resemblances and paleontological evidence provided by Romer, Watson, Steaxis, Tauvik and others clearly establish that the amphibians arose from some fish-like ancestors.

The anatomical changes that took place during transformation from fish to amphibian were as follows:-

- 1) A tetrapod limb evolved to support the body out of water as on land the entire body weight fell on the four limbs, whereas body weight is supported by water and fish have to just propel it forward.
- 2) Gills were lost in the adult stage as lungs became more efficient air breathing organs and air contained more oxygen as compared to water.
- 3) The hyomandibular bone of the second visceral arch transformed into columella to transmit sound vibrations from air to the inner ear.
- 4) Loss of scales permitted cutaneous respiration which evolved as an alternative method of respiration in the absence of gills while the animal lived in water.
- 5) The skull developed four occipital condyles that fitted in an Atlas vertebrae so that skull could move upward and downward for locomotion as well as for better visibility.
- 6) In terrestrial environment - vertebral column must be strong to support the body weight and hence centra of vertebrae transformed from amphicoelous to procoelous type.
- 7) The lateral line system that was not useful in terrestrial environment simply disappeared.
- 8) Adipose tissue that stores fat and provides insulation developed under the skin to stop loss of water by evaporation of land.

TIME OF ORIGIN

the fossil footprints of Thrinacoselache (amphibia) as of skeletal remains of Elphistostege an intermediate form between the crossopterygian osteolepid and the tetrapod (Ichthyostega) from Devonian period strongly suggest that the tetrapods originated in the Devonian.

There is no fossil record of Amphibia during the Silurian period and in the Carboniferous.

Factors of Origin

The climatic and ecological conditions of the Devonian period provide us with the impelling cause of the emergence of Amphibia.

The Devonian was a dry period when streams and pools tended to dry up seasonally. Ancestors of amphibians (= crossopterygians) with their lobed fins could move from drying pools where water was available.

According to Romer 'land limbs' were developed to reach water.

According to Berrill (1955) - enemies in water forced the crossopterygians to explore land.

Other factors were (i) abundance of food on land.

(ii) availability of atmospheric oxygen.

Possible ancestors - During the Devonian period the dominant fish-water fish were Actinopterygii, Aberrant-sharks, Dipnoi and Crossopterygii.

(A) Actinopterygii - they cannot be the ancestors of amphibians because they lack

i) they lack extra rays &

ii) fleshy lobed fins.

(B) Sharks - It is a specialized branch and cannot be regarded as the ancestor of amphibians.

(C) Dipnoi - they were regarded as ancestors of amphibians for a long on the basis of

(i) similarity in respiratory structure and their blood supply

(ii) Pectoral girdle of Necturus similar to that of dipnoans

(iii) Arrangement of muscle in the paired fins of the dipnoans resembles the musculature of the paired limbs of amphibians.

) Single bony piece articulating the paired appendages with the pectoral and pelvic girdles; comparable with the humerus or femur of amphibian limbs.

But dipnoans exhibit many specialized features and can not be the ancestor of amphibians. The similarities are due to convergence for living under similar conditions of life.

(D) Crossopterygii. The crossopterygians or the lobed finned fishes provide the starting point for amphibian origin from the fishes.

The striking features which establish similarities are as follows: -

- (i) The pattern of bony elements of jaws and skull.
- (ii) Two large bars on the roof of skull comparable to amphibian parietal bars.
- (iii) Pectoral fin of Eustheropterus comparable to amphibian fore limbs.
- (iv) Bony elements of pectoral girdle comparable to elements in amphibian girdle.

Thus there are close similarities between the Crossopterygians and early amphibians suggesting that the latter originated from crossopterygians especially the Osteolepidae. Of course these changes are not at all radical and sudden, rather the process of adaptation to land life was gradual and slow.

Evolution. On coming to land the primitive amphibians acquired changes and became specialized and split up into three orders which took three different courses of evolution.

In Labyrinthodontia (ancestor of all tetrapods) the skull was heavily armoured and the large teeth had enfolded enamel layer. While some were terrestrial, many of them remained fully aquatic. The evolution of Labyrinthodontia was essentially a process of reduction of ossification.

The Phyllospodys (= Branchiosaur) - including a group of small Salamanders like amphibians with

large flat head and short tail and are believed to be ancestors of crocodiles and alligators

The Lepospondyli (= Microbaenae & Saurorhina) - represent a residual group and the modern Caecilians, (= Apoda) were derived from them.

So it ~~is~~ observed that once they came on land, they started diverging in different habitats. Since the environment was free from competition they multiplied rapidly and reached the peak of their career during upper Carboniferous and Permian period.
