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Terrestrial Mesozoic stratigraphy

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Summary

Recent progress of studies is stressed, i.e. on isotope dating technology, Palaeogeomagnetism and Biostratigraphic studies, mainly on relatively derived taxa, a cornerstone for accurate correlation. Reference is made to Palaeobotany, Palynology, and vertebrate faunas through the times. Biostratigraphic framework: development and diversity of reptiles, appearance of birds and mammals. Major episodes and their main characters: Lower Trias, Upper Trias, Jurassic and especially Upper Jurassic, Lower Cretaceous, Upper Cretaceous. The KT crisis. Extinctions and their causes.

Keywords: Mesozoic - Terrestrial Stratigraphy, Lithostratigraphy, dating resolution & global correlation, Biostratigraphy, Phylogenetics, Paleontology, Vertebrates, Major episodes

A brief introductory text

1 – Studies on terrestrial Mesozoic stratigraphy have made significant progress in recent years thanks to new discoveries of fossils, in particular, many important vertebrate fossils, as well as chronostratigraphic progress.

Extensive collecting and dating of volcanic ashes interbedded in fossil-bearing deposits has provided an unusual chance to determine the precise age of controversial formations. It is also notable that new technology of isotope datings (i.e., Ar-Ar, Shrimps, ID-TIMS) has not only greatly improved the resolution of dating and also provided more solid evidence of global correlation.

Paleogeomagnetic work, together with Astronomical Polarity Time Scales, has also played important roles in collaborating with other chronostratigraphic methods.

In terms of biostratigraphic study, reliable systematic and phylogenetic study remains the cornerstone for precise correlation. Phylogenetically most closely related taxa and relatively derived taxa (instead of more primitive ones) in a fauna are preferable in biostratigraphic comparison.

Finally, regional stratigraphic boundary should be consistent with international standard. Both chronostratigraphic study and correlation of terrestrial and marine fossils can help establish regional terrestrial biostratigraphic framework, and further achieve high resolution stratigraphy for discussing global and regional geological events and their impacts on biological evolution.

2 – Terrestrial Mesozoic Stratigraphy relies, of course, on lithostratigraphy on a regional scale; climate conditions heavily influenced sedimentation processes and life as well. Mesozoic terrestrial Stratigraphy also relies on paleontological characters, either of Paleobotany / Palinology or on vertebrate fossils. Of course, a general synthesis is a quite unattainable goal.

As a whole, the conquest of land had been accomplished still in Paleozoic times, amphibians being a successful group. In the seas, a lot of extinctions occurred, i.e. of most agnathans and placoderm fishes.

Amniotic eggs and more impermeable teguments as a protection against desiccation, as well as modifications concerning the respiratory organs (and secondary palate) and limbs, paved the way for better adaptations to terrestrial environments. Reptiles acquired those features and further ones, as more robust vertebral column and limbs. After the moist conditions that prevailed during Carboniferous, crisis related to great changes of climates during latest Paleozoic went on. Aridic conditions developed and more or less continued in Lower Triassic. Latest Paleozoic is marked as a time of great extinctions concerning marine faunas; deep, even if less spectacular changes also occurred in terrestrial domains. Evolutionary progress has been a major feature as far as reptiles are concerned. Rapid diversification occurred. Mammalian reptiles acquired a remarkable role, as in Gondwana lands. Some ones acquired a sort of ‘dorsal sail’ sustained by vertebral neurapophyses as a maybe thermal control feature, as well as thermal control, isolating devices as hairs (and maybe fur). Mammals become much diversified, although very small or quite small at best.

On the other hand, Mesozoic is marked by success of reptiles. Mandibular muscles became stronger, a feature that is related to skull changes and broadening of temporal openings. Early reptiles had no temporal openings and hence were less different from amphibian anatomy. Other ones developed a lower temporal fossa, and later an upper temporal opening. Skull structure is typical of reptile differentiation; and mammalian skull structures also derive from some previous, reptilian types with but a single, lateral temporal opening. Meanwhile, a key anatomical structure underwent deep evolutionary changes, i.e. the mandible. From a several bone structure in reptiles, it became a single, mandibular bone made up by the fused left and right dentaries, while other formerly mandibular, very modified bones acquired new functions in the ear.

Among others, that of archosaurs, including forms adapted to diverse environments, as pterosaurs, crocodiles (some attaining huge sizes), and specially dinosaurs, including both the largest land animals of all times as well as small but highly differentiated ones. From some dinosaurs descended the birds, whose knowledge progressed very much.

Very broadly speaking, some major episodes can be distinguished as far as vertebrates, the perhaps more conspicuous fossils, are concerned:

- Lower Trias, development of mammalian reptiles following what happened in Upper Permian, the stegocephalian apogee with taxa diversification and attaining large sizes, marked progress of Actinoperygians (chondrosteans and holosteans), moderate development of dipnoans;
- [Middle Trias is represented in several regions by marine deposits, out of our concern here];
- Upper Trias, the early mammals, advanced mammalian reptiles, a “revolution” in reptiles and archosaurs in special with the appearance of the first crocodilians, dinosaurs and maybe the forerunners of birds, chelonians’ presence, decadence of the stegocephalians, further development of the actinopterygians;
- Jurassic and especially Upper Jurassic, extinction of stegocephalians, development of mammals and birds, spectacular development of dinosaurs, coelacants, progress of the actinopterygians with development of teleosteans;
- Lower Cretaceous, continuation of the previous, Upper Jurassic vertebrate patterns, of course with modifications;
- Upper Cretaceous, with a major change marked by worldwide seas transgressive movements and as a consequence a great reduction of continental areas and the development of islands – demise and extinction of several dinosaurs, development of mammals, great bird differentiation, development of diverse, many small-sized dinosaurs, great progress on crocodilians, predominance of teleosteans among the

actinopterygians, great progress on sharks [and marine reptiles, out of concern here]; the extinction of the last dinosaurs and the causes of it. Fall of temperatures, volcanism, and fall of meteorites contributed to great faunal changes.

Much less warm environments stressed the importance of homoeothermy. Extinctions, mostly of non-homoeothermics ensued. All this is related to the K-T crisis and the beginning of Tertiary times.

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