# Major biotic evolutionary tempos constraining Triassic stratigraphical subdivisions

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**Abstract**

Stratigraphical subdivision was originally defined based on fossil assemblages. For an instance, John Phillips (1800–1874) formally defined the three great eras, Paleozoic ("ancient life"), Mesozoic ("middle life") and Cenozoic ("recent life"), based on their contrasting fossil assemblages, each apparently separated by an extinction event. More accurate stratigraphical definition and correlation are now possible using a wide variety of biozones of various fossil groups. Major evolutionary tempos of various fossil groups are outstanding within the Triassic, which are subdivided into the three series/epochs that contain seven stages/ages. We compiled the dataset of all marine fossil records from the Triassic strata, and recognized the originating, passer-by and extinct components from each stage. The analytical results show that the number of originating taxa and origination rate appear a rapid peak in Anisian and a moderately climbing slope in Carnian, with a relatively high extinction rates in their preceding stages, implying two new biotic evolutionary tracks in these two stages. However, the Carnian Pluvial Event (CPE) was associated with a biotic extinction in mid-Carnian (across the Julian-Tuvalian substage boundary). This means that the present Carnian dataset comprises the pre-CPE and post-CPE fossil records. When the Carnian is subdivided into the pre-CPE (Julian) and post-CPE (Tuvalian), then the Julian saw a much higher extinction rate and the Tuvalian witnessed the higher origination rate. The second evolutionary episode of the Triassic biota therefore started in Tuvalian, which is followed by a plateau in both origination rate and the number of originating taxa in the rest of Late Triassic. Accordingly, the Triassic biotas exhibit three evolutionary episodes, which are calibrated to the Induan-Olenekian, Anisian-Julian, and Tuvalian-Rhaetian intervals, suggesting three epochs/series. Here, we suggest that both the Julian and Tuvalian substages can be upgraded to the stage status and that the Triassic can be subdivided into three series, with the Olenekian-Anisian and Julian-Tuvalian boundaries representing the Lower-Middle and Middle-Upper Triassic. Furthermore, given the Late Triassic Epoch is too long (233.6-201.4 Ma), the Lacian, Alaunian, and Sevatian substages of the Norian Stage can be upgraded to the stage level, and the Upper Triassic Series may be further subdivided into two series and the series boundary is selected when the Late Triassic biotic evolution traits are studied in future.

**Keywords:** Triassic, Series boundary, Carnian Pluvial Event, biotic evolution

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