

Sequence of Permian Tetrapod Faunas of Eastern Europe and the Permian–Triassic Ecological Crisis

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Abstract—Eastern Europe shows the most complete in the world continuous sequence of continental Permian and Triassic deposits, which allows the development of tetrapod faunas over more than 17 successive stages to be traced. The newly obtained data on transitional Vyazniki and Sundyr tetrapod faunas provide more complete characteristics of the Severodvinian (Late Guadalupian, pre-Lopingian) and Permian–Triassic ecological crises and the ways of replacement of the dominant vertebrate groups of Eastern Europe.

Keywords: tetrapod faunas, Permian, Permo–Triassic ecological crisis, Eastern Europe

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INTRODUCTION

In the east of the East European Platform and Cis-Ural Foredeep, Permian and Triassic continental deposits are widespread. They form a stratigraphically continuous section without significant gaps from the Lower Permian to Middle Triassic. These formations are well characterized by fossil vertebrates, invertebrates, and plants, allowing a detailed study of the development of biota in the transition from the Paleozoic to Mesozoic, which was accompanied by the Late Guadalupian (Severodvinian) and Permian–Triassic global biotic crises. In particular, in the history of Permian–Triassic tetrapod faunas, more than 17 successive developmental stages have been recognized. This is a unique, most complete sequence of this kind in the world.

The first stratification scheme of the Upper Permian and Triassic beds based on the terrestrial vertebrate fauna was proposed by Efremov (1937). This scheme involved stepwise development of tetrapod faunas. The stages were distinguished from each by the faunal composition at the generic or higher taxonomic level. The stages were designated as zones numbered in the ascending order. In the Permian, zones I, II, III, and IV were recognized and the Triassic contained zones V and VI. In subsequent works, this scheme was repeatedly specified and supplemented; faunal characteristics and stratigraphic position of the zones were reconsidered. In the last variant of the scheme (Efremov, 1952; Efremov and Vjushkov, 1955), faunal assemblages reflecting taphonomic differentiation of tetrapod localities were recognized along with zones. In

contrast to the zones, the time intervals of the existence of assemblages overlapped to a greater or lesser extent. The Permian beds were characterized by five faunal assemblages: Cis-Ural dinocephalian (Zones I and II), Ishevo dinocephalian (Zone II), Mezen–Belebey cotylosaurian (synchronous to the two first and previously designated as Zone III), Severodvinian pareiasaurian, and Gorky batrachosaurian (synchronous to the preceding assemblage, Zone IV). The Triassic was characterized by three faunal assemblages: Vetluga labyrinthodont–archosaurian (Zone V), lower labyrinthodont–dicynodont (Zone VI), and upper labyrinthodont–dicynodont assemblages (Zone VII). In the new zonal sequence, none of the assemblages corresponded to Zone III. This zone was not characterized by fossil tetrapods, so that it was recognized only speculatively. Efremov proposed that, between the essentially different dinocephalian and pareiasaurian faunas, there should be a transitional fauna known from South Africa, but not yet discovered in Eastern Europe. He designated this hypothetical fauna as Zone III. In addition to the above zones, Zone 0 covering Lower Permian deposits, including the beds with the Inta Tetrapod Fauna, and Zone VII corresponding to the Middle Triassic were distinguished.

Subsequently, the stratification schemes for the Permian and Triassic beds were developed mostly independently; this determined the present-day differences between them. For the stratification of continental Triassic deposits of Eastern Europe, tetrapods became a key group; therefore, in detailed elaboration