



Upper Devonian vertebrate taphonomy and sedimentology from the Klunas fossil site, Tervete Formation, Latvia

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The deposits of the Tervete Formation, Famennian Stage of Latvia, comprising weakly cemented sandstone and sand intercalated with dolomitic marls, siltstone and clay, have been traditionally interpreted as having formed in a shallow, rather restricted sea with lowered salinity. During seven field seasons the excavations took place in the south-western part of Latvia, at the Klunas site, and resulted in extensive palaeontological and sedimentological data. The taphonomical analysis has been performed, having evaluated the size, sorting, orientation of the fossils, articulation and skeletal preservation as well as the degree of fragmentation and abrasion. The sedimentological analysis involved interpretation of sedimentary structures, palaeocurrent direction reconstruction, grain-size analysis and approximate water depth calculations.

The vertebrate assemblage of the Klunas site represents all known taxa of the Sparnene Regional Stage of the Baltic Devonian, comprising placoderms *Bothriolepis ornata* Eichwald, *B. jani* Lukševičs, *Phyllolepis tolli* Vasiliauskas, *Dunkleosteus* sp. and *Chelyophorus* sp., sarcopterygians *Holoptychius nobilissimus* Agassiz, *Platycephalichthys skuenicus* Vorobyeva, *Cryptolepis* sp., *Conchodus* sp., *Glyptopomus* ? sp., "*Strunius*" ? sp., and *Dipterus* sp., as well as an undetermined actinopterygian. Placoderms *Bothriolepis ornata* and *B. jani* dominate the assemblage.

The fossils are represented in the main by fully disarticulated placoderm plates and plate fragments, sarcopterygian scales and teeth, rarely bones of the head and shoulder girdle, and acanthodian spines and scales. The characteristic feature is the great amount of fragmentary remains several times exceeding the number of intact bones. The horizontal distribution of the bones over the studied area is not homogenous, distinct zones of increased or decreased density of fossils can be traced. Zones of the increased density usually contain many elements of various sizes, whereas zones of the decreased density might be subdivided into two types: 1, with limited number of large bones; 2, with scattered relatively small scales or fragments. The shape and size of zones of increased density of fossils slightly resemble that of subaqueous dunes.

Within the Klunas fossil site three taphonomically distinct oryctocoenoses can be traced, differing in the compactness of accumulation, size, disarticulation and fragmentation of bones and showing various degree of mixing of repeatedly buried and very fresh, partially articulated material. Analysis of similarities and differences between these oryctocoenoses demonstrates that all are sedimentary concentrations and have to be assessed as allochthonous assemblages. However, despite these differences, the 1st and the 3rd oryctocoenoses, which have been formed as vertebrate bone accumulations on the bottom of an erosional channel, have much in common contrary to the 2nd oryctocoenosis, which exemplifies the lens of fossil bearing cross-stratified sandstone formed in subaqueous dunes. The concentrations of vertebrate remains have been formed under the influence of fluvial and tidal processes in the shallow water environment, most probably deltaic or estuarine settings. It has been found also that elongated placoderm and sarcopterygian bones might be better indicators of the palaeoflow direction in comparison with very elongated, but dense acanthodian spines or sarcopterygian teeth.