

The Upper Famennian Ketleri Formation of Latvia: fauna and flora from tide-dominated delta deposits in a seasonal climate

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The Upper Famennian in the Baltic Devonian basin consists of the Akmene, Spārnene, Piemare, Ketleri, and Šķervelis regional stages (RS). The Ketleri RS correspond to the Ketleri Formation (Fm) distributed in the southwestern Latvian and western Lithuania. The deposits of the Ketleri Fm are subdivided into three members (Mb), Nīgrande, Pavāri and Varkaļi, cropping out only in Kurzeme (SW Latvia). All three members are well known for their vertebrate fossil content, including one of the best-preserved Late Devonian tetrapod *Ventastega curonica* from the Pavāri and Varkaļi members. Combined sedimentological and palaeontological studies of the vertebrate fossil-bearing deposits of the Ketleri Fm provided new data on the sedimentary environment of the deposits, as well as taxonomical and taphonomical peculiarities of the fossil assemblage.

Fluvial channels with strong tidal influence and tidal bars were identified, suggesting the tide-dominated delta environment during the formation of the Pavāri and Varkaļi members. The current energy changed from very high, when deposits with clay clasts and vertebrate debris accumulated, to moderate, when fine-grained cross-bedded and ripple-laminated sands sedimented, to low, represented by clayey and silty beds. Tidal features were found in almost all types of deposits, which allows us to suggest the tide-dominated settings. Data from the mathematical model of the Baltic Artesian Basin demonstrate that the sandy deposits of the Pavāri and Varkaļi members form a fan-shaped area resembling a wide delta developed in shallow marine settings, thus supporting the results of sedimentological study.

Until recently, the Late Famennian vertebrate, plant and trace fossils from the Ketleri Fm have been studied in detail in two localities: the Pavāri-1 locality at the left bank of the Ciecere River opposite the vanished farmhouse “Pavāri” (Pavāri Mb), and the Ketleri locality at the right bank of the Venta River close to the abandoned farmhouse “Ketleri” (Varkaļi Mb). In 2019, a new fossil site named “Pavāri-2” (Pavāri Mb) was discovered on the left bank of the Ciecere River close to the mouth of the Pakšite River, at a distance of about 400 m from the Pavāri-1 site. Excavations during 2019-2023 field seasons provided a large number of vertebrate specimens, including taxa new for the Ketleri Fm, some skeletal elements previously not known from this formation, and well-preserved plant macroremains. Taphonomic studies testify the sedimentary concentrations of well-preserved vertebrate remains were formed under the influence of fluvial and strong tidal processes in the shallow water environment, most probably deltaic settings.

Abundant trace fossils were recognised in the Ketleri site; burrows of *Palaeophycus* isp. are interpreted as combined domichnia and fodinichnia produced by deposit-feeder or predatory worm-like organisms similar to acorn worms (enteropneusts), and traces of *Planolites* isp. are interpreted as fodinichnia produced by worm-like detritophagous animals. Possibly, the *Planolites*-producers dwelled in the *Palaeophycus*-burrows or around them using the remains of food of animals resembling the acorn worm. Both ichnogenera suggest brackish water or marine environment. The analysis of rhizocretes from the Varkaļi Mb allowed to suggest the strong influence of a seasonal climate.

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