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Aspects of functional analysis and ornamentation of some pliocene viviparids

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Viviparid phylogenetic tree from the Pliocene sands of Slavonia was initially described on the basis of stratigraphy and shell morphology by NEUMAYR and PAUL.

Freshwater Pliocene sands and clays of Slavonia (Croatia) known as Paludina beds, after old name for viviparid gastropods - Paludina, represent the final stages of the sedimentation in the Pannonian Basin of Central Paratethys realm. In such lake and swamp environment viviparid phylogenetic tree evolved. It is possible to distinguish different morphological trends in the viviparid shell evolution, one of the most interesting being the spiral rib development.

In this paper, functional morphologic analysis of Pliocene freshwater gastropods from phylogenetic line *Viviparus neumayri* to *Viviparus ornatus* is carried out. On this section of the phylogenetic line it is possible to follow continuous development of the shell ornamentation (shouldering and rib formation) from ancestral *V. neumayri* with smooth shell, to *V. ornatus*, which represent final stage in the spiral rib formation.

Development of the shell ornamentation and function on viviparid shells has never been discussed in detail from analytical point of view.

In this work, shell morphology and possible function of rib development is presented. The problem of shell ribs function is discussed from analytical point of view, and also analyzed by Finite element method (FEM). Finite element analysis (FEA) is a technique that reconstructs stress, strain, and deformation in a numerical model of the structure. This technique can be used in the paleontological sciences to explore

questions of organism morphology, function, and interaction with the environment.

Our finite-element analysis of viviparid shell models indicates that shells with ribs, with minimal increase in used shell-building material compared with smooth shells, multiply increase their strength (stiffness). If we use the same amount of shell-building material to build models of smooth shells and ribbed shells, thedistribution of the shell wall volume in ribbed shells will increase the second moment of area of the shell wall crossection and in the same time shell stiffness. Spiral rib development represent a morphological trend in viviparid evolution, which resulted in increased resistivity to shell crushing and simultaneous reduction in amount of used shell-material.