Pannonian molluscs and their localities in the Gerecse Hills, Transdanubian Range

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Gerecse Hills, representing the northeasternmost part of the Mesozoic-Paleogene Transdanubian Range, is surrounded by an Upper Miocene-Pliocene (Pannonian) lacustrine to fluvial sedimentary cover to the west and to the north, i.e. towards the Danube–Kisalföld Basin of Slovakia and Hungary. The oldest reports on fossil molluscs from these sediments were published almost 150 years ago. A systematic mapping of the area by the geologists of the Geological and Geophysical Institute of Hungary between 2010 and 2014 revealed a number of natural and artificial outcrops of fossiliferous Lake Pannon sediments.

The Upper Miocene deposits near the Gerecse Hills comprise the Szák and Újfalu Formations, each having its characteristic mollusc fauna. The Szák Fm is exposed in brickyard clay pits within the town of Tata, in the western foreland of the Gerecse Hills. This formation consists of homogeneous, bioturbated, bluish-grey clay and argillaceous marl, deposited from suspension in quiet offshore conditions. Characteristic mollusc species include large dreissenids (*Congeria czjzeki*, *C. partschi*, *C. ungulacaprae*), a wide variety of cockles (*Lymnocardium tegulatum*, *L. triangulatocostatum*, *L. majeri*, *L. apertum*, *L.* aff. *brunnense*, *L.* aff. *rogenhoferi*, *„Pontalmyra" otiophora*, *Paradacna* sp.), and deep-water-adapted pulmonate snails (*Valenciennius reussi*, *Radix kobelti*, *Gyraulus* sp.). This fauna lived in a nutrient-rich and well-oxygenated sublittoral environment, at a few tens of meters water depth.

A highly atypical facies was discovered in one of the northern valleys of the Gerecse Hills (Ivánhalála, Dunaszentmiklós). A poorly-sorted conglomerate consisting of cobble- and boulder-sized clasts with sandy-clayey matrix overlies directly the Cretaceous basement. The imbrication of the clasts indicates N to S transport direction i.e. from the open lake towards the dry land. The matrix contains abundant molluscs fauna, including articulated valves of *Congeria simulans trurgida*, *Dreissenomya arcuata*, and ?*Paradacna* sp. This sediment package is suspected to have been deposited by a tsunami on the rocky coast of Lake Pannon.

The Újfalu Fm is exposed in the northern valleys of the Gerecse Hills (see Bartha et al., *this volume*). This formation consists of few meter thick, shallowing up sedimentary cycles, starting with sublittoral clays (formed below wave base on the prodelta) and ending with littoral sands (deposited on lower shoreface, deltafront or delta plain channels) or even paludal huminitic clays (delta plain marshes or abandoned channel fills). Molluscs reflect this cyclicity and the overall fauna is very different from that of the Szák Formation. The dreissenids are more diverse (*Congeria ungulacaprae, C.* cf. *balatonica, C. simulans turgida, C. czjzeki, Dreissena auricularis, Dreissena sp., Dreissenomya arcuata, Dreissenomya* sp.), and in addition to the rich cockle fauna, dominated by *Lymncoardium penslii* and including *L. ponticum, L. vicinum, L. majeri, Euxinicardium schreteri, Caladacna steindachneri* and *Paradacna wurmbi,* the freshwater-origin *Unio mihanovici* and plant-grazing prosobranch gastropods like *Theodoxus radmanesti, Melanopsis caryota, M. pygmaea, M. decollata, M. sturi, M, kupensis,* and *Viviparus* sp. are common. They indicate shallow water within the photic zone and strong influence of freshwater in accord with the delta environment.

Although superposition of the Szák and Újfalu Fms in this area is well known from boreholes, a direct contact of the two units was not observed in outcrops. An apparently„reverse" succession was recorded in the central part of the Gerecse Hills, at 375 m elevation (Vályúskút, Tardos). In this sequence, lignite-bearing black clay and variegated clays with freshwater molluscs (*Theodoxus radmanesti, Melanopsis sturi sturi, M. sturi tortispina,* Planorbidae sp., Unionidae sp., *Valvata oecsensis, V. obtusaeformis, Oxychilus* sp.) are overlain by clay and silt with *Congeria czjzeki, Lymnocardium majeri,* and other brackish species. This superposition indicates flooding of paludal areas, deepening, and development of intense connection with the sublittoral offshore environment of Lake Pannon.

The Pannonian sediments and their fossil molluscs in the Gerecse hills reflect gradual flooding of the Mesozoic block, locally either producing a transgressive lag (Tata) or a paludal-lacustrine transitional sequence (Vályúskút) before the sublittoral clay with *Congeria czjzeki* (Szák Fm) draped probably much of the recent hills. Sedimentary infilling up to lake level took place in several cycles represented by deltaic parasequences (Újfalu Fm), each displaying faunal changes from open lacustrine bivalve-dominated to paludal snail-dominated assemblages.

Biochronostratigraphic correlations suggest that the age of the entire Pannonian sequence in the Gerecse hills is between 9.7 and 8.7 Ma. Accordingly, reverse magnetic polarity in the lowermost 10 m interval of the Tata outcrop suggests correlation with C4Ar, restricting the age of the flooding of the Gerecse hills to the 9.6-9.1 Ma interval.

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