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CHEMICAL COMPOSITION AND STRUCTURE OF THE SHELL OF *CEPAEA VINDOBONENSIS* (FÉRUSSAC, 1821) (GASTROPODA: PULMONATA: HELICIDAE)

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Abstract: The paper contains analysis of chemical structure and composition of shell of *Cepaea vindobonensis* (Fér.) from Bychawa (SE. Poland), combined with a parallel assessment of the composition of the substratum. The results show suitability of SEM and EDS methods for such studies and are preliminary to a wider study on the effect of substratum on the shell, distribution and population abundance of the species.

Key words: *Cepaea vindobonensis*, carbonate substratum, chemical shell composition, geochemistry, Lublin Upland

INTRODUCTION

Cepaea vindobonensis (Férussac, 1821) is a south-eastern European species, usually found in dry, insolated habitats with a high calcium-content in the substratum (Riedel 1954, 1988, Ożgo 2004, Pokryszko et al. 2004, Wiktor 2004); it thus appears to be stenoecious. On the other hand, it is sometimes found on floodplains of rivers – habitats characterised by completely different conditions (own, unpublished data). Numerous snail species show very distinct requirements with respect to both humidity and chemical composition of the substratum (Russel Hunter 1964, for review of ecological requirements see e.g. Riedel 1988, Wiktor 2004). Though the main component of terrestrial snail shell is calcium carbonate, it can contain an array of other compounds. The shell chemical composition and structure can be affected both by conditions in which it is built and by the chemistry of the substratum (Digby 1968, Jordaens et al. 2007); the substratum composition may also affect the condition and abundance of snail populations.

The aim of the study was a chemical and structural analysis of shells originating from a site of known chemistry of the substratum, in order to assess the suitability of SEM and EDS methods for such analyses. It is preliminary to a wider study on the effect of substratum on the shell, distribution and, possibly, population abundance of the species.

STUDY AREA

The town of Bychawa is located south of Lublin, in the Lublin Upland (SE. Poland), at the confluence of of the rivers Kosarzewka and Gałęzówka. The altitude is 200–250 m a.s.l. The vegetation does not depart from that found in other parts of the Lublin Upland; xerothermophilous plants, among others *Pinus silvestris* L., *Prunus fruticosa* L., *P. spinosa* L., *Rosa canina* L., *Salvia pratensis* L., *Eryngium planum* L., are protected in the nature reserve Podzamcze (Pasztaleniec-Serafińska, 1996).

The study plot is located on the south- and south-west facing slope (c. 35°) of the nature reserve; denivelation of the slope is within 15–20 m, width 200 m, length ca. 500 m. The bedrock consists of eroded upper Cretaceous formations (Maestrichtian). Palaeogene sandstones and recent Neogene deposits (Holocene) occur insularly and are up to 40 cm thick.

METHODS

Population abundance of *C. vindobonensis* was estimated with modified Oekland method. Ninety samples (1 sample = 9 m^2) were taken in 2005. The samples, located along transects from the bottom to the top of the slope, formed a checkerboard arrangement. The total sampling area was 810 m^2.

Analysis of thin plates of Maestrichtian gaize in polarisation microscope CARL ZEISS was aimed at assessment of the bedrock. Analysis of thin sections of shells of *C. vindobonensis* with scanning electron microscope (LEO 1430) coupled with electronic dispersive spectrometer (EDS IBIS) included four sections. In each section eight microareas were selected for quantitative Roentgen analysis. SEM Quant programme was used in the analysis; the accuracy of quantitative analyses for particular elements ranged from 0.5% to 1%.

RESULTS AND DISCUSSION

CHARACTERISTICS OF THE SUBSTRATUM

Macroscopically the rocks are grey or grey-yellow, when newly fractured they are pale yellow; they show a high porosity and relatively small density. They contain well-preserved fossils: belemnites, sponges, bivalves and brachiopods. Microscopically they contain carbonate microsparite, and in places micrite embedded in silicate organic detritus with sponge spicules 0.2 mm long and foraminifers of c. 0.1 mm diameter. Glauconite is present as accessory component (Fig. 1). Microscopic studies confirmed the presence of Maestrichtian gaize in the nature reserve. The chemical composition of the rocks is presented in Table 1.

Fig. 1. Bedrock in the nature reserve Podzamcze (Bychawa): glauconite (green arrow), foraminifer (red arrow), sponge spicule (blue arrow). 80×

POPULATION ABUNDANCE

Within the sampling plot the following numbers of individuals were found: 254 adults, 83 juveniles, 587 adult shells, 52 juvenile shells. The total number of live individuals was 337, mean 1 individual/2 m^2.

CHEMICAL COMPOSITION OF THE SHELL

Chemical analysis (EDS) of shells of *C. vindobonensis* showed 98% mass $CaCO_3$ mainly in the form of aragonite with small quantities of calcite. The remaining 2% mass were probably compounds of Fe, Mg, Mn, Al, Na, K. None of the elements exceeded 1% mass (Figs 2a–2c). SEM examination showed plate-like and needle-like microcrystallites which formed a layer of hypautomorphic aragonite crystals criscrossing at an angle of c. 60° (Fig. 3). Their size ranged from 12 to 20 μm. Shell sutures in places showed the presence of hypautomorphic calcite of a variable size of 3 do 8 μm (Fig. 4).

EDS analysis of microareas of dark and light zones showed a similar chemical composition; the difference consisting probably in a higher relative content of Fe and Mn in the dark zone. A small increase in Fe and Mn with organic compounds may result in formation of dark zones. Detection of differences in the chemical composition of light and dark zones requires a separate analysis with equipment enabling

Table 1. Chemical composition of the bedrock in the Lublin Upland (Bolewski & Parachoniak 1974)

Component	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	P_2O_5	S	SO_3	CO_2	$+H_2O$	$-H_2O$
Mass %	17.06	2.02	0.78	42.71	0.93	0.10	0.14	0.04	33.56	0.91	1.09

measurements of quantitative content of trace elements (Figs 5, 6).

The preliminary analysis, based on one population, shows that the methods applied (SEM, EDS) are suitable for analysis of both substratum and shell com-

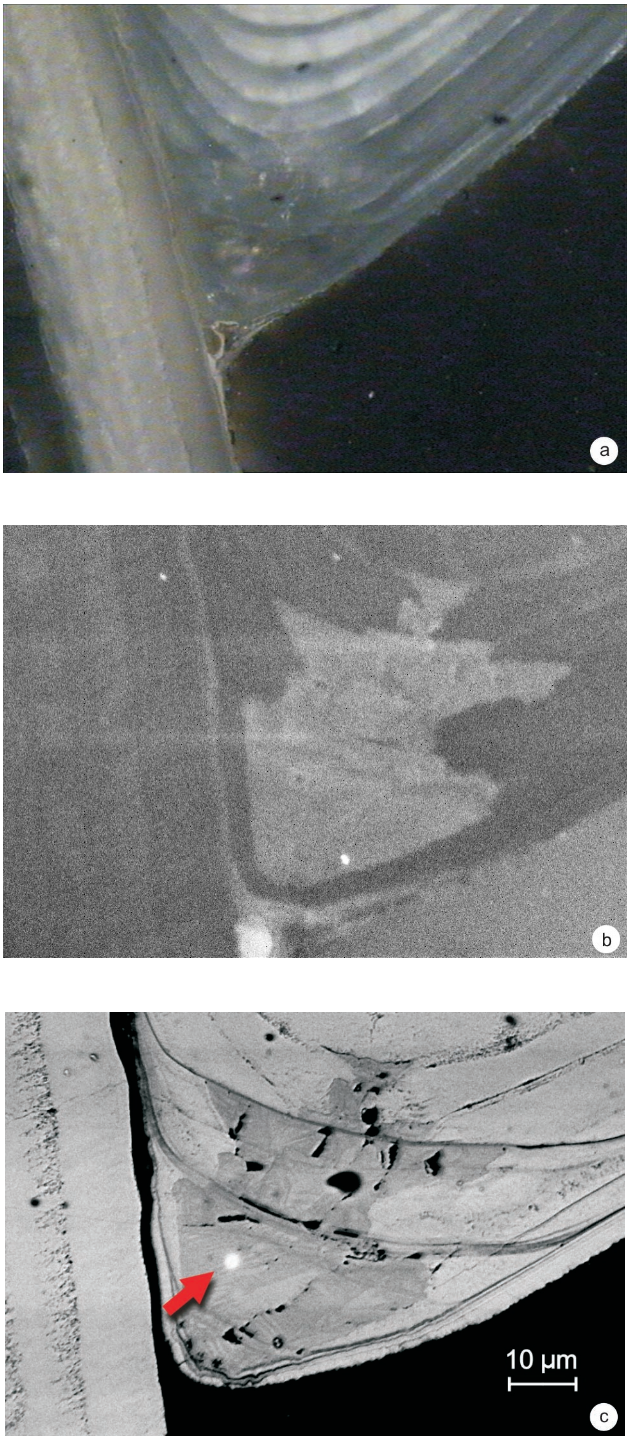

Fig 2. *Cepaea vindobonensis* shell structure: a – SEM photograph of a cross section through the shell; fragment between whorl and suture used for EDS analysis; b – EDS picture, lighter area differs slighty in its chemical composition from the darker zone; c – EDS picture showing the site of microchemical analysis (red arrow)

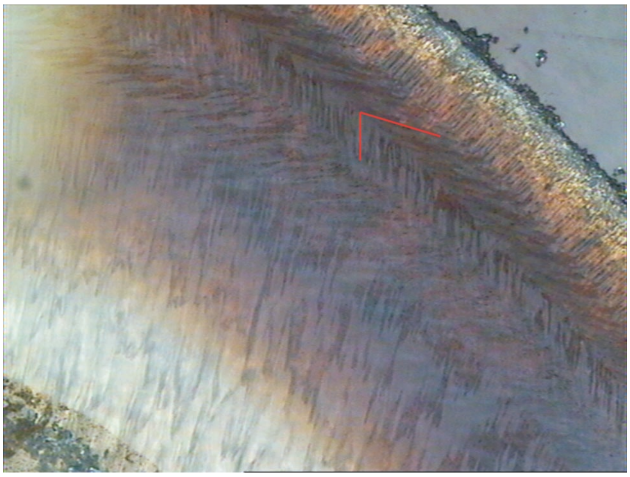

Fig. 3. SEM photograph of a cross section through the shell of *C. vindobonensis*; angle between aragonite microcrystallites c. 60° (red sections)

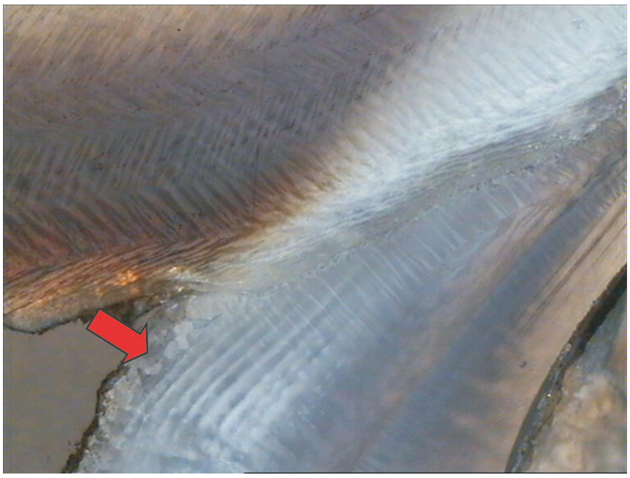

Fig. 4. SEM photograph of a cross section through the shell suture of *C. vindobonensis*; calcite microcrystallites (red arrow)

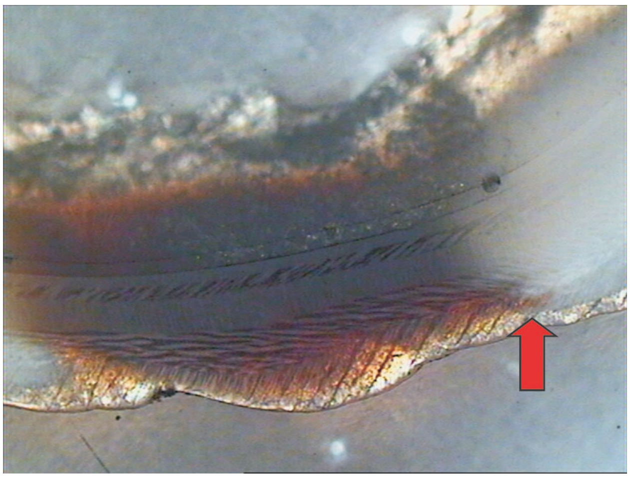

Fig. 5. SEM photograph of a cross section through the shell of *C. vindobonensis*; transition from dark to light zone (red arrow)

position and structure. Further studies will involve more populations, from localities of different substratum chemistry and, additionally, employment of methods which allow for quantitative measurements of content of trace elements. Considering the requirements and habitats of most populations of *C. vindobonensis*, floodplain populations of the species should be included in the future studies.

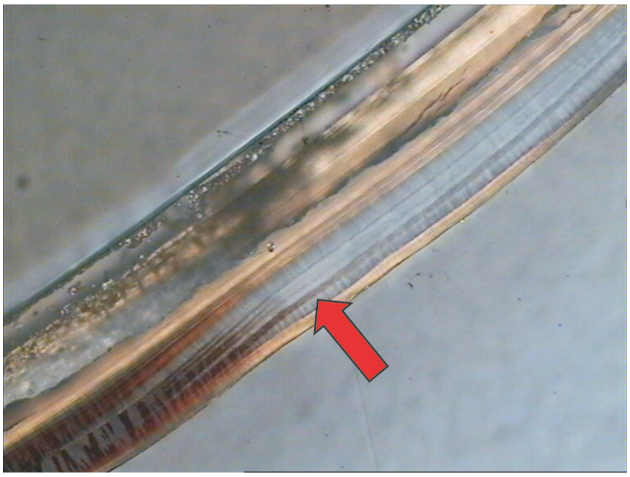

Fig. 6. SEM photograph of a longitudinal section through the shell of *C. vindobonensis,* transition from dark to light zone (red arrow)

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