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SUCCESSIONS OF THE HOLOCENE MOLLUSCAN ASSEMBLAGES IN THE CRACOW UPLAND – PUHATESTŰ FAJEGYŰTTESEK SZUKCESSZIOJA A KRAKKOI SÍKSAG HOLOCÉNJÉBEN

**ABSTRACT:** In the Holocene sediments of the Cracow Upland two succession types of molluscan assemblages may be distinguished. The first series, associated with narrow valleys, is characterised by the occurrence of forest snails, mainly in Middle Holocene deposits. The other comprises water molluscs and snails typical of open environments. This successional type occurs in large valleys. Both assemblage types reflect differences in permanency of ecological conditions during the whole Holocene.

Holocene calcareous tufas and travertines abounding in mollusks occur in several valleys, crossing the palaeozoic and mesozoic carbonaceous formations in the southern part of the Polish Jura Chain (Fig. 1-1). They formed mainly in Boreal, Atlantic and Subboreal periods. In the vicinity of Cracow over 30 outcrops of these sediments are known, the most instructive profiles are situated in the Pradnik, Bedkówka, Szklarka and Raławka valleys (ZARECZNY, 1894; LEWINSKI, 1913; WALCZAK 1956; ALEXANDROWICZ, 1983).

The molluscan assemblages found in calcareous tufas were first reported by ALEXANDROWICZ and STWORZEWICZ (1983) and further described by the author (ALEXANDROWICZ, 1983). Over 70 species of snails as well as shells of slugs and small bivalves (*Pisidium*) were indicated. The investigation of these assemblages was carried out in over 200 samples collected in 16 profiles and outcrops. For the palaeoecological analysis of subfossil mollusks, the method defined and described by LOŽEK (1964) was adopted. According to him the species were divided into 10 ecotypes (E) representing 4 ecological groups: A (E-1, -2, -3) – forest snails, B (E-4, -5) – snails of open environments, C (E-6, -7, -8) – mesophilous snails, D (E-9, -10) – hygrophilous and water mollusks (LOŽEK, 1964).

The percentage of shells of species representing the ecological groups A, B+C and D, is presented in a triangular diagram which is divided into seven fields relating to seven types of mollusk faunas (Fig. 1-2). Three of these types are assemblages dominated by mollusks from specific environments: W – water, M – meadow and wooded or nonwooded areas (mesophilous species), F – forest. The next three types are mixed ones, each composed of two elements: MW, FM, FW. The last one, TC, includes all three components in equal proportion (ALEXANDROWICZ, 1983). In the Holocene tufas described four molluscan assemblage types can be distinguished:

1. Assemblage predominated by forest snails (F). Found in few profiles only.
2. Assemblage with numerous forest snails accompanied by mesophilous, meadow and steppe species as well as by water mollusks (TC, FM, FW). Frequently noted in tufas, and even dominant in few profiles.
3. Assemblage abounding in species typical of open environments and in mesophilous snails with an admixture of water mollusks (M, MW). This is a very common type of malacofauna.
4. Assemblage of hygrophilous and water mollusks (W). Frequent in the material described.

On the basis of the distribution of malacofauna counted in four assemblage types, two kinds of molluscan succession can be distinguished in the Holocene deposits of the Cracow Upland. The first is characterised by the presence of two- or three-component assemblages with numerous forest snails (TC, FW, FM) and even by the typical forest fauna (F), while the other shows a clear prevalence of meadow, steppe and mesophilous snails as well as water mollusks (M, MW, W). These two sequences are separated from each other and occur in different profiles and outcrops. A typical profile of the first succession is accessible in Raławka Valley, and that of the second is found in Pradnik Valley. Both comprise the molluscan assemblages of the Lower and Middle Holocene (Figs 1-2, 3-R,P).

In the Raławka succession type, the deposits of Early Holocene have a poor malacofauna: *Vitrea crystallina* (MÜLLER), *Vallonia pulchella* (MÜLLER), *V. costata* (MÜLLER), *Cochlicopa lubrica* (MÜLLER), *Perpolita radiatula* (ALDER), *Carychium minimum* MÜLLER and *Lymnaea truncatula* (MÜLLER). In this assemblage the mesophilous snails and species typical of open environments predominate. Snails preferring shady habitats are the



subordinate component of the assemblage in question. In some intercalations of tufas numerous water mollusks are found (assemblages MW, TC, W). It is worth mentioning the presence of *Discus ruderatus* (FÉRUSSAC). In the deposits of the climatic optimum there appears a rich malacofauna with numerous snails: *Acanthinula aculeata* (MÜLLER), *Discus rotundatus* (MÜLLER), *Isognomostoma isognomostoma* (SCHRÖTER), *Iphigena plicatula* (DRAPARNAUD), and *Ruthenica filigrana* (ROSSMÄSSLER). They are accompanied by mesophilous and hygrophilous species, as well as meadow snails. Water mollusks occur in some intercalations of calcareous sediments or together with other species (assemblages TC, FW, FM, MW, W). In some profiles richness in Clausiliidae is noted, mainly in sediments of the early stage of the Subboreal period (Epiatlantic). In their late stage there occurs an assemblage rich in mesophilous and hygrophilous snails with many individuals of species characterising open environments. Towards the end of the described succession the forest snails increase markedly in number and then decrease so that in the deposits of the uppermost part of the profile a poor assemblage of hygrophilous, mesophilous and meadow snails are found in some outcrops only (Fig. 1-3R).

The Pradnik succession type comprises molluscan assemblages less differentiated than the ones described above. In the Lower Holocene snails inhabiting open environments are the dominant component of the malacofauna. They occur together or alternate with water mollusks such as *Valvata cristata* MÜLLER, *Anisus leucostomus* (MILLET) and *Lymnaea truncatula* (MÜLLER) (assemblages M, MW, W). In the Middle Holocene the molluscan assemblages are richer and their composition changes indistinctly. Mesophilous, meadow and hygrophilous snails as well as water mollusks are predominant again, but the percentage of forest species increases markedly upwards, reaching about 30% in some samples (assemblages M, MW, W, TC). The last are represented by: *Acicula polita* (HARTMANN), *Aegopinella pura* (ALDER), *Cochlodina laminata* (MONTAGU), *Isognomostoma isognomostoma* (SCHRÖTER), and *Perforatella bidentata* (GMELIN). Some shells of *Vestia elata* (ROSSMÄSSLER) have also been found. The Subboreal period and mainly its late stage is characterised by a malacofauna with numerous water mollusks and snails typical of unshaded habitats (assemblages, M, MW, W). In the uppermost part of the sequence in question only meadow snails occur (Fig. 1-3P).

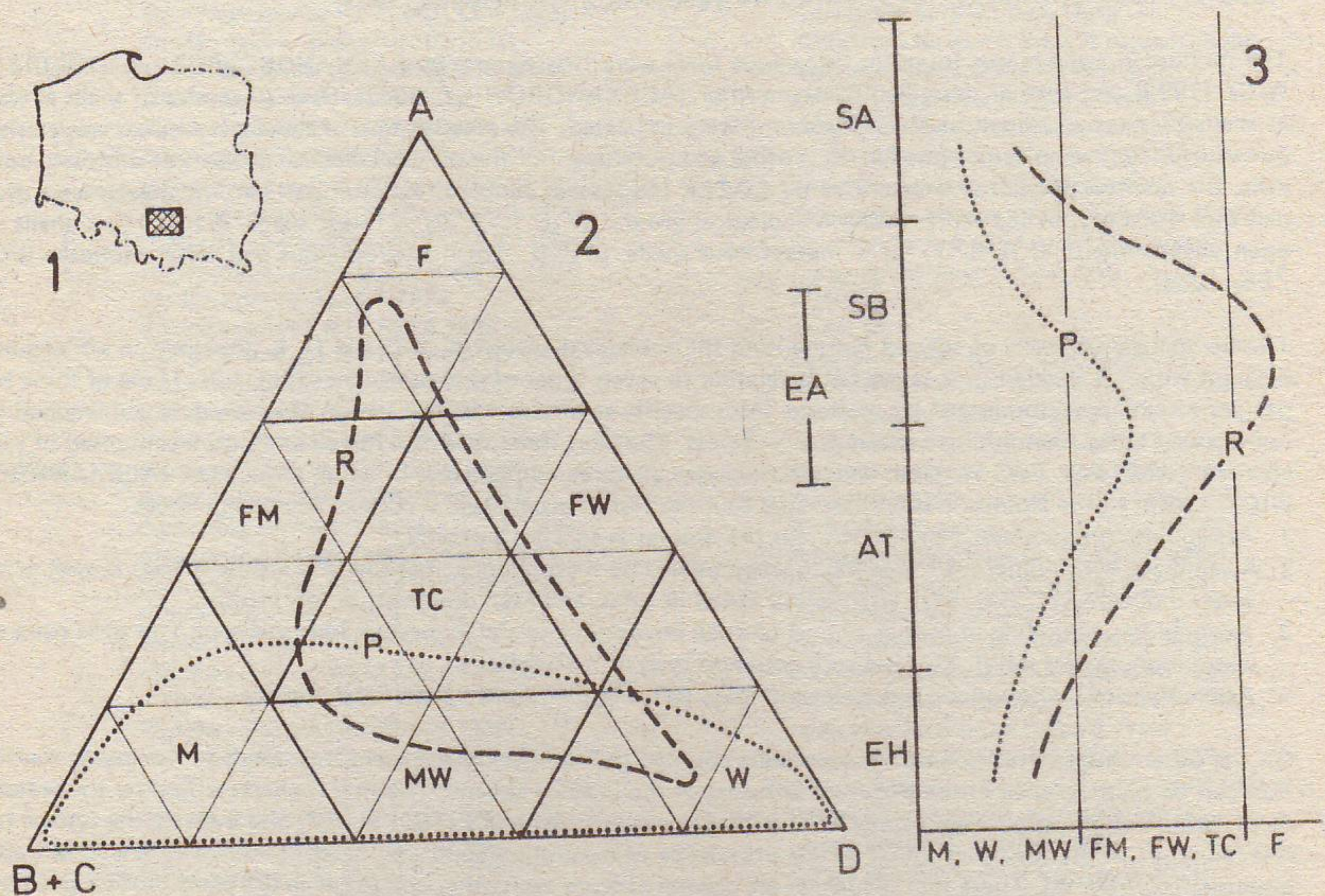


FIG. 1. Differentiation of the Holocene molluscan assemblages in the Cracow Upland. 1 — Localisation of the area described, 2 — Triangular ecological diagram: A, B, C, D — ecological groups of mollusks (after LOŹEK, 1964) described in text, F, M, W... — types of molluscan assemblages described in text, R — Raławka succession type, P — Pradnik succession type, 3 — changes of the mentioned molluscan successions during the Holocene: EH — Early Holocene, AT — Atlantic Period, EA — Epiatlantic Period, SB — Subboreal Period, SA — Subatlantic Period.



The malacofauna described above characterised the sedimentary conditions in which calcareous tufas and travertines are deposited. The first type of molluscan succession (the Racławka succession) is associated with narrow valleys with wooded steep slopes, while the second type (the Pradnik succession) developed on wide, flatfloored valleys occupied by meadows, marshes, swamps and intermittent small water bodies. In the Lower Holocene the difference between the succession types was slight but later it increased markedly in the climatic optimum of the Middle Holocene. At such a time the plateau surface and valley slopes were covered by mixed and deciduous forests and only on the swampy valley floors were meadows marshes and brushwoods widespread. In the Subboreal period the expansion of human settlements and the deforestation of the whole Upland were indicated by a gradual decrease of forest snails. As a consequence, the younger parts of successions in question have mainly the molluscan assemblages MW and M (Fig. 1-3). The deforestation was also responsible for the intensification of erosional processes, due to which Upper Holocene valley floors filled by tufas, travertines and other deposits are dissected.

The differentiation of Holocene malacofauna in the Cracow Upland is observed not only in calcareous sediments but also in slope debris, hillwash and terrigenous stream or river deposits. In all profiles known, one of the described types of molluscan successions can be distinguished. Their elements were also found in the Miechów Upland, in Holy Cross Mountains as well as in the Polish Carpathians and its foreland. Both types of described molluscan assemblages occurring close to each other reflect the differentiation of ecological conditions in valleys filled by calcareous and terrigenous sediments during the whole Holocene.

### ÖSSZEFOGLALÁS

A krakkói síkság holocén üledékeiben a puhatestű fauna két szukcessziós típusa különböztethető meg. Az első típusra erdei csigák jellemzők, melyek főképpen a középső holocén üledékeiben fordulnak elő keskeny völgyekben. A másik típus vízi puhatestűeket és nyílt biotópokon élő csigákat tartalmaz, melyek nagy völgyekben észlelhetők. E típusok léte ökológiai különbségek állandó mivoltát jelzi a teljes holocén időszakban.

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