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# MALACOFAUNA OF THE SZRENIAWA RIVER FLOOD DEPOSITS BETWEEN WOLBROM AND MIECHÓW

IWONA RODZINKA

Chair of Stratigraphy and Regional Geology, Academy of Mining and Metallurgy, Mickiewicza 30, 30-059 Kraków, Poland (e-mail: echelon@poczta.fm)

ABSTRACT: Rich molluscan thanatocoenoses were found in the flood deposits of the Szreniawa River between Wolbrom and Miechów. They comprised 49 taxa of snails and bivalves. The thanatocoenoses were studied using standard methods of malacological analysis. The structure of mollusc assemblages from flood deposits reflects the environment of the drainage basin. The thanatocoenoses correspond with malacofauna living at the bottom of the valleys. Such observations are of basic significance for the interpretation of subfossil Quaternary faunas as paleoenvironment indicators.

KEY WORDS: thanatocoenoses, molluscs, flood deposits, transport of shells

## INTRODUCTION

During periods of increased water level, especially during floods, organic remains accumulate on river banks. The main components of flood debris are tree trunks, branches, plant detritus, seeds and fruits. They are accompanied by sand and silt, as well as anthropogenic debris. Such deposits usually contain many mollusc shells. Accumulations of shell material are termed thanatocoenoses (S. W. ALEXANDROWICZ 1987, 1999). Flood debris accumulates mainly in the outer part of meanders, at dams or other obstacles. Shell thanatocoenoses of river deposits have been studied for over a hundred years (KOTULA 1882, GEYER 1908, CLESSIN 1908, 1911, KLEMM 1973, KÖRNIG 1987 and others), but most of such research was faunistic and focused on species identification and distribution of taxa. Other studies concentrated on the composition and structure of thanatocoenoses, and on conditions of accumulation as well on environment characteristic of whole catchment areas (WASMUND 1923, ZEISSLER 1963, PIECHOCKI 1969, S. W. ALEXANDROWICZ 1991, 1997, 1998, W. P. ALEXANDROWICZ 1999, 2000a, b). Investigations on recently deposited thanatocoenoses may be of basic significance for the interpretation of subfossil Quaternary molluscs as paleoenvironment indicators (ZEISSLER 1963, S. W. ALEXANDROWICZ 1987, 1991, 1999).

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## MATERIAL AND METHODS

Samples of shell-bearing deposits were taken along the upper section of the Szreniawa Valley, between Wolbrom and Miechów (Fig. 1). The deposits were formed in the zone of the river-bed during the flood of May 2003; they included pieces of branches and twigs of various size, other plant debris, seeds, fruits, anthropogenic material as well as numerous mollusc shells. Following drying, all molluscs shells and their identifiable parts were removed. The analysed material included nearly 10 thousand specimens repre-

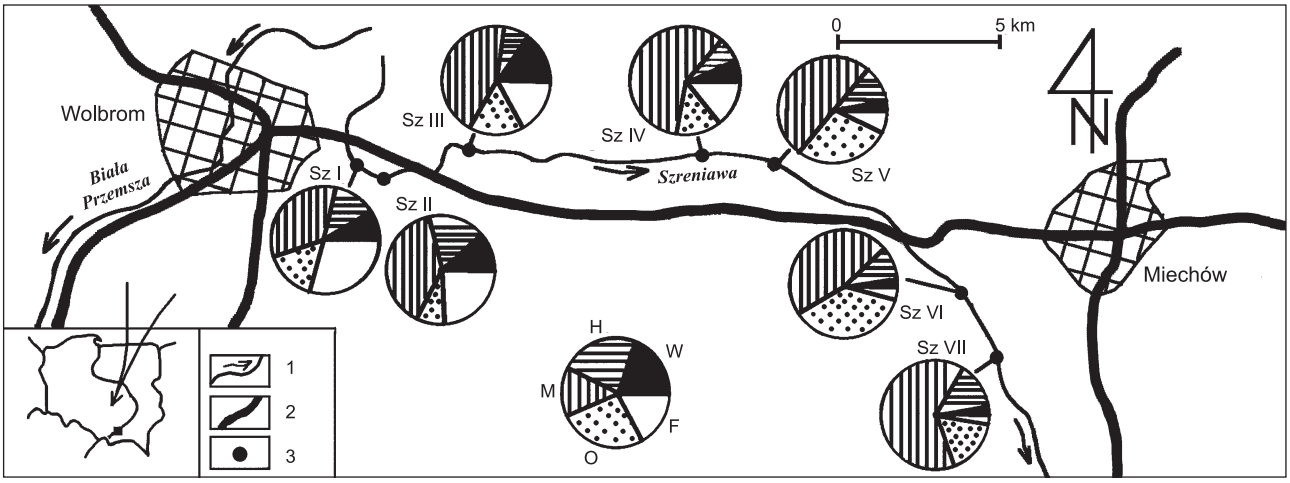


Fig. 1. Localisation of the flood deposits: 1 – river, 2 – roads, 3 – sampling sites and malacospectra (MSI) of shell accumulations from the Szreniawa Valley; ecological groups: F – shade-loving snails, O – open-country species, M – mesophiles, H – higrophiles, W – water molluscs

senting 39 species of land snails, two species of water snails and two species of bivalves (Table 1).

Interpretation of data followed standard methods described by LOŽEK (1964) and S.W. ALEXANDROWICZ (1987, 1999). The composition of the thanatocoenosis was presented as the malacological spectrum of specimens (MSI), with the following ecological groups according to S. W. ALEXANDROWICZ (1998, 1999): F – shade-loving snails (forest and shrubland snails), O – open-country species

Table 1. List of species from the thanatocoenoses of the Szreniawa River. E – ecological groups based on LOŽEK (1964) and S. W. ALEXANDROWICZ (1987): 1 – typical forest species, 2 – species living mostly in forests, 3 – species of humid forests, 4 – xerothermic snails, 5 – open-country species, 6 – mesophile species of dry habitats, 7 – mesophile species of moderately dry habitats, 8 – mesophile species of humid habitats, 9 – higrophiles, 10 – water species, Ci – constancy index, Di – dominance index, K – category of constancy and dominance, N – number of specimens based on S. W. ALEXANDROWICZ (1987): I – 1÷3, II – 4÷9, III – 10÷31, IV – 32÷99, V – 100÷316, VI – 317÷999, VII – >1000

| E | Taxon | Sz-I | Sz-II | Sz-III | Sz-IV | Sz-V | Sz-VI | Sz-VII | Ci | Di | K | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Vitrea diaphana* | III | IV | II | | | I | | 4 | 1 | Cd | 73 |
| 1 | *Aegopinella nitidula* | I | | | | | II | | 2 | 1 | cd | 5 |
| 1 | *Oxychilus depressus* | | | | | | I | | 1 | 1 | cd | 1 |
| 1 | *Perforatella incarnata* | II | II | I | II | I | III | | 5 | 1 | Cd | 34 |
| 2 | *Discus rotundatus* | III | III | I | II | | I | | 4 | 1 | Cd | 43 |
| 2 | *Vitrea crystallina* | | | I | II | II | IV | I | 4 | 1 | Cd | 107 |
| 2 | *Aegopinella minor* | II | II | | II | | | | 3 | 1 | cd | 15 |
| 2 | *Oxychilus glaber* | II | III | II | II | | | III | 4 | 1 | Cd | 52 |
| 2 | *Arianta arbustorum* | V | V | IV | V | I | III | 1 | 5 | 3 | CD | 516 |
| 2 | *Helix pomatia* | | | I | | | | I | 2 | 1 | cd | 2 |
| 3 | *Perforatella bidentata* | | | | | I | IV | I | 3 | 1 | cd | 90 |
| 4 | *Chondrula tridens* | | II | I | I | | II | I | 4 | 1 | Cd | 16 |
| 4 | *Cecilioides acicula* | | | | I | | III | II | 3 | 1 | cd | 26 |
| 4 | *Helicella obvia* | | | | | | III | II | 2 | 1 | cd | 22 |
| 5 | *Truncatellina cylindrica* | I | II | | I | I | III | I | 5 | 1 | Cd | 37 |
| 5 | *Vertigo pygmaea* | I | I | II | I | I | III | I | 5 | 1 | Cd | 38 |
| 5 | *Pupilla muscorum* | II | III | III | IV | II | VI | III | 5 | 3 | CD | 559 |
| 5 | *Vallonia pulchella* | IV | IV | III | IV | III | VII | IV | 5 | 4 | CD | 1,577 |
| 5 | *Vallonia costata* | IV | IV | II | III | I | V | III | 5 | 2 | Cd | 231 |
| 5 | *Euomphalia strigella* | | | I | | | II | | 2 | 1 | cd | 5 |
| 6 | *Cochlicopa lubricella* | | II | | I | | III | | 3 | 1 | cd | 19 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | *Cochlicopa lubrica* | IV | V | IV | V | III | VII | V | 5 | 5 | CD | 2,439 |
| 7 | *Vertigo alpestris* | | I | | | | | | 2 | 1 | cd | 1 |
| 7 | *Punctum pygmaeum* | II | III | II | | I | IV | I | 5 | 1 | Cd | 66 |
| 7 | *Vitrina pellucida* | | III | | I | | III | I | 3 | 1 | Cd | 31 |
| 7 | *Vitrea contracta* | II | III | I | III | I | III | II | 5 | 1 | Cd | 77 |
| 7 | *Oxychilus cellarius* | II | III | | | | | | 2 | 1 | cd | 25 |
| 7 | *Nesovitrea hammonis* | II | III | II | III | II | IV | I | 5 | 1 | Cd | 105 |
| 7 | *Euconulus fulvus* | I | II | | I | | IV | I | 4 | 1 | Cd | 68 |
| 7 | *Laciniaria plicata* | | | II | IV | II | V | III | 4 | 2 | Cd | 210 |
| 7 | *Trichia lubomirskii* | | | | I | | III | I | 3 | 1 | cd | 14 |
| 8 | *Carychium tridentatum* | IV | V | III | III | I | V | IV | 5 | 2 | Cd | 355 |
| 8 | *Succinea oblonga* | | | | I | | IV | III | 3 | 1 | cd | 94 |
| 8 | *Trichia villosula* | III | V | IV | VI | III | VI | VI | 5 | 4 | CD | 1,304 |
| 9 | *Carychium minimum* | | I | | I | | | | 2 | 1 | cd | 4 |
| 9 | *Succinea putris* | II | III | I | III | I | IV | III | 5 | 1 | Cd | 92 |
| 9 | *Vertigo antivertigo* | | I | | I | | II | I | 3 | 1 | Cd | 8 |
| 9 | *Zonitoides nitidus* | IV | V | III | IV | III | VI | V | 5 | 3 | CD | 988 |
| 9 | *Perforatella rubiginosa* | | | | | | III | II | 2 | 1 | cd | 23 |
| 10 | *Valvata cristata* | | | II | I | | I | | 3 | 1 | cd | 8 |
| 10 | *Gyraulus albus* | | | | | | I | | 1 | 1 | cd | 1 |
| 10 | *Physa fontinalis* | | | I | | | | | 1 | 1 | cd | 1 |
| 10 | *Lymnaea peregra* | I | II | I | I | | | | 3 | 1 | Cd | 14 |
| 10 | *Lymnaea truncatula* | I | III | | III | I | III | II | 5 | 1 | Cd | 48 |
| 10 | *Anisus leucostomus* | III | IV | IV | IV | I | IV | II | 5 | 2 | Cd | 186 |
| 10 | *Anisus vortex* | I | III | I | II | | I | | 4 | 1 | Cd | 22 |
| 10 | *Anisus contortus* | I | | | | | | I | 2 | 1 | cd | 2 |
| 10 | *Pisidium subtruncatum* | I | | | | | II | | 2 | 1 | cd | 6 |
| 10 | *Pisidium casertanum* | III | IV | II | III | | IV | III | 5 | 2 | Cd | 184 |

(meadow snails), M – mesophile taxa (with high ecological tolerance), H – higrophile snails and W – water molluscs. For each group the taxonomic diversity index TDI and index of biotic diversity ADI were calculated (S. W. ALEXANDROWICZ 1998, 1999). Constancy (C) and dominance (D) were calculated according to DOBROWOLSKI (1963), and the following division was adopted: CD – common and abundant, Cd – common and unabundant, cD – uncommon and abundant, cd – uncommon and unabundant. Additionally, the synthetic, normalised indices Ci and Di were calculated. The composition of the thanatocoenoses containing ten ecological groups (LOŽEK 1964, S. W. ALEXANDROWICZ 1987) is presented in Table 1. The zoogeographical grouping follows SPARKS (1967) and S. W. ALEXANDROWICZ (1987, 1999).

## STUDY AREA

The Szreniawa River is a left-bank tributary of the Vistula River; it is 79.8 km long. Its sources are located in the Olkusz upland, near Wolbrom, at ca. 380 m a.s.l. Flowing to south-east, through the Miechów upland and Proszowice plateau, it joins the Visula R. at ca. 178 m a.s.l. The catchment area is 706.1 km$^2$. In its mid section the Szreniawa Valley is ca. 2 km wide and its bottom is drained. The Szreniawa catchment area is built of limestone and malm marls which are covered by Quaternary deposits, mainly loess. In the lower part of the valley there are Miocene deposits, mainly loams. The longest tributaries of the Szreniawa are: Cicha stream, Pokojówka stream and Ścieklec stream.

The study area is mostly hilly, with gentle slopes, but some deeper valleys and ravines are also found there. The upper part of the valley is a glen, the bottom is shady, overgrown by trees and bushes. The mid

and lower sections of the Szreniawa Valley are flat-bottomed, with well developed flood plains. In this part the bottom is relatively poorly shaded, though clumps of trees and bushes appear there. The flood plain itself is covered mainly by grasses and cultivated land.

## RESULTS

A relatively poor thanatocoenosis, with 29 species represented by 385 specimens (Table 1) was collected in site Brzozówka I (Sz-I). In the malacological spectrum (MSI) (Fig. 1) euryoecious taxa dominate: *Cochlicopa lubrica* (Müll.), *Carychium tridentatum* (Risso), *Trichia villosula* (Rossm.), as well as shade-loving species: *Arianta arbustorum* (L.) and *Vitrea diaphana* (Stud.). These two groups account for 62% of the whole assemblage. The proportion of open-country (16%) and higrophile species (13%) is also high. Water molluscs are less numerous (9%). The high TDI value (0.7906) reflects the multi-component character of the assemblage.

The thanatocoenosis from Brzozówka II (Sz-II) is rich and contains 32 species represented by 1,284 specimens. Mesophile species constitute 38% of the whole assemblage, with *Cochlicopa lubrica* (Müll.), *Carychium tridentatum* (Risso), *Trichia villosula* (Rossm.). The group is followed by shade-loving snails (24%): *Arianta arbustorum* (L.), *Vitrea diaphana* (Stud.), *Discus rotundatus* (Müll.) and higrophiles (17%): *Zonitoides nitidus* (Müll.). Water molluscs are quite numerous (12%) and represented mainly by *Pisidium casertanum* (Poli) and *Anisus leucostomus* (Mill.). Open-country snails are of minor significance (9%), (Table 1, Fig. 1). The TDI is high (0.7980).

The assemblage from Sulisławice (Sz-III) contains 28 species represented by 347 specimens. It is dominated by mesophile snails (43%): *Cochlicopa lubrica* (Müll.), *Trichia villosula* (Rossm.), *Carychium tridentatum* (Risso). The next most numerous groups are composed of forest-dwellers (17%): *Arianta arbustorum* (L.), *Vitrea diaphana* (Stud.), *Discus rotundatus* (Müll.), and open-country species (17%): *Vallonia pulchella* (Müll.) and *Pupilla muscorum* (L.). Water molluscs constitute 15% (*Anisus leucostomus* (Mill.)). Higrophile species are poorly represented (8%) (Table 1, Fig. 1). The TDI (0.7866) is typical of a polymictic assemblage.

A rich and diverse thanatocoenosis was found in Przybysławice (Sz-IV). It consists of 34 species represented by 1,024 specimens. More than a half (58%) are mesophiles: *Trichia villosula* (Rossm.), *Cochlicopa lubrica* (Müll.), *Laciniaria plicata* (Drap.). Open-country species: *Vallonia pulchella* (Müll.), *Pupilla muscorum* (L.), *Vallonia costata* (Müll.) and shade-loving snails: *Arianta arbustorum* (L.) account for 28% of the assemblage. Less significant are higrophile forms and water molluscs (7% each) (Table 1, Fig. 1). The TDI is 0.6454.

The thanatocoenosis from Witowice (Sz-V) is poor (20 species, 98 specimens), with euryoecious species: *Cochlicopa lubrica* (Müll.), *Nesovitrea hammonis* (Ström.), *Laciniaria plicata* (Drap.) being the most numerous (50%). The proportion of open-country snails is also significant (29%): *Vallonia pulchella* (Müll.), *Pupilla muscorum* (L.). Higrophile, shade-loving and water molluscs account for 12%, 7% and 2% of the association, respectively, and are of secondary significance (Table 1, Fig. 1). The TDI (0.7650) is typical for a multi-component association.

The thanatocoenosiss from Biskupice (Sz-VI) is very diverse. Among its 40 species represented by 5,577 specimens, mesophile forms constitute 50%: *Cochlicopa lubrica* (Müll.), *Trichia villosula* (Rossm.), *Carychium tridentatum* (Risso), *Laciniaria plicata* (Drap.). They are accompanied by open-country species (34%): *Vallonia pulchella* (Müll.), *Pupilla muscorum* (L.), *Vallonia costata* (Müll.) and higrophile forms (10%): *Zonitoides nitidus* (Müll.). Shade-loving snails and water molluscs were only accessory and accounted for 4% and 2% of the whole fauna, respectively (Table 1, Fig. 1). The TDI was 0.6583.

A relatively diverse thanatocoenosis, with 32 species and 925 specimens, was collected in Kamieńczyce (Sz-VII). Like in Biskupice, mesophiles dominate, constituting 62% of the assemblage: *Cochlicopa lubrica* (Müll.), *Trichia villosula* (Rossm.), *Carychium tridentatum* (Risso), *Laciniaria plicata* (Drap.). Open-country snails account for 19%: *Vallonia pulchella* (Müll.), *V. costata* (Müll.), *Pupilla muscorum* (L.), and higrophiles for 15%: *Zonitoides nitidus* (Müll.), *Succinea putris* (L.). Shade-loving taxa and water molluscs are few (each group 2%) (Table 1, Fig. 1). The TDI is 0.6603.

The dominant components of the thanatocoenoses of the Szreniawa River species represented by the highest number of shells and reaching the highest constancy and dominance indices (Tables 1, 2) include *Cochlicopa lubrica* (Müll.) (C–D=5–5), *Vallonia*

Table 2. Structure of thanatocoenoses of the Szreniawa River Valley: C-1÷C-5 – classes of constancy, D-1÷D-5 – classes of dominance; 5.5÷5.3 – dominant species

| | D-1 | D-2 | D-3 | D-4 | D-5 |
|---|---|---|---|---|---|
| C-5 | 8 | 4 | 3 | 2 | 1 |
| C-4 | 7 | 1 | 5–5 – *Cochlicopa lubrica*<br>5–4 – *Vallonia pulchella*<br>5–4 – *Trichia villosula*<br>5–3 – *Zonitoides nitidus*<br>5–3 – *Pupilla muscorum*<br>5–3 – *Arianta arbustorum* | | |
| C-3 | 10 | | | | |
| C-2 | 10 | | | | |
| C-1 | 3 | | | | |

*pulchella* (Müll.) and *Trichia villosula* (Rossm.) (C–D=5–4). They are followed by less abundant but frequent taxa: *Zonitoides nitidus* (Müll.), *Pupilla muscorum* (L.), *Arianta arbustorum* (L.) (C–D=5–3) (Table 2). These species were classified in CD category; they form 75% of whole assemblage. Species of C–D classes 5–2 and 4–2, classified in Cd category, are *Vallonia costata* (Müll.), *Carychium tridentatum* (Risso), *Pisidium casertanum* (Poli), *Anisus leucostomus* (Mill.), *Laciniaria plicata* (Drap.). Other taxa are accessory components and fall into C–D classes 5–1, 4–1, 3–1, 2–1 and 1–1 (Table 2). The proportion of additional, nonsignificant components in the analysed association is low, however taxa characterised by the lowest dominance indices account for 87.7% of the whole assemblage. The value of normalised constancy index is very high (64.28%), whereas the normalised dominance index is very low (10.71). It means that the constancy of many species is substantial, but only few reach a high abundance.

The molluscan assemblages from the Szreniawa Valley include taxa of various geographic ranges (Fig. 2). Widespread species (HP) of four zoogeographical groups are common: Holarctic (Hl), Palaearctic (Pl), Euro-Siberian (Es) and European (Ep), and constitute 68% of the fauna. The assemblage is supplemented by Middle-European (ME) species: Central-European (Me), Alpine-Carpathian (Ma) and European taxa of limited range (EO): East-European (Ee), Balkan (Eb), South-European (Mediterranean) (Em), West-European (Ew) and Boreo-Alpine (Ba); each of these two groups accounts for 16% of the fauna.

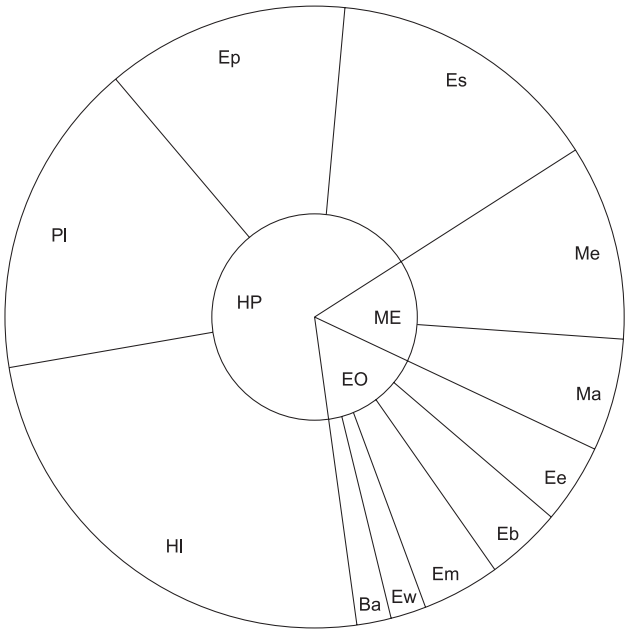


Fig. 2. Zoogeographical structure of mollusc assemblages. See explanations in the text.

## RESULTS AND DISCUSSION

The structure and composition of thanatocoenoses reflect the diverse habitats along the Szreniawa Valley (Fig. 1). The high proportion of shade-loving species is a characteristic feature of assemblages from the upper part of the valley (sites Sz-I, II, III) (Fig. 3). Downstream they are replaced by open-country and mesophile snails (Fig. 3).

The significant proportion of mesophile taxa and open-country species, combined with the low number of shade-loving snails, indicates a scarcity of forests. Shade-loving species found in the analysed material are usually associated with clumps of trees and bushes, which grow on river banks. Open-country species originate from the grassy and cultivated areas, which is confirmed by the presence of *Cecilioides acicula* (Müll.), a snail characteristic of ploughed land. Another important group of components of the thanatocoenosis includes higrophile forms which are associated with wet habitats of the flood plain.

The high percentage of mesophile and open-country species is characteristic of wide valleys with flat bottom (PIECHOCKI 1969, S. W. ALEXANDROWICZ 1998, 1999, W. P. ALEXANDROWICZ 1999). The significant proportion of higrophiles and water molluscs is typical for lowland-rivers with wide valleys. Thanatocoenoses formed in large valleys are impoverished in shells of molluscs living on slopes, but instead enriched with species of flood plains and river terraces. This last group consists mostly of open-country and mesophile snails, higrophile species and molluscs of temporary water basins.

The thanatocoenoses of the Szreniawa Valley, sampled between Wolbrom and Miechów, represent mostly fauna of the Cracow-Wieluń Upland (RIEDEL 1988). A new species which had not been recorded from the area before is *Cecilioides acicula* (Müll.),

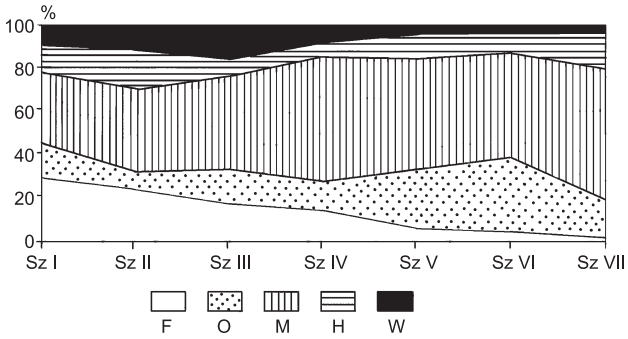


Fig. 3. Changes of mollusc assemblages along the Szreniawa River. For explanation see Fig. 1

which is rather common in farmlands. The assemblage is polymictic, which is confirmed by the high TDI values, ranging from 0.6454 (Sz-IV) to 0.7980 (Sz-II). The mollusc fauna found in individual samples is slightly differentiated (ADI=0.43).

Composition and structure of mollusc assemblages depend on the habitats located in the valley bottom and around it, as well as on the width of flood plain terrace from which the shell material comes, and on the degree of redeposition of material from valley slopes. Till now research of this kind has been conducted only on a limited scale. The data from the Szreniawa Valley may provide a basis for constructing a model describing formation of shell deposits in fluvial environment.

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