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# MALACOFAUNA AND CALCAREOUS DEPOSITS IN THE PTICH VALLEY (MINSK UPLAND, BELARUS)

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Abstract. Holocene calcareous deposits in the Minsk Upland were accumulated on river valley bottoms. A section of calcareous tufas of the Late Glacial, Early and Middle Holocene age in the Ptich Valley were studied by malacological method. It was the period particularly favourable for the formation of calcareous sediments in the area of present swamps within the Minsk Upland. Changes in molluscan assemblages correspond with the development of both the climate and environment.

## INTRODUCTION

The area studied is situated in the central part of the Minsk Upland, approximately 10 km south-west of Minsk. Calcareous deposits occur on the swampy floor of the Ptich river valley (Fig. 1). They contain a rich and differentiated molluscan fauna.

The Minsk Upland is a marginal structure, formed during the Sozh (Warta) stage of the Dnieper glaciation. Modern and ancient fluvial forms of the relief are widespread in this area. The major part of ancient valleys is recently arranged into the modern fluvial system of the Ptich, Svisloch, Ussa and other rivers. These valleys are several kilometres long, with flat, concave, mainly swampy and peaty floors, surrounded by steep slopes.

## SITE DESCRIPTION

The bottom and slopes of the valley around the described exposure, situated between Volchkovichy and Samohvalovichy villages, are composed of sand-gravel deposits and the till of the Dnieper Glaciation (Fig. 1). Holocene calcareous tufas occur on the valley floor, ranging 1–3 m in thickness. They overlie organic sediments, developed as peaty muds with plant remains or peat, and are covered by silty mud and recent soil.

Calcareous deposits in the Ptich Valley have been reported first by DANILOVSKY (1928), who determinated the malacofauna (27 species) from three sites: Rusinovichy, Zabolotie and Volchy Khvost. According to DANILOVSKY (1928), deposits from the first locality are of lacustrine origin, whereas the remaining two exposures represent alluvial sediments.

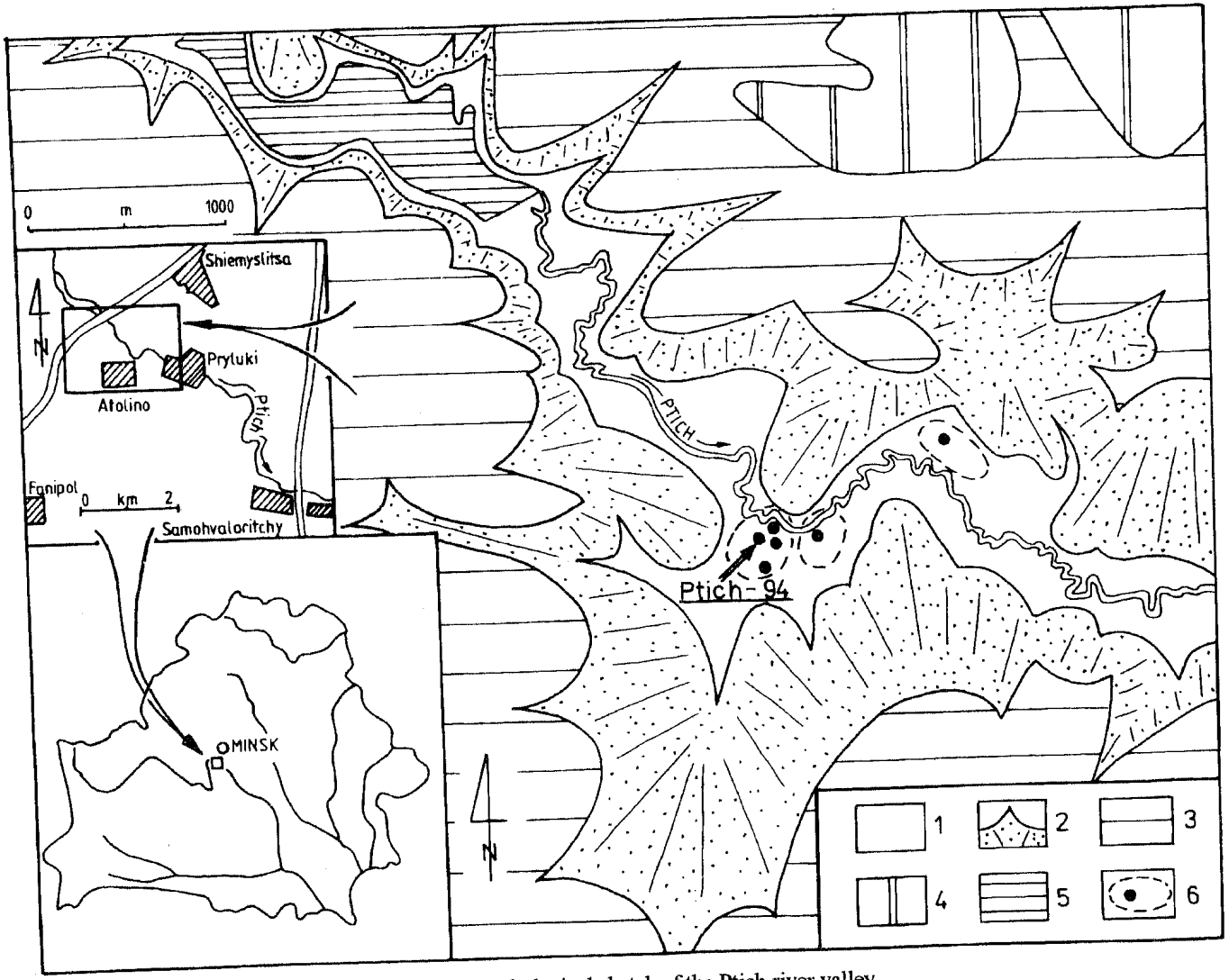


Fig. 1. Geomorphological sketch of the Ptich river valley

1 – Ptich river valley, 2 – slopes rising 25 m above the Ptich valley, 3 – surface rising 50 m above the Ptich river valley, 4 – tills of the Dnieper Glaciation, 5 – Volchkovichy reservoir, 6 – localities of the logs of calcareous tufas

About ten sites of calcareous tufas abounding in shells of molluscs are visible in six exposures (Fig. 1). Most of them were described by KALICKI *et al.* (1997). The reconstruction of the evolution of the Ptich valley was based on lithological, malacological, as well as palynological analyses. According to these authors, the development of calcareous tufas was connected with the Younger Dryas, and Lower and Middle Holocene. Malacofauna and radiocarbon datings from the log Ptich – 94 are an important supplement to the reconstruction of the Ptich river valley. The sequence of layers is described from the bottom upwards:

0.00–0.30 m – white and gray sandy mud with plant remains;
0.30–0.50 m – dark-brown and gray organic mud;
0.50–0.65 m – dark organic mud with plant remains. A sample of wood was dated at 9600±50 years BP (Gd-7564);
0.65–0.75 m – white-gray sandy loam;
0.75–2.00 m – white calcareous tufa intercalated by black, organic mud and peat;
2.00–2.50 m – dark-brown organic mud covered by the recent soil.

The described log is situated about 50 m from the river side, on the floodplain elevated 2 m above the river channel. The base of deposits is not accessible (Fig. 2P).

## MOLLUSCAN ASSEMBLAGES

Eleven samples of mollusc – bearing deposits were collected (Fig. 1S). The fauna comprises 40 species of snails and bivalves. The number of taxa varies between 3 and 29 per sample, whereas the number of specimens attains 4786 (Fig. 2N). Species connected with different types of environment are the components of particular assemblages. Land snails are represented by 18 taxa, whereas water molluscs contain 17 species of snails and 5 species of bivalves. Seven ecological groups of molluscs have been distinguished, according to LOŽEK (1964), PIECHOCKI (1979), S. W. ALEXANDROWICZ (1987a) and DYDUCH-FALNIOWSKA and PIECHOCKI (1993):

1. Shadow-loving snails – there are only two species represented by single shells, found in sample Pt-1 (Table 1).

2. Open-country snails – are represented by *Vallonia costata* (Müll.) and *Vallonia pulchella* (Müll.) that reach a considerable number of specimens throughout the section (Table 1).

3. Mesophile snails – include seven taxa, commonly noted in the whole section (Table 1).

4. Higrophile snails – seven species were found (Table 1), including *Vertigo geyeri* Lindh. and *Vertigo muolinsiana* (Dup.), indicating changes of the climate. Both these species live chiefly in humid habitats, but in different climatic conditions. *Vertigo geyeri* Lindh. is connected with the subarctic climate, and nowadays lives mainly in Northern Europe. In Central Europe it is noted only as a glacial relict (S. W. ALEXANDROWICZ 1987a, POKRYSZKO 1990, KROLOPP and SÜMEGI 1993). *Vertigo moulinsiana* (Dup.) is a snail reported from Middle Holocene deposits (S. W. ALEXANDROWICZ 1987a, POKRYSZKO 1990), typical of warm and humid climate. *Succinea putris* (L.), *Vertigo antivertigo* (Drap.) and *Zonitioides nitidus* (Müll.) occur additionally (Table 1).

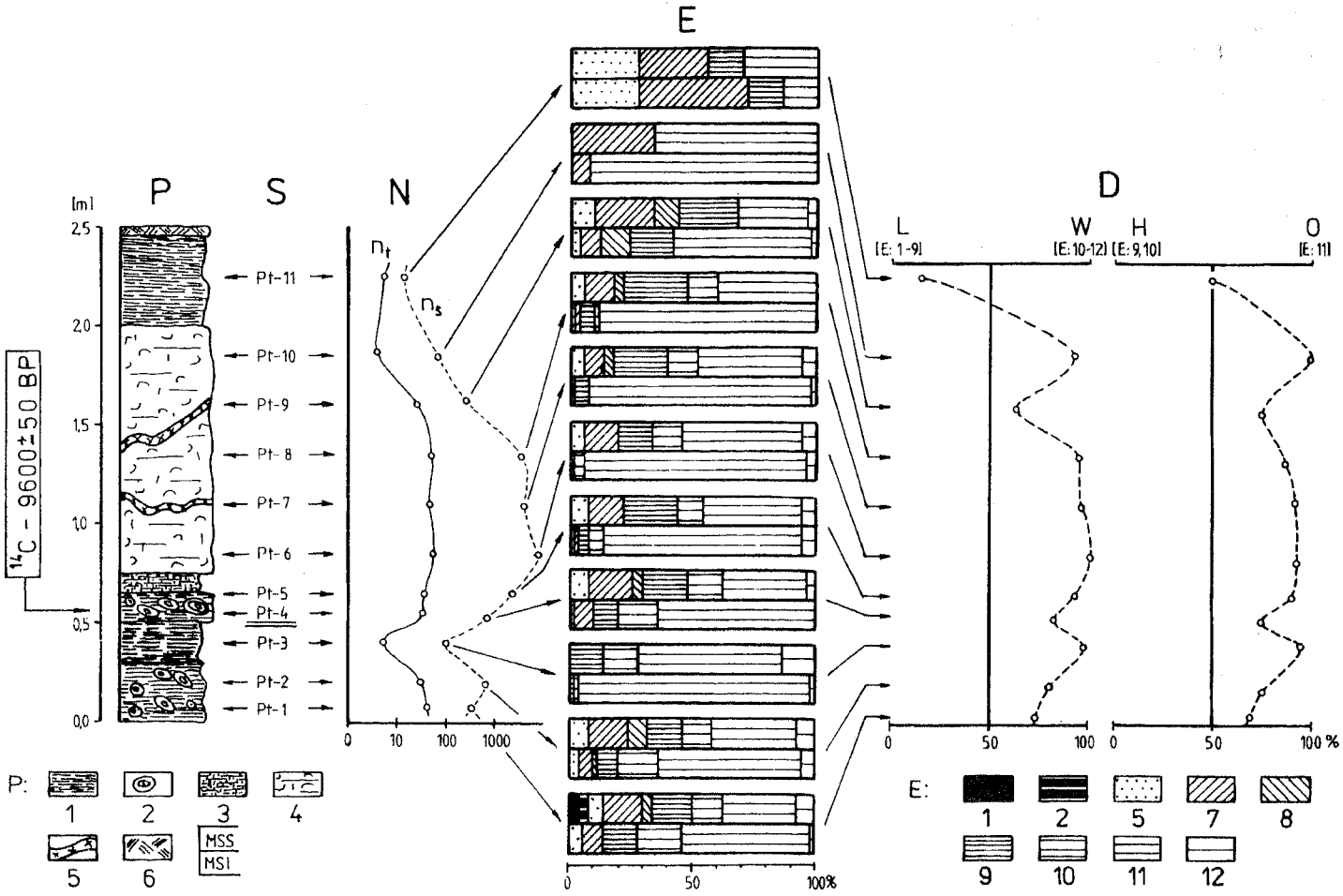


Fig. 2. Lithology and malacological composition of the log Ptich-94

P – lithology: 1 – loams and muds, 2 – plant remains, 3 – sandy loams, 4 – calcareous tufas, 5 – organic muds, 6 – recent soil; S – samples; N – number of species (nt) and number of specimens (ns); E – malacological spectra (based on LOŻEK 1964 and S. W. ALEXANDROWICZ 1987a): MSS – malacospectrum of species, MSI – malacospectrum of specimens; symbols of ecological groups: 1 – typical forest species, 2 – species inhabiting mostly forests, 5 – open-country species, 7 – mesophile species of moderately dry environments, 8 – mesophile species of moderately moist environment, 9 – species of very moist habitats, 10 – species typical for temporary water bodies, 11 – species of stagnant water basins, 12 – species of flowing waters; D – two-components diagrams:

Table 1

## Malacological composition of muds and calcareous tufas in the Ptich River valley

E – ecological groups (based on LOŽEK 1964 and S. W. ALEXANDROWICZ 1987a): 1 – typical forest species, 2 – species inhabiting mostly forests, 5 – open-country snails, 7 – mesophile species of moderately dry environment, 8 – mesophile species of moderately moist environment, 9 – species of very moist habitats, 10 – species typical for temporary water bodies, 11 – species of stagnant water basins, 12 – species of flowing waters; number of specimens: 1 – 1–3, 2 – 4–10, 3 – 11–31, 4 – 32–100, 5 – 101–316, 6 – 317–999, 7 – more than 1000; Pt-1 – Pt-11 – sample numbers

| E | Taxon | Pt-1 | Pt-2 | Pt-3 | Pt-4 | Pt-5 | Pt-6 | Pt-7 | Pt-8 | Pt-9 | Pt-10 | Pt-11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Discus ruderatus | 1 | | | | | | | | | | |
| 2 | Aegopinella minor | 1 | | | | | | | | | | |
| 5 | Vallonia costata | 2 | 2 | | 2 | 1 | 1 | 3 | 2 | 1 | | 1 |
| 5 | Vallonia pulchella | 3 | 3 | | 3 | 3 | 1 | 3 | 2 | 2 | | 1 |
| 7 | Cochlicopa lubrica | 1 | 1 | | 2 | 1 | 1 | 2 | 1 | 2 | | 2 |
| 7 | Punctum pygmaeum | 2 | | | 1 | 1 | 1 | | 1 | 1 | | |
| 7 | Nesovitrea hammonis | 3 | 3 | | 3 | 2 | | 2 | 3 | 2 | | |
| 7 | Limacidae | 1 | 1 | | 3 | | 1 | | | 1 | 2 | 1 |
| 7 | Euconulus fulvus | 2 | 1 | | 1 | 1 | 2 | 2 | 1 | 1 | | |
| 8 | Vertigo angustior | 1 | | | | | | 3 | 3 | 3 | | |
| 8 | Vertigo substriata | | 1 | | | | | | | | | |
| 9 | Carychium minimum | 3 | 3 | | 3 | 3 | | 3 | 2 | 2 | | |
| 9 | Vertigo antivertigo | 2 | 1 | | 3 | 2 | 1 | 3 | 2 | 2 | | |
| 9 | Vertigo moulinsiana | | | | | | | 4 | 2 | | | |
| 9 | Vertigo geyeri | 2 | 1 | 1 | 2 | 2 | 2 | | | | | |
| 9 | Succinea putris | 2 | 2 | | 3 | 3 | 3 | 4 | 3 | 3 | | 1 |
| 9 | Succinea elegans | | | | | 2 | 2 | 2 | | 2 | | |
| 9 | Zoinitioides nitidus | 2 | 2 | | 3 | 1 | 3 | 2 | 1 | 1 | | |
| 10 | Valvata pulchella | 3 | 4 | | | | 2 | 2 | | | | |
| 10 | Lymnaea truncatula | 1 | | | 3 | | | 1 | 3 | | | |
| 10 | Lymnaea peregra peregra | 1 | 1 | | 3 | 3 | 3 | 2 | 2 | | | |
| 10 | Planorbis planorbis | | | | 3 | 3 | 4 | 2 | | | | |
| 10 | Pisidium obtusale | 4 | 3 | 1 | 5 | 3 | 5 | | 1 | | | |
| 11 | Valvata piscinalis | 2 | 2 | | | | 2 | | 1 | | | |
| 11 | Valvata cristata | 4 | 5 | 3 | 6 | 6 | 7 | 7 | 6 | 5 | | |
| 11 | Bithynia tentaculata | 4 | 4 | 4 | 3 | 5 | 7 | 6 | 3 | 2 | 4 | 1 |
| 11 | Lymnaea stagnalis | | | 1 | | 3 | 2 | 2 | 2 | 1 | 1 | |
| 11 | Stagnicola palustris | 3 | | | 1 | 4 | 3 | 3 | 1 | 1 | | |
| 11 | Planorbarius corneus | | | | | 2 | 2 | 3 | 2 | | | |
| 11 | Anisus vortex | | | | | 4 | 4 | 1 | | | | |
| 11 | Bathyomphalus contortus | | | | 3 | 3 | 5 | 3 | 2 | | | |
| 11 | Gyraulus albus | | 2 | | | 2 | 5 | 4 | 4 | | | |
| 11 | Gyraulus laevis | 2 | 4 | | | | | | | | | |
| 11 | Armiger crista | | 2 | | 1 | | 2 | 2 | 4 | 3 | | 1 |
| 11 | Hippeutis complanatus | 1 | | | 1 | 2 | 4 | 2 | 1 | 1 | | |
| 11 | Acroloxus lacustris | 1 | 1 | | | | 1 | | | | | |
| 11 | Pisidium milium | 3 | 3 | | 3 | 4 | 5 | 3 | 1 | | | |
| 11 | Pisidium subtruncatum | 4 | 4 | 1 | 5 | 5 | 7 | 4 | 1 | | | |
| 12 | Pisidium nitidum | 1 | 3 | 1 | 1 | 4 | 5 | | | | | |
| 12 | Pisidium pulchellum | 2 | 3 | | | 4 | 4 | 3 | | 2 | | |

5. Molluscs of temporary water bodies – this group comprises amphibiotic species, such as: *Lymnaea truncatula* (Müll.), *Lymnaea peregra peregra* (Müll.), *Planorbis planorbis* (L.) and others. They were found mainly in the middle part of the sequence (Table 1).

6. Molluscs of stable, stagnant water bodies – include molluscs of quite different ecological preferences. Apart from eurotopic species: *Pisidium subtruncatum* Malm, *Pisidium milium* Held, *Valvata cristata* Müll., *Bithynia tentaculata* (L.), snails connected with shallow overgrown water bodies, such as *Bathyomphalus contortus* (L.), *Anisus vortex* (L.), and *Armiger crista* (L.), were found in the whole section (Table 1).

7. Molluscs living in streams and rivers (reophile taxa) – are represented by two taxa of bivalves (*Pisidium pulchellum* Jenys, *Pisidium nitidum* Jenys), distributed mainly in the lower and middle parts of the sequence (Table 1).

The structure of malacological assemblages is presented by malacological spectra MSS and MSI (Fig. 2S), arranged according to LOŽEK (1964) and S. W. ALEXANDROWICZ (1987a). In the lower part of the sequence (samples Pt-1 and Pt-2), higrophile and water molluscs prevail, and the admixture of the land snails is up to 15%. Shells of shadow-loving taxa [*Discus ruderatus* (Fér.), *Aegopinella minor* (Stab.)] were found only in this part of the log. Molluscs living in permanent water basins dominate [*Stagnicola palustris* (Müll.), *Bithynia tentaculata* (L.), *Gyraulus laevis* (Ald.)]. The occurrence of *Vertigo geyeri* Lindh. and *Gyraulus laevis* (Ald.) indicates cold climatic conditions. This interval of the sequence probably corresponds with the swampy bottom of the river valley with a limited flow.

In the sample Pt-3, the assemblage is very poor and dominated by *Bithynia tentaculata* (L.). Shells and opercula of this snail were found in approximately equal numbers (Bithynia index Bi = 0.08) (S. W. ALEXANDROWICZ 1987a, 1991). It indicates a small, temporary water body, free of reed and isolated from the river.

In the middle part of the sequence (samples Pt-4 – Pt-10) the fauna is the richest one. Bithynia index changes from 0.09 (sample Pt-4) to 0.65 (sample Pt-10), indicating the progressive overgrowing of the water basin by reed and bulrush. The molluscs connected with stagnant water bodies prevail. Species typical of lakes, ponds and oxbows with rich vegetation (*Bathyomphalus contortus* (L.), *Bithynia tentaculata* (L.), *Stagnicola palustris* (Müll.), *Anisus vortex* (L.), *Gyraulus albus* (Müll.), *Hippeutis complanatus* (L.), *Pisidium subtruncatum* Malm) are the main components of the fauna. Species living in temporary water bodies [*Lymnaea truncatula* (Müll.), *Lymnaea peregra peregra* (Müll.), *Planorbis planorbis* (L.)] are the other important components of the assemblage. A few taxa of land snails, mainly higrophile ones, were found as well. The occurrence of numerous shells of *Vertigo moulinsiana* (Dup.), a taxon typical of the postglacial climatic optimum, is noteworthy. The sequence characterises a gradually overgrowing water body, developed in moderately warm climatic conditions.

In the uppermost part of the log (sample Pt-11), the fauna becomes poorer and less differentiated. Land snails dominate [*Vallonia pulchella* (Müll.), *Vallonia costata* (Müll.), *Cochlicopa lubrica* (Müll.)], whereas water molluscs are represented by single shells of *Armiger crista* (L.), and *Bithynia tentaculata* (L.) only. This assemblage corre-

sponds with the last stage of development of the swampy valley floor, being transformed into a wet meadow.

The environmental changes are reflected in two-component diagrams (Fig. 2D) (S. W. ALEXANDROWICZ 1987a). The left one illustrates relationships between land snails (L) and water molluscs (W). In the whole section (except sample Pt-11) water species prevail, reaching 60–95% of the assemblage, whereas in the uppermost part of the sequence land snails dominate, attaining 80%. The development of progressively overgrowing water basin is presented in this diagram. The second diagram illustrates relations between higrophile snails (H) and molluscs connected with stagnant water bodies (O). It indicates the transformation of the water basin in the lower and middle part of the sequence into a swamp or even a wet meadow in the upper interval.

## INTERPRETATION

The sequence of calcareous deposits and molluscan assemblages of the Ptich Valley indicates both stratigraphy of this region and environmental changes. Calcareous tufas of the Minsk Upland are noted in several profiles in the same stratigraphic position, being underlain by sandy and peaty silts, which form the lowermost part of described sequence. Similar successions of terrigenous and calcareous deposits can be observed at several coeval localities (YAKUSZKO 1971).

According to C-14 dating, the lower part of the log is of the age 9600±50 BP (Gd--7564) (Fig. 2P). The molluscan assemblage of organic deposits from the lower part of the sequence contains species typical for the Late Glacial and Early Holocene [*Vertigo geyeri* Lindh., *Gyraulus laevis* (Ald.)]. This fauna occurs both in sediments underlying calcareous tufas, and in the layer dated by radiocarbon method. The lower part of this log was probably formed in the Late Glacial and the Preboreal phase of the Holocene. Similar assemblages of the same age were noted from several localities in Poland (S. W. ALEXANDROWICZ 1987b, 1991, S. W. ALEXANDROWICZ and TCHÓRZEWSKA 1981). The fauna passes upwards into an assemblage dominated by *Bithynia tentaculata* (L.) and several other water molluscs, connected with temporary climatic conditions. It indicates the progressive warming of the climate. In samples Pt-7 and Pt-8, several shells of *Vertigo moulinsiana* (Dup.) were found. It is a snail typical of the Middle Holocene communities (S. W. ALEXANDROWICZ 1987a). The malacological communities recognised in the log Ptich-94 are similar to the assemblages, described from other outcrops in this valley by KALICKI *et al.* (1997). According to these authors, the first stage of deposition of calcareous deposits was connected with the Preboreal Phase or even with Younger Dryas. However, radiocarbon datings (9600±50 BP) (Gd-7564) and molluscan assemblages indicate that the beginning of sedimentation of calcareous tufas was connected with the Boreal phase and the early part of the climatic optimum. In the Atlantic phase the Ptich river incised into the valley floor, and terminated sedimentation of calcareous deposits (KALICKI *et al.* 1997). Calcareous sediments are overlain by organic muds that contain a poor molluscan assemblage without any characteristic species; probably connected with the Subboreal phase. The malacological communities recognised

in the log Ptich-94 are similar to the assemblages described from other exposures in this valley (KALICKI *et al.* 1997).

Molluscan assemblages are strongly connected with environmental changes. At the end of the Late Glacial, the swamps and small water bodies inhabited by water and hygrophile molluscs originated at the bottom of the Ptich Valley. During the Holocene the bottom was gradually filled with sediments, overgrown, finally passing into a swamp and wet meadow. The development and differentiation of molluscan assemblages in the lower and middle part of the succession illustrate the evolution of the valley floor. Similar transformation of small lakes and swamps was described from numerous localities in Poland (S. W. ALEXANDROWICZ 1981, 1987b, 1991, S. W. ALEXANDROWICZ and STWORZEWICZ 1980, S. W. ALEXANDROWICZ and CHMIELOWIEC 1991, S. W. ALEXANDROWICZ and W. P. ALEXANDROWICZ 1995, and W. P. ALEXANDROWICZ *et al.* 1992).

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STRESZCZENIE

## MALAKOFAUNA I OSADY WĘGLANOWE W DOLINIE RZEKI PTYCZ NA WYŻYNIE MIŃSKIEJ W BIAŁORUSI

W dolinie rzeki Ptycz, w odległości około 10 km na południowy zachód od Mińska, występuje martwica wapienna podścielona i przykryta osadami organicznymi. Materiał poddany analizie malakologicznej pochodzi z profilu Ptycz-94 (ryc. 1). Profil ten ma miąższość 2,5 m i odsłania, ciemne mułki torfowe z licznymi fragmentami drzew, nad którymi leży biała, luźna martwica wapienna, przykryta ciemnymi mułkami ze szczątkami roślin (ryc. 2P). W całym profilu występują liczne skorupki ślimaków i małżów (tabela 1). W części dolnej (próbki Pt-1 – Pt-3) dominują gatunki wodne wskazujące na stały zbiornik (ryc. 2S), w niewielkim stopniu zarośnięty przez trzciny. Na taką sytuację wskazuje wartość wskaźnika Bithynia-index, wynosząca 0,08. W części wyższej (próbki Pt-4 – Pt-10) zespół mięczaków zmienia się, podkreślając stopniowe zarastanie i spłycanie zbiornika wodnego. W tym interwale fauna jest najbardziej zróżnicowana. Wartość Bithynia-index dochodzi do 0,65 wskazując na rozwój trzcin. Zespół rozpoznany w próbce najwyższej (Pt-11) znamionuje zanik otwartego zwierciadła wody i powstanie siedliska o charakterze podmokłej łąki. Zmienność i skład zespołów mięczaków obrazuje ewolucję podmokłego dna doliny z niewielkimi jeziorkami. Malakocenozy występujące w dolnej części profilu zawierają liczne skorupki *Vertigo geyeri* Lindh i *Gyraulus laevis* (Ald.) co świadczy, iż omawiany zbiornik powstał w późnym glacjale. Mułki torfowe podścielające martwicę były datowane metodą radiowęglową na 9600±50 lat BP. Sama martwica jest więc wieku holoceńskiego i tworzyła się w fazie borealnej i w młodszej części fazy atlantyckiej. Na taki wiek wskazuje obecność charakterystycznego dla początku optimum klimatycznego gatunku *Vertigo moulinsiana* (Dup.). Leżące na martwicy mułki organiczne są prawdopodobnie związane z fazą subborealną.