

BIOLOGISCHE STATION NEUSIEDLERSEE
BIOLOGISCHES FORSCHUNGSMUSEUM FÜR BURGENLAND
A 7142 ILLMITZ, BURGENLAND, TEL. 02175/328

BFB - Bericht 25

1978

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of South Slovakian Lowland

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Quaternary Mollusca of the Southern Part of South Slovakian Lowland

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1. Introduction
2. Material and Methods
3. Analyses of Quaternary Mollusca
4. Lithological Survey of Sediments
5. Systematic Survey of Quaternary Mollusca
6. Ecological Evaluation of Quaternary Mollusca
7. Stratigraphical Evaluation of Quaternary Mollusca
8. Conclusion
9. Acknowledgement
10. References

1. Introduction

The examined region of East Slovakian lowland is bordered on the West with neovolcanics of Slánské Mountains range. Zemplínské Hills protruding from lowland between Rónva and Ondava rivers are mostly formed with younger Paleozoic, sporadically with Mesozoic and a row of volcanic bodies in mountains and on their periphery. The Quaternary underlying in examined region is formed with sedimentary Neogen, chiefly Badenian, Sarmatic and Pliocene group of strata. The older sediments, e.g., Eggenburg-sediments occur only on the periphery of East Slovakian Neogen and Carpathian basins, less in the basic part of Neogenic filling.

The Praequaternary relief has been changed during the Quaternary period (Banacký, 1974). Beside of young tectonic mobility, the external processes have been strongly effective. Water is very important during the whole development of Quaternary as sedimentary - and erosion factor.

Under influence of fluvial activity the sediments of great thickness have been formed. The very young fluvial sediments occur in small depressions on the large territory along the both banks of Latorica, Laborec, Ondava, Bodrog, Rónva rivers. They are represented with sandy-, loam- and clay inundation muds on Pleistocene sands, loams and clays.

Gravels and sands spread approximately from the North to the line Trebisov-Budkovce-Lekárovce; from this line to the South and South-East the area of sandy sediments begins. The group of gravel layers do not reached the surface. The sandy fluvial sediments are deposited prevalently in southern and southeastern part and their thickness ranges after morphology of substrate depending on the manifestation of young tectonics and erosion. The thickness of sandy sediments reached 15 - 70 m.

Beside of fluvial activity, eolian activity in the forming of East Slovakian lowland has been of importance. The results of this activity are cower of loesses and loessic loams and eolian sands deposited in different formations.

The compact area of loesses occurring between Ondava and Laborec rivers, from Bánovce above Ondava to the locality Oborín reached of thickness 2 - 15 m. They are limestonic sediments with amounts of CaCO₃ concretions. The loessic sediments are deposited on Pliocene clays and gravels. The loesses as relics may be followed on different localities on periphery of Zemplín-islet, e.g., Brehov, Borsa etc. The loessic loams on the eastern slopes and foothills of Zemplín-islet reached of very high thickness.

Beside of volcanic bodies protruding over surrounding terrain, the surface of southern and southeastern part is variegated with eolian sands. Area of these sands spreads prevalently from Latorica river to the South up to Tisa river. The sands cower also the slopes and the whole hills protruding from andesites. The dunes spread in altitude of 105 - 113 m, on the volcanites up to of 200 m altitude. The bases of dunes are situated on the fluvial sands and loams of young Pleistocene and belong to the young Pleistocene or late glacial. The dunes on alluvion of Ondava river are morphologically very striking. Recently, the eolian relief is strongly changed owing to erosion and deflation.

The evolution of system of alluvial-cones on the western foot of Zemplín hills and under Slánské Mountains belongs mainly into Riss and continued through Würm-glacial.

2. Material and Methods

Mollusca 11 903 in number in different state of preservation, juvenils and adults were yielded. The samples weighing 12 - 15 kg (exceptionally 4 - 5 kg) were collected in the years 1971 - 1973 during the Quaternary geological (Banacký) and geomorphological investigations (Kvitkovic). The flotation metod for treatment of samples was used.

3. Analyses of Quaternary Mollusca

The analyses of Quaternary Mollusca are given in tables 1-18. The original designation of sounding profiles was used.

4. Lithological Survey of Sediments

The lithological conditions are evaluated graphically (see Figs 2 and 3).

5. Systematic Survey of Quaternary Mollusca from Sounding-Profiles on East-Slovakian Lowland

The different species of fossil Mollusca yielded during quaternary geological (Banacký 1972, 1973) and geomorphological investigations (Kvitkovic, 1971) on East-Slovakian lowland belong to the 17 families.

VALVATIDAE

Valvata O.F.MÜLLER, 1774

Valvata cristata O.F.MÜLLER, 1774

Valvata piscinalis (O.F.MÜLLER, 1774)

Valvata pulchella (STUDER, 1820)

HYDROBIIDAE

Lithoglyphinae

Lithoglyphus HARTMANN, 821

Lithoglyphus naticoides (C.PFEIFFER, 1828)

BITHYNIIDAE

Bithynia LEACH, 1818

Bithynia tentaculata (LINNE, 1758)

Bithynia leachi (SHEPPARD, 1823)

LYMNAEIDAE

Lymnaea LAMARCK, 1799

Galba SCHRANK, 1803

Lymnaea palustris (O.F.MÜLLER, 1774)

Radix MONTFORT, 1810

Lymnaea peregra (O.F.MÜLLER, 1774)

PLANORBIDAE

Planorbinae

Helisomateae

Planorbarius FRORIEP, 1806

Planorbarius corneus (LINNE, 1758)

Planorbinae

Anisus STUDER, 1820

Anisus spirorbis (LINNE, 1758)

Anisus leucostomus (MILLET, 1813)

Gyraulus CHARPENTIER, 1837

Gyraulus albus (O.F.MÜLLER, 1774)

Gyraulus acronicus (FERRUSSAC, 1807)

COCHLICOPIDAE

Cochlicopa RISSO, 1826

Cochlicopa lubrica (O.F.MÜLLER, 1774)

VERTIGINIDAE

Truncatellinae

Columella WESTERLUND, 1878

Columella columella (MARTENS, 1830)

Vertigo O.F.MÜLLER, 1774

Vertigo pseudosubstriata V.LOZEK, 1954

Vertigo genesii (GREDLER, 1856)

Vertigo parcedentata (A.BRAUN, 1847)

PUPILLIDAE
Pupillinae

- Pupilla FLEMING, 1828
Pupilla triplicata (STUDER, 1820)
Pupilla muscorum (LINNE, 1758)
Pupilla muscorum densegrata LOZEK, 1954
Pupilla sterri (VOITH, 1838)
Pupilla loessica LOZEK, 1954

VALLONIIDAE
Valloninae

- Vallonia RISSO, 1826
Vallonia costata (O.F.MÜLLER, 1774)
Vallonia pulchella (O.F.MÜLLER, 1774)
Vallonia tenuilabris (A.BRAUN, 1843)

ENIDAE
Chondrulinae

- Chondrula BECK, 1837
Chondrula tridens (O.F.MÜLLER, 1774)

- SUCCINEIDAE
Succinea DRAPARNAUD, 1801
Succinea putris (LINNE, 1758)
Succinella MABILLE, 1870
Succinea oblonga DRAPARNAUD, 1801
Oxyloma WESTERLUND, 1885
Oxyloma elegans (RISSO, 1826)

- VITRINIDAE
Vitrina DRAPARNAUD, 1801
Vitrina pellucida (O.F.MÜLLER, 1774)

- ZONITIDAE
Zonitinae
Perpolita H.B.BAKER, 1928
Perpolita hammonis (STRÖM, 1765)
Oxychilus FITZINGER, 1833
Riedelius HUDEC, 1961
Oxychilus inopinatus (ULICNY, 1887)
Vitrea FITZINGER, 1833
Vitrea crystallina (O.F.MÜLLER, 1774)

- EUCONULIDAE
Euconulus REINHARDT, 1883
Euconulus fulvus (O.F.MÜLLER, 1774)

- CLAUSILIIDAE
Clausiliinae
Clausilia DRAPARNAUD, 1805
Clausilia dubia DRAPARNAUD, 1805

- HELICIDAE
Helicidae sp.
Hygromiinae
Trichia HARTMANN, 1840
Trichia cf. striolata (C.PFEIFFER, 1828)
Trichia hispida (LINNE, 1758)

- SPHAERIIDAE
Sphaerium SCOPOLI, 1777
Sphaerium sp.
Pisidium C. PFEIFFER, 1821
Pisidium sp.

6. Ecological Evaluation of Quarternary Mollusca

Locality Brehov, S - 1. The first biotope (0.40 - 2.00 m) represents an open landscape of loessic-steppe (Pupilla muscorum, P.loessica, Vallonia pulchella, V.tenuilabris, Oxychilus inopinatus,⁺ Chondrula tridens), on the border of humid swampy forest along stream (Clausilia dubia). This reality has been confirmed with finding of Valvata piscinalis (living in standing or running water) in horizon 0.40 - 1.00 m. The superficial samples (0.40 - 1.00 m) in ecological characteristics of faunistic complex show a certain

retreat of steppes and increasing environmental humidity. The solitary occurrence of Vallonia sp. in samples (4.20 - 4.90 m) indicates also an open stand of loessic-steppe.

The second faunistic complex of this sounding-profile is represented with sediments in depth from 7.36 - 10.23 m (Kvitkovic). The maximum occurrence of conchs was observed in samples from depth of 9.01 - 9.66 m. The findings of species as Pupilla loessica, P.muscorum, P.m. densegrata, P.triplicata (solitary) and Columella columella, Vertigo pseudosubstriata, V.parcidentata, V.tenuilabris, and loessic-species Succinea oblonga or other species respectively living locally on loess indicate an open steppe-landscape with very humid but not wet substrate (dominance of Succinea oblonga (51.2 %) and the presence of mesophilic element Euconulus fulvus). The same results were obtained from samples collected by Banacky in depth from 8.40 - 8.50 m.

In overlying of this, with conchs rich horizon in sediments from 7.80 - 8.47 m, especially from 7.36 - 7.80 m the Mollusca were very rare. Only the species indicating the standing or running water occurred (Valvata piscinalis, Bithynia tentaculata) most probably the current (Lithoglyphus naticoides) with presence of hygrophilic species Succinea oblonga in depth of 7.80 - 8.47 m. The similar ecological ratios as in profile S - 1 7.36 - 7.80 m (Kvitkovic) were confirmed in outcrop No 86 7.40 - 7.80 m (Banacky).

The underlying is characterized with rapid decrease of conchs. The high dominance of hygrophilic Succinea oblonga (95.34%) and sporadic occurrence of open stands-elements (Pupilla muscorum and Columella columella) testify a humid biotope on the margin of loessic-steppe in alluvial plain.

On the basis of fragmentary preserved occurrence of conchs belonging to families Succineidae and Helicidae in depth of 10.98 - 11.48 m we can assume the developmental analogy of previous humid biotope on the margin of loessic-steppe in alluvial plain.

On the basis of ecological analysis of samples from 7.36 - 10.23 m in profile S - 1 we conclude cold to middle-humid environment with maximal humidity on bottom.

Locality Cejkov, S - 2 KCH

Two specimens of Pupilla sp. indicate most likely an open xerothermic landscape of loessic-steppe.

Locality Zemplinské Jastrabie, S - 3 KCH

On the basis of dominance of Mollusca we suppose an open landscape (Pupilla loessica, cf. Vallonia sp.) in gulf of larger current (cf. Planorbis corneus, cf. Anisus leucostomus) or an open landscape with possible existence of periodic swamps.

Locality Petrikovce, S - 2 - B (+BV 56)

Association of fossil Mollusca in sounding profile is represented with high dominance of Pupilla loessica, P.sterri, P.muscorum, Vallonia tenuilabris, Columella columella and Vertigo parcedentata. We suppose an open landscape of steppe-biotope, cold periglacial environment of glacial Pleistocene-period. Occurrence of mesophilic elements as Euconulus fulvus, especially of Trichia hispida and bog-species cf. Anisus sp., Vertigo genesii, Gyraulus acronicus in sediments of sample-horizons (from 3.80 - 6.00 m) indicates a near alluvial plain or clear swampy wood, steppe-forest or forest steppe, respectively. This opinion is supported with high dominance of constant hygrophilic species Succinea oblonga.

The sediments of deeper horizons 6.90 - 7.40 m indicate exclusively an open landscape of loessic-type a steppe; the possibility of periodic swamps is not excluded as showed a sample from depth of 6.90 - 7.20 m (BV - 56).

Locality Malcice, S - 3 B

The important loessic-species, the extinct Pupilla loessica, Vallonia tenuilabris with Succinea oblonga indicate an open landscape with xerothermic herbaceous community of loessic-steppe.

Point 10 - Gas-supply

Association of Quarternary Mollusca with high predominance of important loessic-species (Pupilla loessica, P.muscorum densegrata, P.muscorum, P.sterri), and the chief fossils Vallonia tenuilabris and Columella columella, substantiate convincingly the existence of an open landscape of cold, dry loessic-steppe.

Point 24 - Gas-supply

Community of fossil Mollusca in depth of 1.20-1.80 m also in this locality shows an open and cold landscape of dry loessic-steppe.

⁺ This species is known as immigrant of the late Holocene. Owing its terricolous mode of life its conchs occur commonly in more older strata.

Solitary presence of the Central European element *Clausilia dubia* signalizes a middle-humid biotope (partial influence of forest or rock-stand, respectively). It is very frequent species on loesses on the periphery of mountains - in this case on the periphery of the Carpathians.

Point 25 - Gas-supply

Sediment of this sample from 1.80 - 2.40 m arisen in conditions of cold climate in open landscape, locally with swampy biotopes (*Vertigo genesii*, *Lymnaea palustris*, *Anisus spirorbis*, and high dominance (74.8%) of hygrophilic *Succinea oblonga*) in dry loessic-steppe bordering with alluvial forest or slope-forest, respectively.

Point 59 - Gas-supply

Community (*Anisus leucostomus*, *Lymnaea palustris*, *Succinea putris*, *Valvata cristata*, cf. *Oxyloma elegans*, *Sphaerium* sp.) in depth of 1.90 - 2.10 m in this locality indicates the existence of swampy biotope (swampy-loess).

Locality Drahnov, outcrop 42

Dominance of fauna in identical biotopes (Fig.) of whole profile shows a more or less constant complex of middle-xerothermic steppe-community (*Pupilla muscorum*, *P.m.densegyrata*, *P.triplicata*) with *Chondrula tridens*, *Vallonia costata*, *Vitrea crystallina*, *Cochlicopa lubrica*, associated with more humid and cold elements as *Succinea oblonga*, *Vallonia tenuilabris* and *Clausilia dubia*.

Maximum of xerothermic biotope is in superficial layers 2.70-4.50 m, chiefly in horizon 2.70 - 3.90 m and dry environment at least is indicated with fauna of middle of profile (5.00 - 6.50 m). Conversely, the samples of depth 7.00 - 8.50 m are characterized with increasing xerothermity. As a whole three mentioned sample-elevations on the basis represented with mesophilic species (*Trichia striolata*, *T.hispida*) and the presence of *Vitrea crystallina*, *Euconulus fulvus*, *Cochlicopa lubrica* permit to suppose the period of their origin the cold climate of open landscape with xerothermic herbaceous community, further the biotope of forest-less rocks (or slopes) on the border with alluvial forest (forest-steppe).

The basal sample-elevation in profile No 42 (sample 9.60 - 10.00 m) representing the beginning of formation of fossils-bearing complex of sediments (formed with loessic sediments with exception of basis), with occurrence of *Planorbis cornutus* supports the existence of standing water, periodic swamps near a river flow. The composition of fauna in basal elevation indicates only weakly a certain mild warmer environment and the existence of standing water (swamps) which may be important in this period.

Locality Drahnov, D - 1

Three different loessic-complexes of Molluscan fauna are distinguishable, each with the constant development of biotopes. The basal complex of loesses (samples 9.73 - 10.60 m) is characterized with species of middle humid biotopes (*Vitrea crystallina*, *Cochlicopa lubrica*, *Trichia hispida*, as hygrophilic *Succinea oblonga*), also with biotopes indicating the existence of swamps (*Lymnaea palustris*, *Succinea putris*) or neighbourhood of running water, respectively (*Lymnaea peregra*) and slightly represented elements of xerothermic herbaceous communities - *Pupilla loessica*, *Vallonia tenuilabris*. These findings testify the development of sediments in swampy environment of clear alluvial forest or forest-steppe, respectively. Maximum of this development was observed in layers of 10.13 - 10.45 m.

The middle complex of loesses (samples 4.40 - 5.18 m) is characterized with xerothermic community (*Pupilla loessica*, *Vallonia tenuilabris*, *Succinea oblonga*) already distinctly colder and more dry climatic period of loessic-steppe in a landscape probably on the border of swampy wood (*Trichia hispida*) or slope-forest, respectively.

The upper loessic-complex is characterized with higher abundance of Quarternary Mollusca and with great number of species. Conversely, the sediments in the basal and middle layers (3.30 - 3.80 m and 2.84 - 3.30 m) has been developed in typical swampy-environment of middle humid alluvial forest (very high predominance of mesophilic elements as *Cochlicopa lubrica*, *Vitrea crystallina*, *Trichia hispida*, and elements of standing water and swamps as *Valvata piscinalis*, *V.pulchella*, *Gyraulus albus*, *Lymnaea palustris*, *Lymnaea peregra*, *Succinea putris*, above the steppe-elements of

open landscape: *Columella columella*, and *Vallonia tenuilabris*). Conversely, in superficial layer the Molluscan fauna has been developed in dry environment of loessic-steppe (*Columella columella*, *Pupilla muscorum*, *P.m.densegyrata*, *Vallonia tenuilabris*) without trees or in neighbourhood of alluvial (or slope-forest), respectively (*Trichia hispida*, *Clausilia dubia*) which phenomenon may be confirmed with presence of *Valvata piscinalis*.

The Molluscan fauna of the first and second loessic-complexes shows the mutual affinity and differs from that of third complex. The second loessic-complex may be considered as the beginning evolutionary line of the environment expressed in the first one.

Locality Drahnov, colony

Open landscape with humid biotope (*Cochlicopa lubrica*, *Euconulus fulvus*, *Perpolita hammonis*, *Clausilia dubia*, *Trichia hispida*, and hygrophilic *Succinea oblonga*) of loessic-steppe (*Vallonia tenuilabris*, *Pupilla muscorum*, *P.m.densegyrata*) in neighbourhood of alluvial plain or alluvial-forest, respectively (*Clausilia dubia*, *Trichia hispida*).

Drahnov, water-supply

Open landscape locally with slightly humid mesophilic biotope of loessic-steppe (forest-steppe) neighbouring with a swampy-wood (*Trichia hispida*, *Clausilia dubia*).

Trebitsov, TR - 1

Xerothermic biotope strongly humid locally with high dominance of *Succinea oblonga* (more than 50%); the presence of *Vertigo genesii* is characteristic for both samples 2.10 - 2.50 m and 2.50 - 3.10 m.

Vranov, Vv - 1

Typical swampy-biotope, probably of an open landscape (*Vallonia costata*).

7. Stratigraphical Evaluation of Quarternary Mollusca

Locality Brehov, S - 1

The both faunistic complexes are separated with eemian fossil soil horizon (5.80 - 6.78 m) without Mollusca. Holoarctic element *Vallonia pulchella* in horizon 4.20 - 4.90 m in profile Brehov, outcrop 86 (Banacký) indicates the end of warm interglacial period or the beginning of cooling of atmosphere in insignificant initial stadial period of Würm-glacial.

But the first (upper) significant faunistic complex in profile Brehov S - 1 (depth of 0.40 - 2.0 m) belongs to the cold, prevalently dry period (*Pupilla loessica*, *P.muscorum*, *Vallonia tenuilabris*, *V.pulchella*, *Chondrula tridens*) probably of the third stadial of Würm-glacial (W 3). However, in maximum of mentioned climate-characteristics in horizon 1.00 - 1.50 m of sounding profile (Kvitkovic), nevertheless the end of generally cold, dry climate of this stadial may be considered and this tendency increased especially significantly in elevation above 1.00 m. This interpretation may be supported with ecologically problematic species as *Vallonia pulchella* which occurs first of all in relatively warmer phases similarly as *Oxychilus inopinatus*.⁺ The lasting reach of periglacial climate at the end of Würm-glacial is trustworthy confirmed by presence of Palaearctic elements *Valvata piscinalis* and *Vitrea pellucida*. With their ecological requirements they belong to the cold and mild humid climate (0.40 - 1.00 m).

The maximum of paleontological findings in underlying of eemian interglacial in profile S - 1 has been observed in sample of depth 9.01 - 9.66 m. Association of Mollusca indicates a maximum of cold climate in dry loessic-steppe of younger Riss-glacial. This characteristics of climate and biotope is represented only with frigidophilic (recently extinct) species as *Pupilla loessica* (34.54%), *P.muscorum densegyrata* and *Vertigo parcedentata* with *V.pseudosubstriata* and with chief species of cold Pleistocene-periods, Northasiatic element *Vallonia tenuilabris* (9.66%) in this horizon. The presence of *Columella columella*, the high dominance of hygrophilic species *Succinea oblonga* and occurrence of mesophilic species *Euconulus fulvus*, show an analogy with general climatic conditions in culminating Würm in this region. But the stand-feature has been more of mesophilic character locally (neighbourhood of swampy-wood, slope-wood) than during the third stadial of Würm-glacial (Occurrence of *Trichia hispida*, cf. *T.striolata*, *Perpolita hammonis* in depth of 2.00 - 2.50 m sounding Brehov, S - 2 (Kvitkovic - Schmidt). We cannot overlook also the possibility of the end of younger Riss-glacial in both sounding-proliferes in

agreement with the presence of *Meridional Pupilla triplicata* in profile S - 1 (cf. its occurrence also in sounding S - 2) in depth of 9.01 - 9.66 m. It occurs in relatively warm phases of cold period, but also in culminating glacial (Lozek, 1964). It was found also in depth of 8.40 - 8.50 m, outcrop 86 in locality Brehov.

However, the culminating glacial is indicated with *Vertigo parcedentata*, *V. pseudosubstriata*, the Palaearctic species *Valvata pscinalis* occurring in overlying sediments of this horizon indicates the periglacial, mild climatic conditions at the end of younger Riss-glacial.

The sediment in underlying of this horizon (elevation under 9.66 m) is of origin in warmer and more humid climatic conditions, probably at the beginning of younger Riss-glacial (very high dominance of *Succinea oblonga* (95.35%).

On the basis of fragmentary preserved conchs of families Succineidae and Helicidae in depth of 10.98 - 11.14 m in sounding S - 1, we cannot indicate the climate during the genesis of this sediment. The established families enable to suppose an analogy of climatic conditions with overlying samples - change of cold and dry climate into mild one. The age incorporation into older Riss-glacial cannot be accented.

Locality Brehov, S - 2

The sounding profile Brehov S - 2 (Kvitkovic and Schmidt) in depth of 1.50 - 3.50 m and the sounding profile S - 1 in depth of 8.47 - 10.23 m show the same species-dominance in community of Quarternary Mollusca and therefore the same diagnosis. It may be noted that the composition of Molluscan fauna in profile S - 2 in depth of 3.00 - 3.50 m indicates mostly the mild climate at the end of the second stadial of Riss-glacial. The samples of profile S - 2 have the accessoric presence of *Cochlicopa lubrica*, *Clausilia* sp. and especially *Trichia* cf. *striolata*.

Locality Cejkov, S - 2 KCH

The specimens of *Puilla* sp. (untill undetermined) testify the existence of culminating period of glacial Pleistocene phase.

Locality Zemplínske Jastrabie, S - 3 - KCH

The established species: *Pupilla loessica*, *Succinea oblonga*, cf. *Vallonia* sp., cf. *Anisus leucostomus*, cf. *Planorbis* *corneus* from this sediment confirmed unambiguously the glacial character of climate, most probably of the young Pleistocene (Würm).

Locality Petríkovec, S - 2B (+ BV - 56)

The high dominance of chief fossils of glacials, extinct species - *Vallonia tenuilabris*, *Pupilla loessica*, *P.m.denssegrata*, further *Columella columella* and *Vertigo parcedentata* enable to include the genesis of fossils-bearing sediments in depth of 3.80 - 6.00 m in both profiles (S - 2 B and BV - 56) to the culminating parts of glacial (periglacial) most probably to the younger Pleistocene, Würm (W 3, less probably W 2). The extremely cold climate culminates in samples from depth of 4.60 - 6.00 m.

Locality Malčice S - 3 B

The molluscan community: *Pupilla loessica* (72.09%), *Vallonia tenuilabris* (18.61%), *Succinea oblonga* (9.30 %) indicate first of all the third stadial of younger Pleistocene (Würm 3). The Molluscan fauna and slightly-brown loessic sediment indicate the dessication as consequence of cold climate.

Point 10, Gas-supply

Association of fossil Mollusca is composed from the chief-species of the culminating part of glacial (*Columella columella*, *Vertigo parcedentata*, and glacial-elements of Pleistocene, *Vallonia tenuilabris*). After age of sediments of samples from 0.90 - 1.50 m depth they belong to the younger Pleistocene - Würm (most probably Würm 3) with minimum of cold climate and with humid environment in sample from 2.00 - 2.10 m (neighbourhood of impermeable underground).

Point 24 - Gas-supply

The molluscan community in this sample (1.20 - 1.80 m) confirmed the cold and dry nature of climate in third stadial of younger Pleistocene, Würm 3; locally mesophilic character may be noted (*Succinea oblonga* (42.15%), *Clausilia dubia*).

Point 25, Gas-supply

The culminating part of glacial (periglacial of Würm) in younger Pleistocene. The strong humid sediment (*Succinea oblonga* 74.83%) has been caused locally. This assumption is confirmed with findings of swampy species *Vertigo genesii*, *Lymnaea palustris*, *Anisus spirorbis*, also mesophilic cf. *Trichia hispida*.

Point 59, Gas-supply

The fossil Mollusca (*Anisus leucostomus*, *Lymnaea palustris*, *Succinea putris*, *Valvata cristata*, cf. *Oxyloma elegans*, *Sphaerium* sp.) in sample from depth of 1.90 - 2.10 m belong probably into final period of culminating part of Würm-glacial. Cold or mild humid climate, respectively; mild climate at least locally.

Locality Drahnov, outcrop 42

The evaluation of Quarternary Mollusca on loess in depth of 2.70 - 10.00 m showed in complexity that in sample-elevations up to 8.50 m (mainly under 4.00 m) the stadial development of Molluscan community belongs to the young Pleistocene, Würm. Certainly it belongs to the culminating part of Würm glacial (W 2, W 3), especially Würm 2, in superficial sample-elevation (2.70 - 3.90 m), probably to the last stadial (W 3). This age is confirmed first of all with the finding of *Pupilla muscorum* and *P.triplicata*, *Vallonia costata* and *Chondrula tridens*, with presence of more humid and colder elements *Succinea oblonga*, *Vallonia tenuilabris* and *Clausilia dubia* in the lower sample-elevations of fossils-bearing complex of sediments (7.00 - 8.50 m) and nearly identical abundance of both elements, especially of *Clausilia dubia* and *Vallonia costata* in the higher sample-elevations (middle and upper, i.e., the samples from 2.70 m and chiefly 4.00 - 6.50 m. This is characteristic for the biostratigraphy of the second stadial of Würm-glacial (W 2) in our regions (Lozek, 1955).

The basal sample-elevation (9.60 - 10.00 m) on the basis of ecological analysis indicates the existence of conditions belonging probably to the interstadial period of early Würm (sensu Lozek, 1973), first of all to the final phase of interstadial W 1/2 Brömp).

Locality Drahnov, D - 1

In connection with age of three faunistic loessic-complexes in this locality we look the first (upper) complex in depth of 2.24 - 3.80 m. The striking occurrence of typical frigidophilic elements as *Columella columella*, *Pupilla loessica*, *P.m.denssegrata*, *Vallonia tenuilabris*, and the presence of *Clausilia dubia* enable unambiguously to include this loessic-complex into the third stadial of Würm-glacial (W 3) with generally cold and dry climate.

The significant refrigeration (presence of Nothasiatic element *Vallonia tenuilabris*) and more dry character of climate is signalized with fauna in samples from depth of 4.40 - 5.15 m which belongs probably to the beginning of the last stadial of Würm-glacial (W 3).

The significant insufficiency of chief-species of cold fauna *Vallonia tenuilabris*, the small abundance of xerothermic elements of Pupilla-fauna and the highly prevalent elements of middle humid biotopes (*Cochlicopa lubrica*, *Vitrea crystallina*, *Trichia hispida*) in the basal sample-complex of loesses (samples 9.73 - 10.60 m) testify the relatively mild warm conditions of more humid phase, probably of the first stadial period of Würm-glacial (W 1).

Drahnov-colony

The presence of Palaearctic element *Perpolita radiatula* and Holarctic element *Cochlicopa lubrica* indicate the passage-period or more humid phase of loesses of the final period of culminating glacial in young Pleistocene (Würm). The cold, mild humid climate. The presence of *Vallonia pulchella* indicates a relatively mild climate.

Drahnov - Water-supply

The Molluscan fauna belongs to the culminating Würm, probably to the second stadial of Würm-glacial (W 2).

Trebisov - TR - 1

Columella - fauna (*Columella columella*, *Succinea oblonga*, *Vallonia tenuilabris*, *Pupilla loessica*, *P.muscorum*) is characteristic for upper loesses of stadial periods of culminating part of Würm-glacial (Lozek, 1955). The cold climate, locally strongly humid stands (*Vertigo genesii*).

Vranov - Vv - 1

Faunistic-community of this sample inclines to the colder and more humid phase of some climatic period of the last glacial (culminating through Würm?).

8. Conclusion

Spectrum and character of association of Quarternary Mollusca give a new evidence on paleogeographic conditions in the

East Slovakian lowland first of all on specific development of loessic-sediments in conditions prevalently of aquatic environment (swampy-loesses) or mesophilic stand, respectively in range of lowland regions of the Slovak Carpathians.

The biostratigraphical analyses carried out in this region confirmed the general validity of general climate-character in different periods of climatic oscillation in middle and young Pleistocene. On the basis of our investigation we are of opinion that probably the younger Riss-glacial (locality Brehov) has been more arid; conversely, Würm in all localities - more humid.

The finding of such species as *Pupilla tridens*, *Cochlicopa lubrica*, *Vitrea crystallina*, *Vertigo genesii*, *Valvata piscinalis*, *Vitrina pellucida* and others indicate the cold, cold and dry climatic conditions or relatively warmer and more humid phases of arising or ending stadial or interstadial-periods of younger Pleistocene-Würm, respectively. From this aspect the Molluscan fauna from the sediments of surrounding profiles in Drahnov (D-1, and outcrop 42) and Petrikovce (S - 2 B and BV - 56) is very interesting.

Consideration on analogical relationships between the genesis of sediments and the relevant climatic factors enable the comparison of loessic regions in the East Slovakian-and Danube-lowlands. Stated on the basis of our investigation, the climate in the East Slovakian lowland in Pleistocene (younger and especially middle) has been characterized with continentality (constant occurrence of extremely frigidophilic elements commonly of Northasiatic origin, e.g., *Vallonia tenuilabris*, and tundra-species *Vertigo pseudosubstriata*, *V. parcedentata*; further boreo-alpine element *Columella columella* and repeated findings of *Vertigo genesii* and *Pupilla loesica*, *P.m.densegyrata*). The continentality of climate to a certain degree is expressed also in the recent climate here. The correlative stratigraphical survey used for comparison of these results was elaborated by Dr.R.Halouzka for International Geological Correlation Program for Slovakian Quarternary.

9. Acknowledgement

Our thanks are due to Dr.V.Locek D.Sc. for reading of manuscript and revision of determination of some species.

10. References

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Explication to the fig.1:

Fig.1. Localities in which the Quarternary Mollusca were found.

Explication to the figs 2-3:

1. Loam (soil) without granular differentiation
2. Loam (generally) without granular differentiation
3. Dusty loam
4. Slightly sandy dusty loam or dusty-sandy loam or fine sandy loam, respectively
5. Sandy-loam (generally)
6. Loess
7. Dusty-sandy loess or fine sandy loess, respectively
8. Sandy loess (generally) and strongly sandy loess
9. Clay-loam
10. Clay
11. Dusty sand (and fine granular) loamized sand
12. Dusty sand and fine granular sand
13. Sand (generally) or middle and coarser sand, respectively
14. Sandy gravel
15. Earth of weather-worn substrate, e.g., of andesites
16. Carbonate horizon

The lithological tables were established after documentation of Kvítkovic and Banacký (Orig.R.Halouzka).

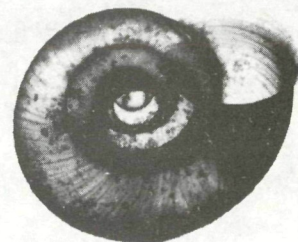
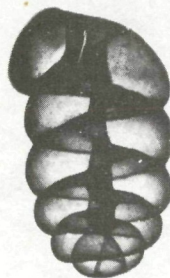
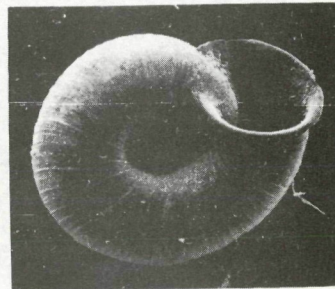
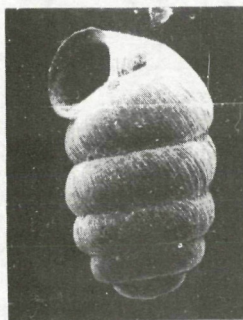
Explication to the Ecological Characteristics of Fossil Mollusca

- H = Hygrophilic species
M = Mesophilic species (middle humid biotopes)
SW - RW = Standing and running water
B = Species living in very humid biotopes (swamps, bogs, swampy forests, water-shores)
PS = Periodic swamps
F = Forest, forest species only
F_(p) = Forest, rocks, rubble
O = Open stands without trees (from humid meadows to steppes); semixerothermic species
S = Steppe-elements (dry, sunny stand without trees)

Remarks:

- x = extinct species
+ + = important loess-species
+ = loess-species
(+) = species occurring locally on loess-soils

Figs 4 - 11 Orig. Z.Schmidt



SCANNING AND X-RAY PICTURES

Fig. 1

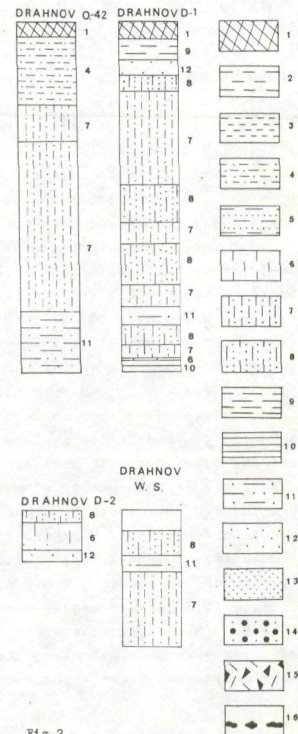
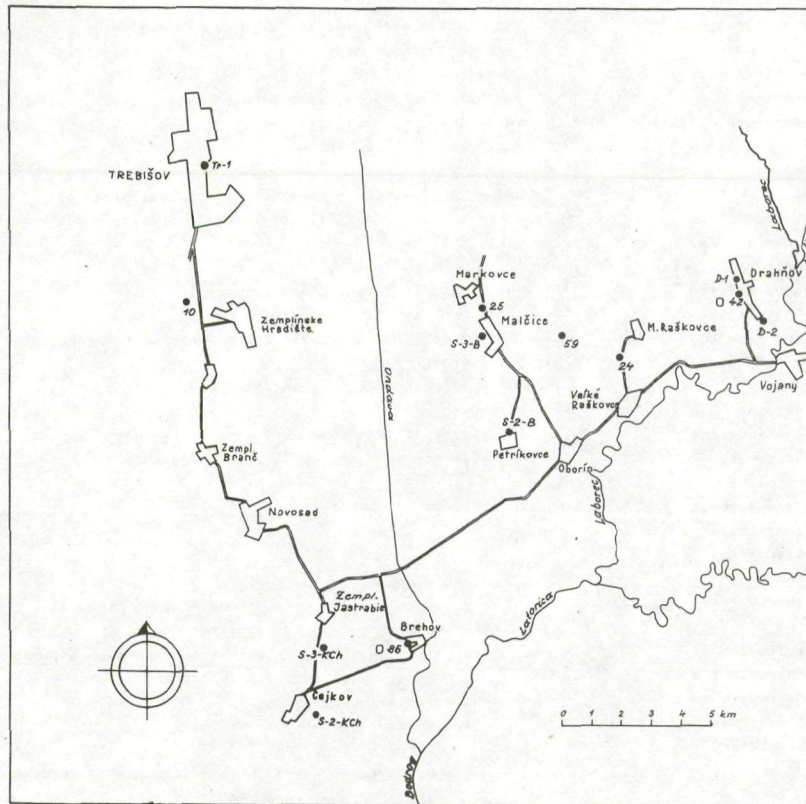


Fig. 2

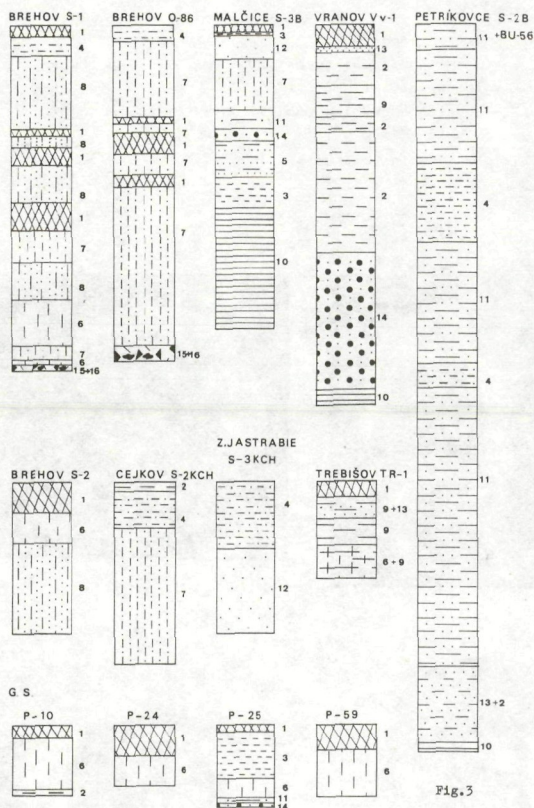


Fig. 3

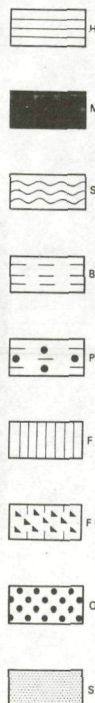


Fig. 4

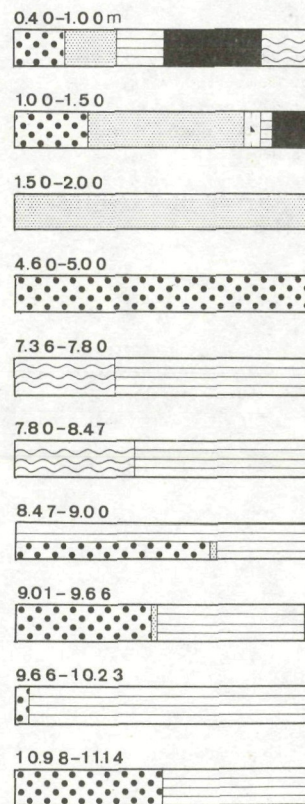


Fig. 5

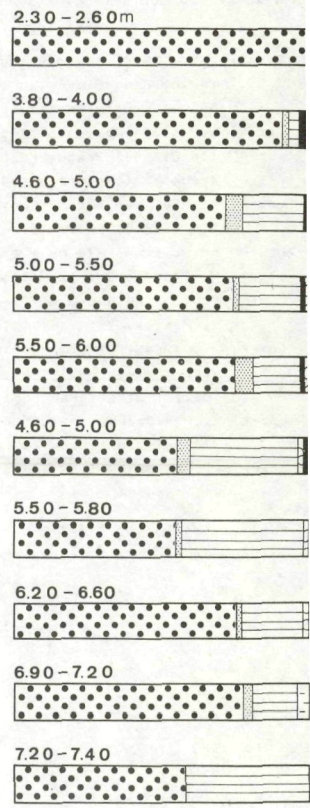


Fig. 7

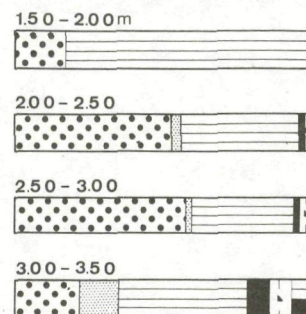


Fig. 6

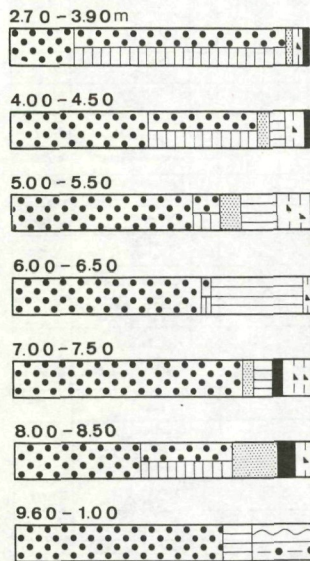


Fig. 8

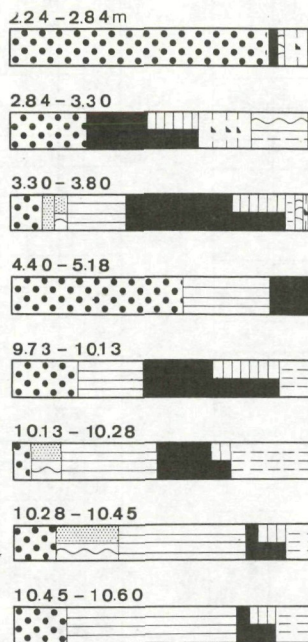


Fig. 9

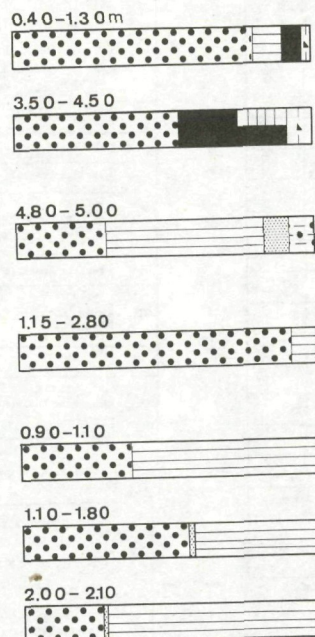


Fig. 10

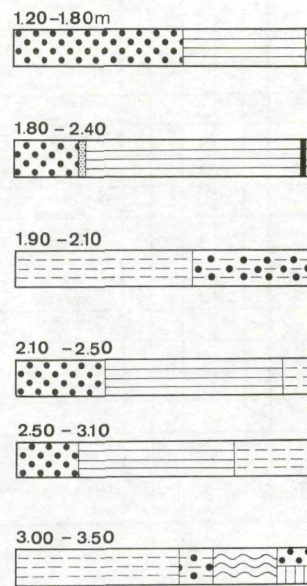


Fig. 11

BREHOV, S-1 /J. Kvitkovič-Z. Schmidt/

Sample	Depth	Biotope
1	0,40-1,00	SW-RW
2	1,00-1,50	RW
3	1,50-2,00	SW-RW
4	2,00-2,50	O ++
5	2,50-3,00	O ++
6	3,00-3,50	O ++
7	3,50-4,00	O ++
8	4,00-4,50	O ++
9	4,50-5,00	O ++
10	5,00-5,50	O ++
11	5,50-6,00	O ++
12	6,00-6,50	O ++
13	6,50-7,00	O ++
14	7,00-7,50	O ++
15	7,50-8,00	O ++
16	8,00-8,50	O ++
17	8,50-9,00	O ++
18	9,00-9,50	O ++
19	9,50-10,00	O ++
20	10,00-10,50	O ++
21	10,50-11,00	O ++
22	11,00-11,50	O ++
23	11,50-12,00	O ++
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307	153,50-154,00	O ++
308	154,00-154,50	O ++
309	154,50-155,00	O ++
310	155,00-155,50	O ++
311	155,50-156,00	O ++
312	156,00-156,50	O ++
313	156,50-157,00	O ++
314	157,00-157,50	O ++
315	157,50-158,00	O ++
316	158,00-158,50	O ++
317	158,50-159,00	O ++
318	159,00-159,50	O ++
319	159,50-160,00	O ++
320	160,00-160,50	O ++
321	160,50-161,00	O ++
322	161,00-161,50	O ++
323	161,50-162,00	O ++

Sample	Biotope	Depth	Number of individuals
1	4,60 - 5,00	39	5
2	5,50 - 5,80	52	4
3	6,20 - 6,60	17	4
4	6,90 - 7,20	3	5
5	7,20 - 7,40	2	1
6	7,40 - 7,60	2	1
7	7,60 - 7,80	2	1
8	7,80 - 8,00	2	1
9	8,00 - 8,20	2	1
10	8,20 - 8,40	2	1
11	8,40 - 8,60	2	1
12	8,60 - 8,80	2	1
13	8,80 - 9,00	2	1
14	9,00 - 9,20	2	1
15	9,20 - 9,40	2	1
16	9,40 - 9,60	2	1
17	9,60 - 9,80	2	1
18	9,80 - 10,00	2	1
19	10,00 - 10,20	2	1
20	10,20 - 10,40	2	1
21	10,40 - 10,60	2	1
22	10,60 - 10,80	2	1
23	10,80 - 11,00	2	1
24	11,00 - 11,20	2	1
25	11,20 - 11,40	2	1
26	11,40 - 11,60	2	1
27	11,60 - 11,80	2	1
28	11,80 - 12,00	2	1
29	12,00 - 12,20	2	1
30	12,20 - 12,40	2	1
31	12,40 - 12,60	2	1
32	12,60 - 12,80	2	1
33	12,80 - 13,00	2	1
34	13,00 - 13,20	2	1
35	13,20 - 13,40	2	1
36	13,40 - 13,60	2	1
37	13,60 - 13,80	2	1
38	13,80 - 14,00	2	1
39	14,00 - 14,20	2	1
40	14,20 - 14,40	2	1
41	14,40 - 14,60	2	1
42	14,60 - 14,80	2	1
43	14,80 - 15,00	2	1
44	15,00 - 15,20	2	1
45	15,20 - 15,40	2	1
46	15,40 - 15,60	2	1
47	15,60 - 15,80	2	1
48	15,80 - 16,00	2	1
49	16,00 - 16,20	2	1
50	16,20 - 16,40	2	1
51	16,40 - 16,60	2	1
52	16,60 - 16,80	2	1
53	16,80 - 17,00	2	1
54	17,00 - 17,20	2	1
55	17,20 - 17,40	2	1
56	17,40 - 17,60	2	1
57	17,60 - 17,80	2	1
58	17,80 - 18,00	2	1
59	18,00 - 18,20	2	1
60	18,20 - 18,40	2	1
61	18,40 - 18,60	2	1
62	18,60 - 18,80	2	1
63	18,80 - 19,00	2	1
64	19,00 - 19,20	2	1
65	19,20 - 19,40	2	1
66	19,40 - 19,60	2	1
67	19,60 - 19,80	2	1
68	19,80 - 20,00	2	1
69	20,00 - 20,20	2	1
70	20,20 - 20,40	2	1
71	20,40 - 20,60	2	1
72	20,60 - 20,80	2	1
73	20,80 - 21,00	2	1
74	21,00 - 21,20	2	1
75	21,20 - 21,40	2	1
76	21,40 - 21,60	2	1
77	21,60 - 21,80	2	1
78	21,80 - 22,00	2	1
79	22,00 - 22,20	2	1
80	22,20 - 22,40	2	1
81	22,40 - 22,60	2	1
82	22,60 - 22,80	2	1
83	22,80 - 23,00	2	1
84	23,00 - 23,20	2	1
85	23,20 - 23,40	2	1
86	23,40 - 23,60	2	1
87	23,60 - 23,80	2	1
88	23,80 - 24,00	2	1
89	24,00 - 24,20	2	1
90	24,20 - 24,40	2	1
91	24,40 - 24,60	2	1
92	24,60 - 24,80	2	1
93	24,80 - 25,00	2	1
94	25,00 - 25,20	2	1
95	25,20 - 25,40	2	1
96	25,40 - 25,60	2	1
97	25,60 - 25,80	2	1
98	25,80 - 26,00	2	1
99	26,00 - 26,20	2	1
100	26,20 - 26,40	2	1
101	26,40 - 26,60	2	1
102	26,60 - 26,80	2	1
103	26,80 - 27,00	2	1
104	27,00 - 27,20	2	1
105	27,20 - 27,40	2	1
106	27,40 - 27,60	2	1
107	27,60 - 27,80	2	1
108	27,80 - 28,00	2	1
109	28,00 - 28,20	2	1
110	28,20 - 28,40	2	1
111	28,40 - 28,60	2	1
112	28,60 - 28,80	2	1
113	28,80 - 29,00	2	1
114	29,00 - 29,20	2	1
115	29,20 - 29,40	2	1
116	29,40 - 29,60	2	1
117	29,60 - 29,80	2	1
118	29,80 - 30,00	2	1
119	30,00 - 30,20	2	1
120	30,20 - 30,40	2	1
121	30,40 - 30,60	2	1
122	30,60 - 30,80	2	1
123	30,80 - 31,00	2	1
124	31,00 - 31,20	2	1
125	31,20 - 31,40	2	1
126	31,40 - 31,60	2	1
127	31,60 - 31,80	2	1
128	31,80 - 32,00	2	1
129	32,00 - 32,20	2	1
130	32,20 - 32,40	2	1
131	32,40 - 32,60	2	1
132	32,60 - 32,80	2	1
133	32,80 - 33,00	2	1
134	33,00 - 33,20	2	1
135	33,20 - 33,40	2	1
136	33,40 - 33,60	2	1
137	33,60 - 33,80	2	1
138	33,80 - 34,00	2	1
139	34,00 - 34,20	2	1
140	34,20 - 34,40	2	1
141	34,40 - 34,60	2	1
142	34,60 - 34,80	2	1
143	34,80 - 35,00	2	1
144	35,00 - 35,20	2	1
145	35,20 - 35,40	2	1
146	35,40 - 35,60	2	1
147	35,60 - 35,80	2	1
148	35,80 - 36,00	2	1
149	36,00 - 36,20	2	1
150	36,20 - 36,40	2	1
151	36,40 - 36,60	2	1
152	36,60 - 36,80	2	1
153	36,80 - 37,00	2	1
154	37,00 - 37,20	2	1
155	37,20 - 37,40	2	1
156	37,40 - 37,60	2	1
157	37,60 - 37,80	2	1
158	37,80 - 38,00	2	1
159	38,00 - 38,20	2	1
160	38,20 - 38,40	2	1
161	38,40 - 38,60	2	1
162	38,60 - 38,80	2	1
163	38,80 - 39,00	2	1
164	39,00 - 39,20	2	1
165	39,20 - 39,40	2	1
166	39,40 - 39,60	2	1
167	39,60 - 39,80	2	1
168	39,80 - 40,00	2	1
169	40,00 - 40,20	2	1
170	40,20 - 40,40	2	1
171	40,40 - 40,60	2	1
172	40,60 - 40,80	2	1
173	40,80 - 41,00	2	1
174	41,00 - 41,20	2	1
175	41,20 - 41,40	2	1
176	41,40 - 41,60	2	1
177	41,60 - 41,80	2	1
178	41,80 - 42,00	2	1
179	42,00 - 42,20	2	1
180	42,20 - 42,40	2	1
181	42,40 - 42,60	2	1
182	42,60 - 42,80	2	1
183	42,80 - 43,00	2	1
184	43,00 - 43,20	2	1
185	43,20 - 43,40	2	1
186	43,40 - 43,60	2	1
187	43,60 - 43,80	2	1
188	43,80 - 44,00	2	1
189	44,00 - 44,20	2	1
190	44,20 - 44,40	2	1
191	44,40 - 44,60	2	1
192	44,60 - 44,80	2	1
193	44,80 - 45,00	2	1
194	45,00 - 45,20	2	1
195	45,20 - 45,40	2	1
196	45,40 - 45,60	2	1
197	45,60 - 45,80	2	1
198	45,80 - 46,00	2	1
199	46,00 - 46,20	2	1
200	46,20 - 46,40	2	1
201	46,40 - 46,60	2	1
202	46,60 - 46,80	2	1
203	46,80 - 47,00	2	1
204	47,00 - 47,20	2	1
205	47,20 - 47,40	2	1
206	47,40 - 47,60	2	1
207	47,60 - 47,80	2	1
208	47,80 - 48,00	2	1
209	48,00 - 48,20	2	1
210	48,20 - 48,40	2	1
211	48,40 - 48,60	2	1
212	48,60 - 48,80	2	1
213	48,80 - 49,00	2	1
214	49,00 - 49,20	2	1
215	49,20 - 49,40	2	1
216	49,40 - 49,60	2	1
217	49,60 - 49,80	2	1
218	49,80 - 50,00	2	1
219	50,00 - 50,20	2	1
220	50,20 - 50,40	2	1
221	50,40 - 50,60	2	1
222	50,60 - 50,80	2	1
223	50,80 - 51,00	2	1
224	51,00 - 51,20	2	1
225	51,20 - 51,40	2	1
226	51,40 - 51,60	2	1
227	51,60 - 51,80	2	1
228	51,80 - 52,00	2	1
229	52,00 - 52,20	2	1
230	52,20 - 52,40	2	1
231	52,40 - 52,60	2	1
232	52,60 - 52,80	2	1
233	52,80 - 53,00	2	1
234	53,00 - 53,20	2	1
235	53,20 - 53,40	2	1
236	53,40 - 53,60	2	1
237	53,60 - 53,80	2	1
238	53,80 - 54,00	2	1
239	54,00 - 54,20	2	1
240	54,20 - 54,40	2	1
241	54,40 - 54,60	2	1
242	54,60 - 54,80	2	1
243	54,80 - 55,00	2	1
244	55,00 - 55,20	2	1
245	55,20 - 55,40	2	1
246	55,40 - 55,60	2	1
247	55,60 - 55,80	2	1
248	55,80 - 56,00	2	1
249	56,00 - 56,20	2	1
250	56,20 - 56,40	2	1
251	56,40 - 56,60	2	1
252	56,60 - 56,80	2	1
253	56,80 - 57,00	2	1
254	57,00 - 57,20	2	1
255	57,20 - 57,40	2	1
256	57,40 - 57,60	2	1
257	57,60 - 57,80	2	1
258	57,80 - 58,00	2	1
259	58,00 - 58,20	2	1
260	58,20 - 58,40	2	1
261	58,40 - 58,60	2	1
262	58,60 - 58,80	2	1
263	58,80 - 59,00	2	1
264	59,00 - 59,20	2	1
265	59,20 - 59,40	2	1
266	59,40 - 59,60	2	1
267	59,60 - 59,80	2	1
268	59,80 - 60,00	2	1
269	60,00 - 60,20	2	1
270	60,20 - 60,40	2	1
271	60,40 - 60,60	2	1
272	60,60 - 60,80	2	1
273	60,80 - 61,00	2	1
274	61,00 - 61,20	2	1
275	61,20 - 61,40	2	1
276	61,40 - 61,60	2	1
277	61,60 - 61,80	2	1
278	61,80 - 62,00	2	1
279	62,00 - 62,20	2	1
280	62,20 - 62,40	2	1
281	62,40 - 62,60	2	1
282	62,60 - 62,80	2	1
283	62,80 - 63,00	2	1
284	63,00 - 63,20	2	1
285	63,20 - 63,40	2	1
286	63,40 - 63,60	2	1
287	63,60 - 63,80	2	1
288	63,80 - 64,00	2	1
289	64,00 - 64,20	2	1
290	64,20 - 64,40	2	1

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Zeitschrift/Journal: [BFB-Bericht \(Biologisches Forschungsinstitut für Burgenland, Illmitz 1](#)

Jahr/Year: 1978

Band/Volume: [25](#)

Autor(en)/Author(s): Schmidt Z., Halouzka R., Nosek Josef, Sixl Wolf

Artikel/Article: [Quarternary Mollusca of the southern part of south slowakian lowland 1-10](#)