Romanian Journal of STRATIGRAPHY

continuation of
DĂRI DE SEAMĂ ALE ŞEDINŢELOR INSTITUTULUI DE GEOLOGIE ŞI GEOFIZICĂ
COMPTES RENDUS DES SÉANCES DE L'INSTITUT DE GÉOLOGIE ET GÉOPHYSIQUE
(4. Stratigrafie)

Founded 1906 by the Geological Institute of Romania

ISSN 1220-5664

Vol. 76
Supplement No. 6

XIth. CONGRESS
RCMNS
BUCURESTI·1995

IUGS, REGIONAL COMMITTEE ON MEDITERRANEAN NEOGENE STRATIGRAPHY

4 - 9 September

GUIDES TO ONE-DAY EXCURSIONS (C1, C2, D)

FACIES AND STRATIGRAPHY OF THE LOWER AND MIDDLE MIOCENE FORMATIONS OF THE SLĂNIC SYNCLINE (C1)

Mircea Săndulescu, Gheorghe Popescu, Mariana Mărunţeanu

NEOGENE MAMMALIAN FAUNA FROM THE BEND ZONE OF THE EAST CARPATHIANS (C2)

Costin Rădulescu, Emanoil Ştiucă, Titus Brustur, Sorin Zaharia

UPPER NEOGENE FROM THE DACIC BASIN (D)

Costin Rădulescu, Petre-Mihai Samson, Emanoil Ştiucă, Viorel Horoi

Institutul Geologic al României
Bucureşti 1995

GEOLOGICAL INSTITUTE OF ROMANIA

The **Geological Institute of Romania** is now publishing the following periodicals:

Romanian Journal of Mineralogy
Romanian Journal of Petrology
Romanian Journal of Mineral Deposits
Romanian Journal of Paleontology
Romanian Journal of Stratigraphy
Romanian Journal of Tectonics and Regional Geology
Romanian Journal of Geophysics

They supersede "Dări de Seamă ale Şedinţelor", "Memorii" and "Studii Tehnice şi Economice", whose apparition goes back to 1910. Beside regular volumes, each series may occasionally contain Supplements (for abstracts and excursion guides to congresses and symposia held in Romania) and Special Issues (for larger papers of special interest). "Anuarul Institutului Geologic al României" will appear also in a new form, containing both the annual activity report and review papers.

Editorial Office:
Geological Institute of Romania
Str. Caransebeş No. 1
RO - 79678 Bucureşti - 32
Tel. (+40) 1 665 66 25, 665 75 30
Fax (+40) 1 312 84 44
e-mail GIRBHR@ROEARN.ICI.RO

The editor has changed the name as follows: Institutul Geologic al României (1910–1952), Comitetul Geologic (1953–1966), Comitetul de Stat al Geologiei (1967–1969), Institutul Geologic (1970–1974), Institutul de Geologie şi Geofizică (1975–1993), Institutul Geologic al României (since 1994).

ROMANIAN JOURNAL OF STRATIGRAPHY supersedes "Dări de Seamă ale Şedinţelor", Series 4/Stratigrafie – the last volume with this title being No. 74.

The manuscripts should be sent to the scientific editor and/or executive secretary. Correspondence concerning advertisments, announcements and subscriptions should be sent to the Managing Editor.

ISSN 1220–5664
Classification index for libraries 55(058)

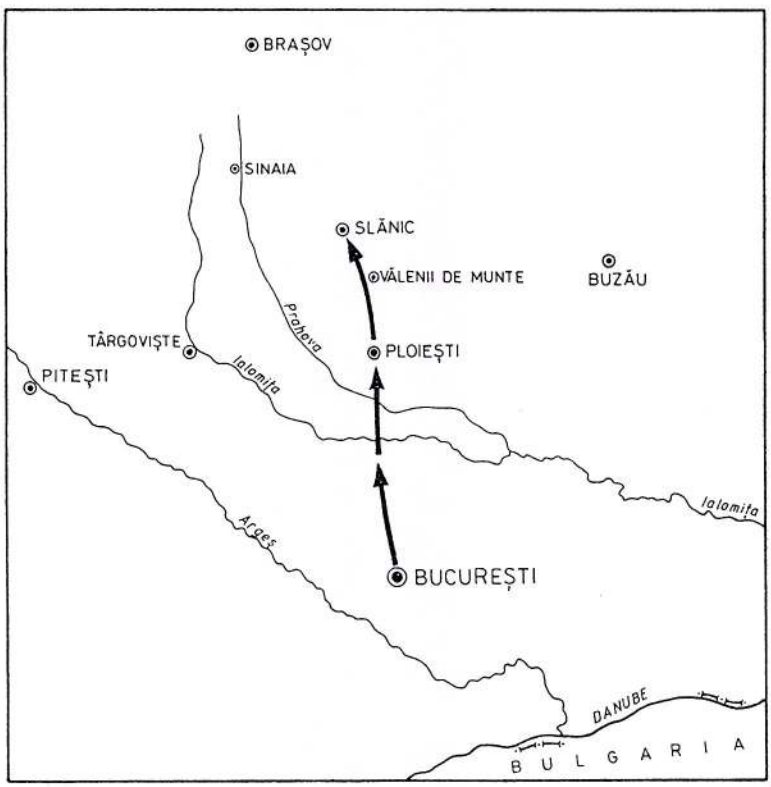
Printed by the Geological Institute of Romania
Bucharest

GUIDE TO EXCURSION C1 (INTRA – CONGRESS)

FACIES AND STRATIGRAPHY OF THE LOWER AND MIDDLE MIOCENE FORMATIONS OF THE SLĂNIC SYNCLINE

by

Mircea Săndulescu, Gheorghe Popescu, Mariana Mărunţeanu



Excursion itinerary (C1)

Sponsor : "SALINA SLĂNIC"

GENERAL OUTLOOK ON THE GEOLOGY OF THE TELEAJEN AND SLĂNIC VALLEYS

The area covering the Teleajen and Slănic rivers hydrographic basins is situated from the geological point of view in the East Carpathian Flysch Zone and the north limb of the molassic Foredeep.

The East Carpathians Flysch Zone is the outermost group of tectonic units in the whole Carpathian Orogen. They are nappes (thrust-sheets) of different ages, involving sedimentary formations of Cretaceous and Tertiary ages; in the innermost part of the Zone some slices of mafic rocks are associated with the lower levels of the nappes. The tectonic units of the Flysch Zone were deformed during several tectogenetic moments in the Cretaceous (the innermost) and Miocene. The Miocene nappes, grouped together in the Moldavides, are - from inside toward outside of the Zone - as follows: Convolute Flysch, Macla, Audia, Tarcău, Marginal Folds and Subcarpathian nappes (Fig. 1). In the area of the one-day excursion in Teleajen and Slănic valleys crop out formations belonging to the Tarcău Nappe in the Flysch Zone.

The Tarcău Nappe is built up of Cretaceous, Paleogene and Lower Miocene sedimentary formations. The predominantly shaly ("Black Shales") Lower Cretaceous is followed by a Vraconian-Lower Senonian argilitic variegated sequence, above which a Senonian flysch develops. The Paleogene shows different isochronous lithofacies mostly of flysch type. In the visiting area the Oligocene lithofacies, which reach also the Lower Miocene are of interest. At these levels two main lithofacies were recognized in the Tarcău Nappe: the Bituminous Lithofacies in the external part and the Pucioasa-Fusaru Lithofacies in the internal part. Transitional ("mixed") successions are also known.

The Bituminous Lithofacies is characterized by:

- the development of two bituminous silicolitic levels: one (the Lower Menilites) situated in the Lower Rupelian, just above the Eocene/Oligocene boundary, and the second one (the Upper Menilites) in the upper sequence of the Lithofacies, in the Lower Miocene;
- the development of bituminous argilites and argilitic silts, known as dysodilic shales, at different levels of the whole succession, representing the lithological "ground" of this Lithofacies;
- the development of two quartzose sandstone sequences - the Lower and the Upper Kliwa Sandstones - whose supply area was situated in the foreland of the sedimentary basin.

A specific feature of the Bituminous Lithofacies of the external part of the Tarcău Nappe is the development of a flysch-type sequence - the Podu Morii Formation - which is stratigraphically situated between the Lower and the Upper Kliwa sandstones. The Oligocene/Miocene boundary is situated within the Podu Morii Formation.

The Pucioasa-Fusaru Lithofacies is characterized by:

- the development of marly, partly bituminous, rocks (the Pucioasa Marls) instead of the dysodilic shales, mostly concentrated in the lower part of the succession;
- the development, in the middle part of the succession, of micaferous sandstones (Fusaru Sandstone) of subgreywacke type whose supply area was situated in the internal (Carpathian) side of the sedimentary basin;

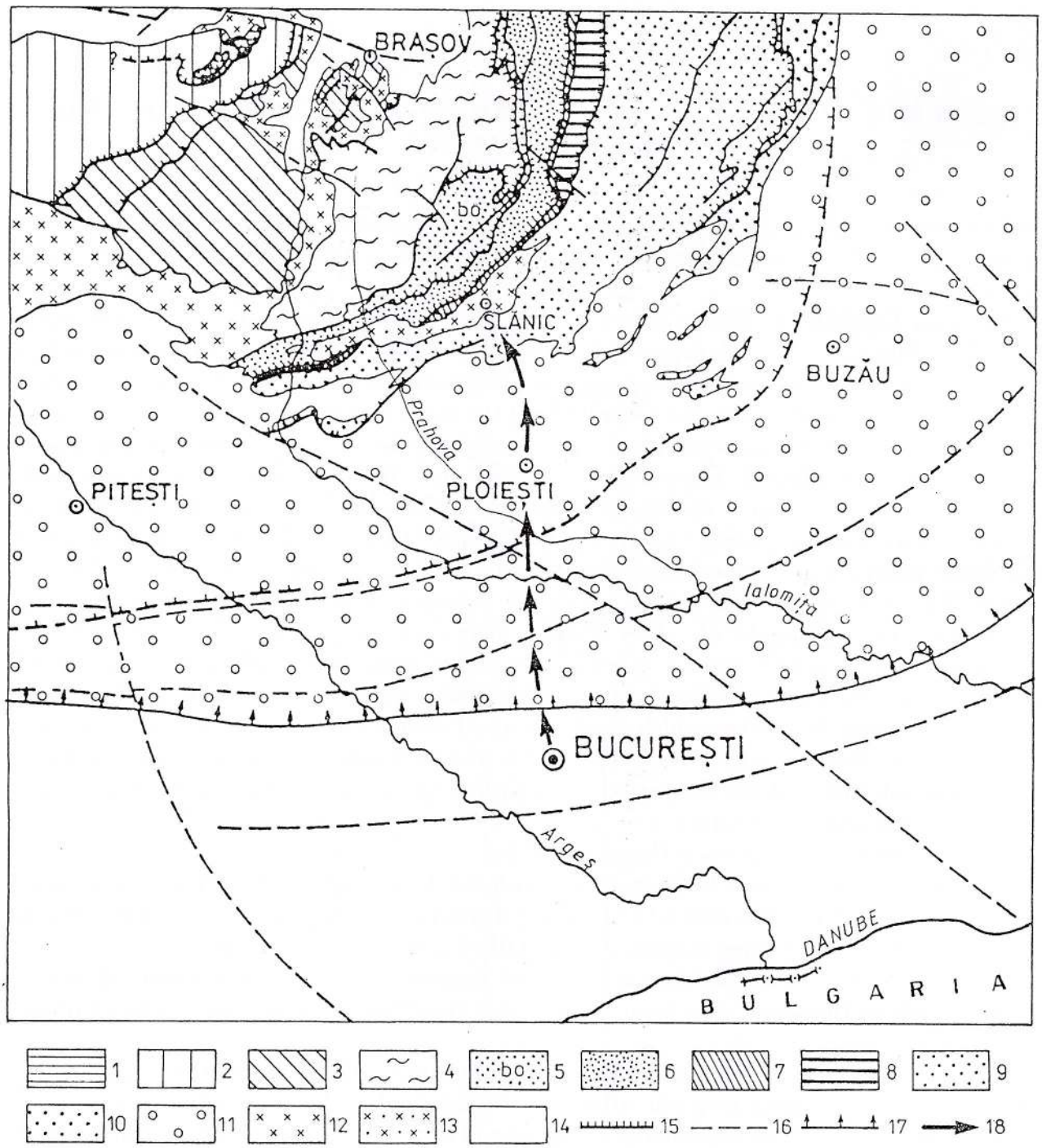


Fig. 1 – Structural Sketch of the Southern East Carpathians.

1–3, Median Dacides: 1, Bucovinian Nappe; 2, Supragetic (Subbucovinian) Nappe; 3, Getic (Infrabucovinian) Nappe; 4–5, Outer Dacides: 4, Ceahlău Nappe; 5, Bobu Nappe; 6–10, Moldavides: 6, Convolute Flysch Nappe; 7, Macla Nappe; 8, Audia Nappe; 9, Tarcău Nappe; 10, Subcarpathian Nappe; 11, Foredeep; 12, Post-tectogenetic Cover of Dacides; 13, Post-tectogenetic Cover of Moldavides; 14, Molasse depressions; 15, Nappe (Thrust-sheet); 16, Deep Faults; 17, Flexure; 18, Field-trip itinerary.

- the development, above the Fusaru Sandstone, of a flysch formation (the Vineţişu Formation), partly equivalent to the Podu Morii Formation.

The Pucioasa-Fusaru Lithofacies succession ends with dysodilic shales and menilites, equivalent to the Upper Menilites of the Bituminous Lithofacies. The Oligocene/Miocene boundary is situated within the Vineţişu Formation.

The Bituminous Lithofacies, known in the external part of the Tarcău Nappe, is largely developed in the Marginal Folds Nappes as well as in the Subcarpathian Nappe, both paleogeographically more external than the former one.

A widespread Lower Miocene Evaporitic Formation follows both Bituminous and Pucioasa-Fusaru formations, in Tarcău, Marginal Folds and Subcarpathian nappes. In the last two units it is predominantly saliferous while in the first one it is represented only by a gypsum sequence (the "Lower Gypsum"). In the Tarcău Nappe the evaporitic rocks are followed by a marine sequence - the Cornu (*s.str.*) Formation - constituted of marls, clays and sandstones.

Molasse deposits are known in the Tarcău Nappe, as well as in the Marginal Folds and Subcarpathian ones, above the Cornu and/or the Evaporitic formations. Conglomerates and/or coarse grained sandstones developed, in the Tarcău Nappe being supplied by the internal, "carpathian", source. They are followed by schlier deposits (marls, sands and sandstones) with gypsum intercalations (discontinuously developed). The Lower Miocene/Middle Miocene boundary is situated within these schlier deposits.

A classical litostratigraphic succession of the Middle Miocene is known in the Slănic Syncline. Four lithostratigraphical units were recognized: (1) Slănic Tuff (with Globigerina Marls intercalations), (2) Evaporitic Formation (salt and gypsums), (3) Radiolarian Shales Formation and (4) Spirialis Marls Formation. The first two are of Langhian age, the last two are of Kossovian age.

In the Teleajen basin the frontal part of the Tarcău Nappe is covered discordantly by the Upper Miocene-Pliocene formations of the Carpathian Foredeep. It is to stress out that in this area the Marginal Folds Nappe is supposed to be tectonically situated below the Tarcău Nappe and that the Subcarpathian Nappe, external in respect to the Tarcău one, is also discordantly covered by the Foredeep molassic deposits.

The Carpathian Foredeep is a marginal trough in respect to the deformed orogenic belt, filled up with clastics proceeding from this one. The Foredeep is superposed over the outer part of the outermost deformed units and over the Foreland (Platforms). It shows two zones: the Inner Zone which is folded during the Lower Pleistocene and the Outer Zone which is located mostly on the Foreland and which is an asymmetrically subsiding area.

In the Teleajen River basin the Inner Foredeep belongs to the so called "Diapiric Folds Zone" where the processes of diapirism were defined by L. Mrazek at the beginning of this century. Several types of diapiric structures are known, the intensity of the process decreasing from north (interior) toward south (exterior).

DESCRIPTION OF ITINERARY AND OUTCROPS

The field-trip starts from Bucharest situated on the Moesian Platform, the Foreland of the South Carpathians and the Bend Area of the East Carpathians.

From Bucharest as far as Ploieşti the Moesian Platform and the outer zone of the Neogene Foredeep, superposed on it are crossed. Morphologically the area is represented by a large plain – the Romanian Plain – which develops between the Danube, in south, and the Subcarpathians hills, in north.

In the north-east vicinity of the Ploieşti town the southernmost hills of the Subcarpathians correspond to anticlinal structures of the inner zone of the Foredeep, namely the Bucov and the Boldeşti anticlines which are oil-bearing structures (Middle Miocene reservoirs).

North of the Boldeşti Anticline, marked by a more flat morphology, the Măgurele Syncline develops. The youngest deposits involved in the core of this syncline – the Cândeşti Gravels – are of Lower Pleistocene age, being the youngest formations deformed by the so called "Wallachian Phase" of tectogenesis.

At Coada Malului village the field-trip reaches the thrust-fold situated on the southern limb of the Scăioşi Syncline. The Coada Malului thrust-fold involves Sarmatian, Meotian and Pontian deposits.

1st Stop : **Coada Malului Village : Meotian Formations**

In several small outcrops near the road, oolithic sandstones alternatig with sands develop. In the base of the outcrop, the Dosinia level occurs (see Fig. 2). The silty clays overlying the oolithic sandstones contain, in the upper part, specimens of *Leptanodonta*, a fossil characteristic of the Upper Meotian. The siltic-clays contain a scarce nannoplankton assemblage with *Discoaster berggrenii* BUKRY, *D.* : cf. *D. quinqueramus* GARTNER, *Calcidiscus leptoporus* (MURR. & BLACK), *Reticulofenestra pseudoumbilicus* (GARTNER), *Amaurolithus primus* (BURK. & PERCIV.) and *A. delicatus* GARTNER. These nannofossils indicate the beginning of the Discoaster quinqueramus Zone – NN_{11}.

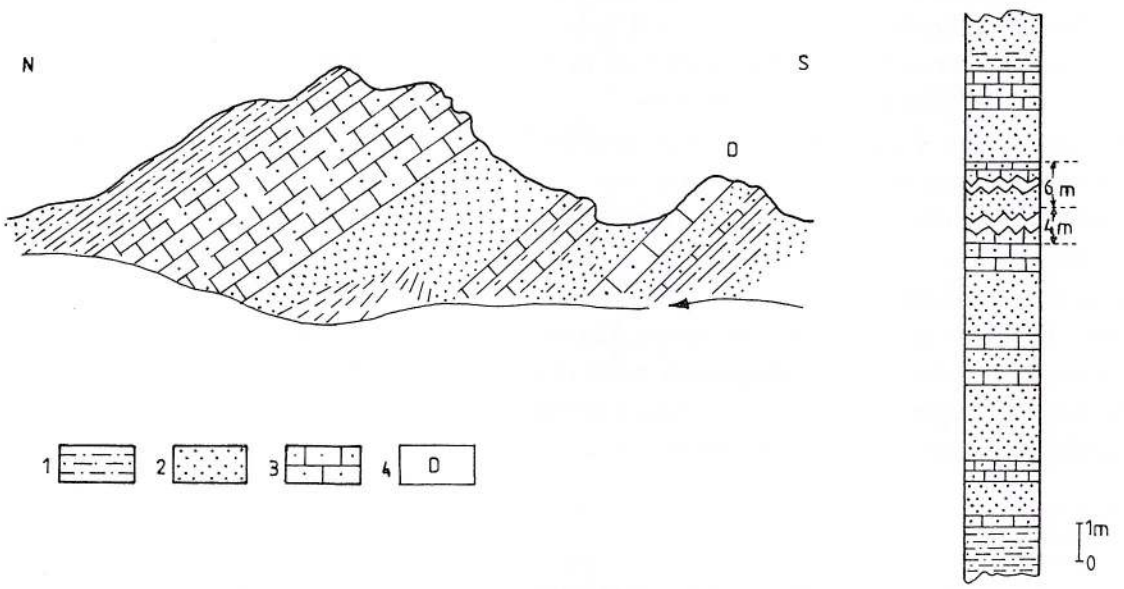


Fig. 2 – Coada Malului Geological Section. 1, silty-clays; 2, sands; 3, oolithic sandstones; 4, Dosinia level.

From Coada Malului the field-trip follows the Teleajen Valley as far as Gura Vitioarei Village, penetrating in the Oligocene-Lower Miocene formations of the Tarcău Nappe, developed in the Bituminous Lithofacies.

2nd Stop : **Gura Vitioarei : Upper Kliwa Sandstone**

In the left side of the Teleajen River, large outcrops may be examinated. Orthoquartzitic sandstones and compact sands, light-coloured, crop out in massive sequences, separated by dysodilic shales. The fine- and medium-grained orthoquartzites (Kliwa) proceed from partly eolian sands transported into the depositional basin by hydrodynamic ways.

Situated above the Podu Morii Formation within which runs the Oligocene/Miocene boundary, the Upper Kliwa Sandstone can be accepted as Lower Miocene in age (Lower Burdigalian), even if no direct paleontological evidences were found in it.

3rd Stop : **Vălenii de Munte : Podu Morii Formation** (Fig. 3)

From Gura Vitioarei the field-trip continues toward north few kilometers along the Teleajen Valley. In the Vălenii de Munte town, in both banks of the Teleajen River, the Podu Morii Formation crops out. This flysch is built-up by two-component rhythms (limy sandstone alternating with marls or clays) with thicknesses between 10–40 cm. The total thickness of the formation is of about 400 m. In the lower part or at the boundary with the Upper Kliwa Sandstone, dysodilic shales may intercalate. The paleontological content consists of rare planktonic foraminifera but rich assemblages of calcareous nannoplankton.

The foraminiferal content is represented by some small globigerinas (*Globigerina ciperoensis* BOLLI, *Globigerina praebulloides* BLOW, *Globigerinoides primordius* BLOW & BANNER). Near the Podu Morii Tuffs (Fig. 3), in a small silty-clay intercalation, numerous specimens of *Globoquadrina* were recorded. These are the first specimens belonging to the genus which occurs in the Lower Miocene deposits.

As concerns the nannoplankton, the Upper part of Podu Morii Formation contains an assemblage typical of Discoaster druggii Zone – NN_2.

The boundary between the Sphenolithus dissimilis Subzone – NN_{2a} (with *Reticulofenestra pseudoumbilicus* (GARTNER), *Helicosphaera mediterranea* MÜLLER, *Sphenolithus dissimilis* BURK. & PERCIV., *S. delfix* BUKRY, *Discoaster druggii* BRAML. & WILCOX. etc.) and Helicosphaera kamptneri Subzone – NN_{2b} (with *Reticulofenestra pseudoumbilicus* (GARTNER), *Helicosphaera ampliaperta* BRAML. & WILCOX., *Discoaster druggii* BRAML. & WILCOX. etc.) is in point A (Fig. 3), below the Vineţişu and Podu Morii Tuffs. Based upon the calcareous nannoplankton, the Upper part of the Podu Morii Formation is Upper Aquitanian–Lower Burdigalian in age.

In order to reach the Slănic Valley, situated west of the Teleajen one, the field-trip turns from Vălenii de Munte toward west crossing the water shed between the two rivers.

In the Slănic Valley the field-trip will cross the Slănic Syncline from south toward north.

4th Stop : **Vărbilău Village : Grey Schlier Formation**

In a small outcrop the upper part of the Doftana Formation, which is of schlier type can be examined. Grey or dark-grey marls are the main lithotype, sands, silts or sandstones being interlayered irregularly.

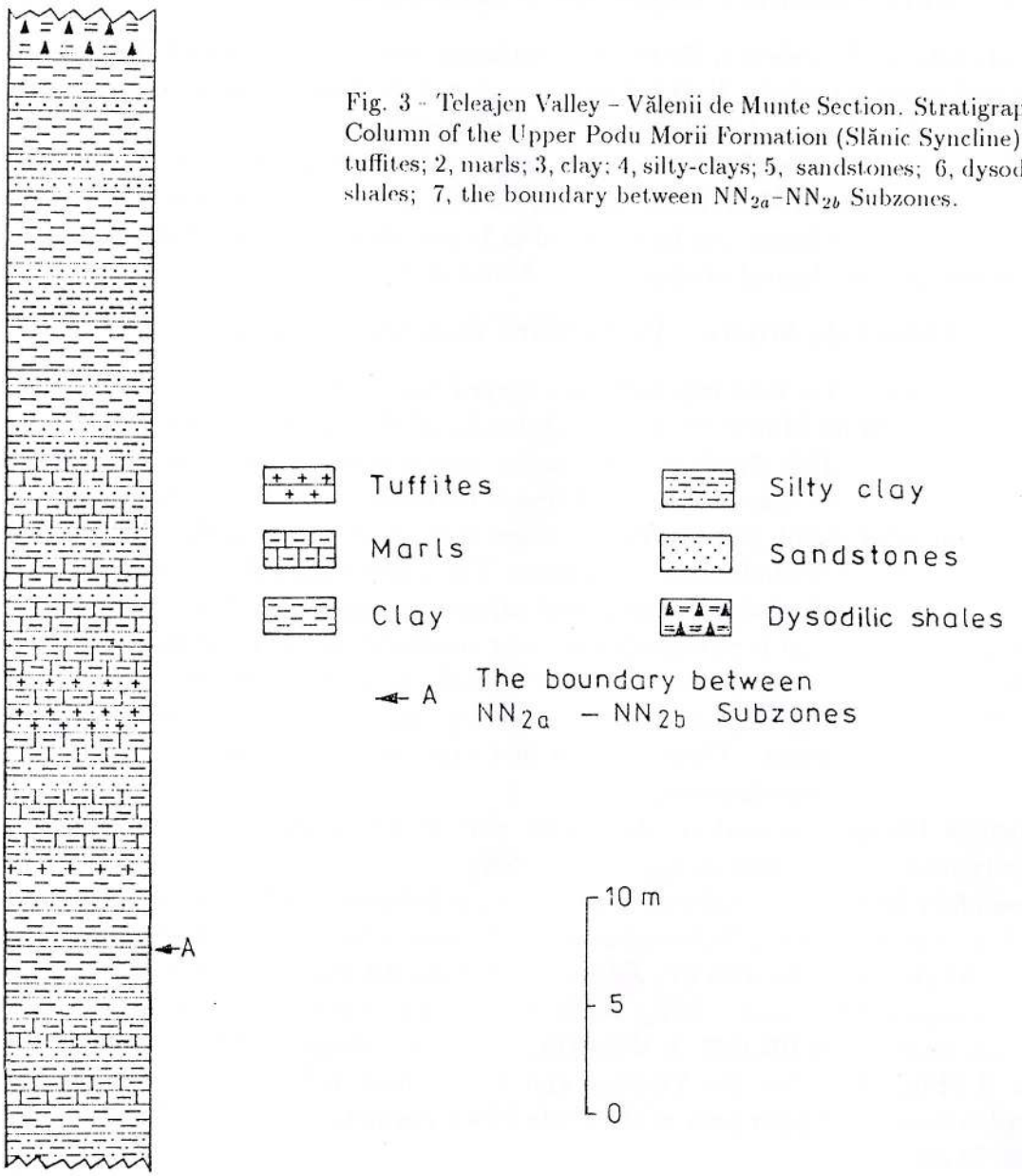


Fig. 3 - Teleajen Valley – Vălenii de Munte Section. Stratigraphic Column of the Upper Podu Morii Formation (Slănic Syncline). 1, tuffites; 2, marls; 3, clay; 4, silty-clays; 5, sandstones; 6, dysodilic shales; 7, the boundary between NN_{2a}–NN_{2b} Subzones.

After crossing the Slănic town the field-trip reaches the northern limb of the Slănic Syncline.

5th Stop : **Piatra Verde Hill : the Lithostratigraphic Succession of the Langhian and Kossovian in the Slănic Syncline**

Following by foot a small road in the Piatra Verde Hill area the Badenian formations can be examined. Their succession is classical for the most important part of the East Carpathian Middle Miocene. In their stratigraphical order crop out:

– the Slănic Tuff: dacitic cinerites (tuffites), massive or layered, with intercalations of marls rich in planktonic foraminifers;

– the Evaporitic level, represented in the walking area by gypsums, which are an equivalent to the Salt Formation of Slănic mining (Stop ?);

– the Radiolarian Shales Formation: siltic clays, argilites and sands, in irregular alternation;

– Spirialis Marls Formation: massive marls and clays with few sand or sandstone intercalations; a level of gypsums also develop in the lower part of the formation.

The age of these different lithostratigraphic levels are documented as follows:

Marly intercalation in the base of the Slănic tuffs (sample A, Fig. 4) contains a very rich assemblage of planktonic foraminifera and calcareous nannoplankton. Here, there was recorded a foraminiferal assemblage typical of N_9 Zone (lower part): *Candorbulina universa* JEDL., *C. glomerosa* BLOW, *Globigerinoides transitoria* BLOW, *G. bisphaericus* TODD, *G. triloba* (RSS.), *G. irregularis* LE ROY, *G. immaturus* LE ROY, *G. bulloideus* CRESCENTI, *Globorotalia (Hirsutella) bykovae* AIS.

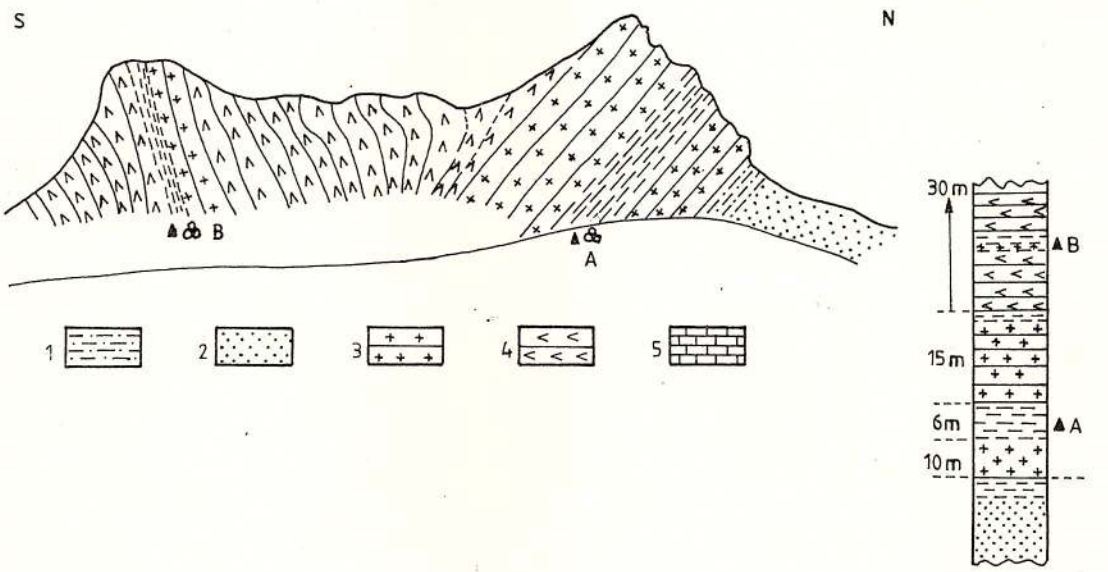


Fig. 4 – Geological Section at Slănic, Piatra Verde Hill (lower part). 1, silty-clays; 2, sands; 3, tuffs, tuffits; 4, gypsum; 5, chemical limestones.

The calcareous nannoplankton assemblage is typical of Sphenolithus heteromorphus Zone – NN_5 (with *Discoaster exilis* MART. & BRAML., *D. variabilis* MART. & BRAML., *Sphenolithus heteromorphus* DEFL.).

The silty-clays imediatelly underlying chemical deposits (Evaporitic Level), or interbeded in it (see sample B, Fig. 4) the foraminiferal assemblage belongs to the lower part of Globorotalia (Fohsella) peripheroacuta Zone – N_{10} (*G. (F.) peripheroacuta* BLOW & BANNER, *G. (Hirsutella) transsylvanica* POPESCU, *Globigerinoides triloba* (RSS.), *Uvigerina orbignyana* CJZJ., *Pseudotriplasia minuta* (RSS.) This assemblage is a typical of Wieliczka assemblage (Middle Badenian).

As concerns the calcareous nannoplankton coming from the same deposits, the assemblage contains *Discoaster broweri* Tan (bloom) but without *Sphenolithus heteromorphus* DEFL., which characterizes the beginning of the Discoaster exilis Zone – NN_6.

As the age of the Evaporitic Level (after foraminifera) is Middle Badenian, it is very clearly that the boundary between NN_5 and NN_6 does not correspond to the boundary between Lower-Middle and Upper Badenian.

The Radiolarian Shales contain, in this very place, a poor foraminiferal assemblage and other fossil remnants which characterize this lithostratigraphic unit, namely - silicious microfossils (radiolarians, silicoflagellates, diatoms, ebridians).

The nannoplankton assemblage is rich. This is represented by *Triquetrorhabdulus rugosus* BRAML. & WILCOX., *Cyclolithella anulla* COHEN, *Discoaster musicus* BRAML. $ WILCOX., *Discoaster exilis* MART. & BRAML. indicating the lower part of Discoaster exilis Zone – NN_6, namely Cyclolithella annula Subzone – NN_{6a}, Lower Kossovian in age.

The Spirialis Marls, the last lithostratigraphic unit belonging to the Kossovian (= Upper Badenian = Lower Serravalian), contain a poor foraminiferal assemblage (in this very place). Sample 6 (Fig. 5) contains *Globigerinoides triloba* (RSS.), *Globigerina quinquelobata* RSS., *Pararotalia spinimargo* (RSS.), *Baggarella gutzulica* (LIV.), *Glabratella* sp. Besides foraminifera, numerous specimens of gastropod genus Spiratella (index fossil defining this lithostratigraphic unit) occur.

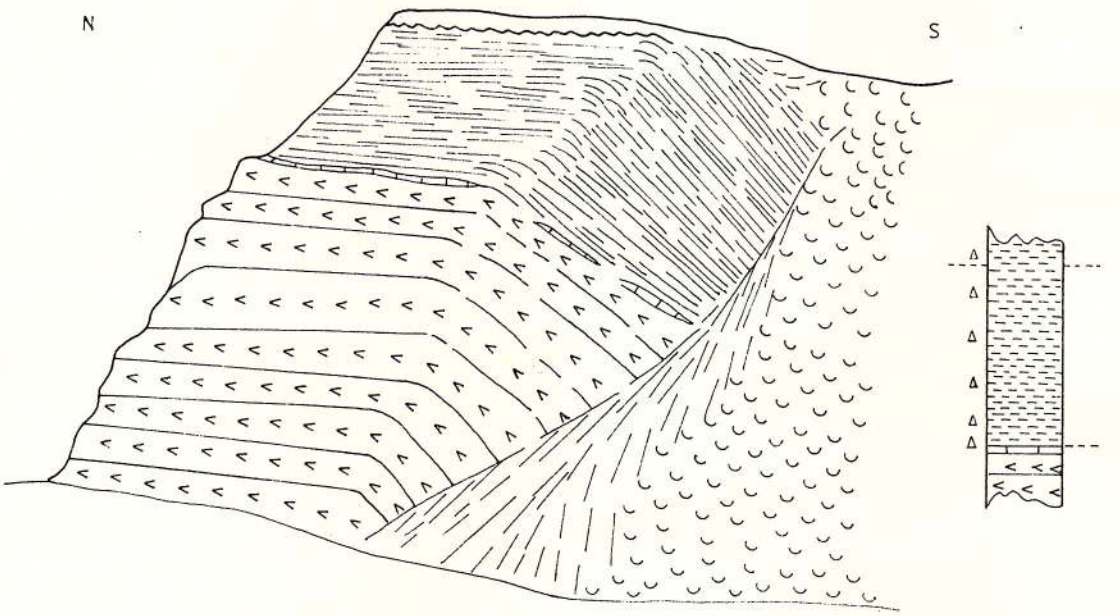


Fig. 5 – Geological Section at Slănic, Piatra Verde Hill (upper part). 1, silty-clays; 2, chemical limestones; 3, gypsum.

6th Stop : **Slănic, Slănic Salt Mine (Slănic Saline) : Middle Miocene**

The second lithostratigraphic unit of the marine Middle Miocene (so-called "Evaporitic Formation") is here represented by a thick pile of salt lenses (over 200 m).

The worked lens consists of an alternation of white and grey salt strata, containing, sometimes, very small hydrocarbon pockets.

Between salt strata, some thin marly intercalations containing plant remnants are interbedded. The salt massive shows internal folding generated during small diapiric processes.

7th Stop : **Slănic, Grota Miresei : Middle Miocene**

Grota Miresei (The Bride's Grotto) is a result of the old mining activity into an outcropping salt "mountain" (Evaporitic Formation).

The "Salt Mountain" is constituted of an horizontal alternance of white and grey (dark) bands which do not correspond to the inner salt structure: the bands were secondary generated by dissolution and filling up of the small hollows produced by the rain-falls.

Selected Bibliography

Dumitrică, P., Gheţa, N., Popescu, Gh. (1975) New data of the biostratigraphy and correlation of the Middle Miocene in the Carpathian area. *D. S. Inst. Geol. Geofiz.*, LXI/4, p. 65–84, Bucureşti.

Săndulescu, M., Micu, M., Popescu, B. (1980) La structure et la paléogéographie des formations miocènes des Subcarpathes Moldaves. *Mat. XI Kongr. Karp.-Balk. Gheol. Assoţ.*, Tektonica, p. 184–197, Kiev.

— **(1984)** Geotectonica României. Edit. Tehn., 336 p., 130 fig., 2 pl., Bucureşti.

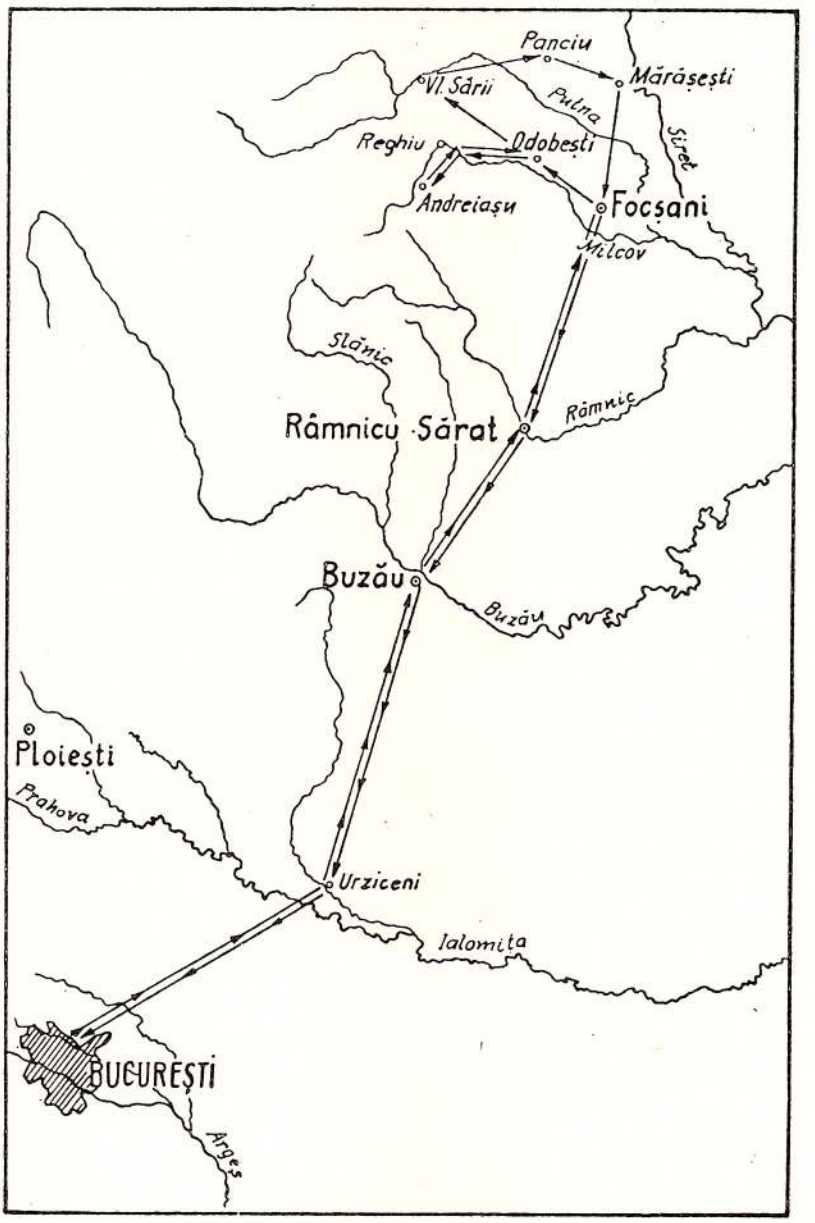
Ştefănescu, M., Mărunţeanu, M. (1980) The age of Doftana Molasse. *D. S. Inst. Geol. Geofiz.*, LXV/4, p. 169–182, Bucureşti.

GUIDEBOOK TO EXCURSION C2 (INTRA - CONGRESS)

NEOGENE MAMMALIAN FAUNA FROM THE BEND ZONE OF THE EAST CARPATHIANS

by

Costin Rădulescu, Emanoil Ştiucă, Titus Brustur, Sorin Zaharia



Excursion itinerary (C2)

Sponsor : I.A.S. "PANCIU"

NEOGENE OF THE EAST CARPATHIANS

Neogene formations of Romania are largely spread in the Carpathian regions and Vorland. They belong to both Central and Eastern Paratethys. The Dacic Basin represents a communication between the two areas.

The excursion C 2 will be held in an area belonging to the vast geomorphologic unit of the East Carpathians, namely to the Bend Zone which has the most complex structure.

The East Carpathians extend from the northern boundary of Romania to the Rucăr - Bran corridor over a distance of about 130 km. Their general NW-SE direction is changed in the Vrancea - Buzău sector in order to join the South Carpathians. From morphologic view point, the area we refer to is located at the limit between the mountainous zone and the Subcarpathian hills. The mountainous zone includes the Vrancea Mountains and Buzău Mountains with elevations comprised between 1600 and 1800 m (Penteleu 1715, Siriu 1600, Goru 1783, Pietrosu 1675, Coza 1627).

The Subcarpathian zone is distinguished, generally, by heights oscillating from 400 to 600 m, except the Măgura Odobeştilor Hill which attains 1001 m.

From hidrographic view point, the Siret River is the most important, all the rivers coming from the East Carpathian (between the Suceava Valley in the north and the Buzău Valley in the south) being its tributaries. In the Subcarpathian zone delimited by the Trotuş Valley and the Buzău Valley, there are some watercourses which are of interest as the Putna River in the north with its tributaries called Milcovul and Zăbala and the Râmnicu Sărat River in the south. These rivers drain the eastern slope of the Vrancea Mountains, cutting the marginal "flysch" formations on the one hand and the Neogene Subcarpathian deposits on the other. The watercourses present a mixed orientation including both longitudinal and transverse segments.

We will enter the area under considerations by the county highway leading from Focşani to Odobeşti - Mera- Reghiu - Andreiaşu and Nereju. Several communal roads branching from the county highway are leading toward the localities of Fărcaşa, Răiuţ, Podul Stoica, Năruja and Ursoaia.

GEOLOGICAL SETTING

The Neogene zone covers, for most extent, the Foredeep of the East Carpathians and is subdivided into the Miocene inner subzone and the Sarmatian - Pliocene outer subzone.

The inner limit of the Foredeep is indicated by very heterogeneous elements: the Pericarpathian fault north of the Trotuş Valley and the Caşin - Bisoca fault (or the fault complex) extending from the Trotuş Valley to the Buzău Valley; afterwards, to south and west the Foredeep deposits cover gradually, after a discordance, the outer Moldavides nappes till in the vicinity of the Dâmboviţa Valley.

The outer limit, established in a conventional manner, corresponds to the zone of maximum thickening of the Neosarmatian - Pliocene Deposits covering the platform.

EARLY MIOCENE

The Early Miocene deposits of the studied zone belong to the Subcarpathian Nappe and include two lithostratigraphic entities, as follows: Lower Salt Formation and Măgireşti Formation.

Lower Salt Formation (Burdigalian)

Deposits of this age are the oldest ones and they crop out in the northwestern portion of the area as diapirs. They are described as a saliferous gypsum breccia with allogene elements consisting of greenish schists, rare limestone fragments, gypsum and salt blocks included in a clayey matrix grayish brownish in colour. The groundmass contains porphyroblastically developed gypsum spathic crystals, a structure indicating an authigenous diagenetic active process, whereas the minerals (especially the anhydrite) show an epigenetic secondary transformation. The age of this formation was appreciated on the basis of the stratigraphic relationship.

Măgireşti Formation (Burdigalian)

The Măgireşti Formation includes at the base a mass of deposits 300 - 350 m thick, consisting of an alternation of various rocks with sandstones of subgraywacke type (Condor Sandstones) showing grain-grading, stream lamination and numerous mechanoglyphs (flute-, lood- groove-casts, etc), overlain by gray, red, greenish and blackish brown marls intercalated with conglomerates and microconglomerates including greenish schist elements and, accessorily, limestone fine-grained elements. At the upper part there are intercalations of white and gray bedded gypsum showing intense recrystallisation.

The upper limit cannot be defined owing to be fact that the contact with the Gray Schlier Formation is a tectonic one.

EARLY - MIDDLE MIOCENE

The Early - Middle Miocene deposits of the studied area include the following entities: Gray Schlier Formation, Răchitaşu Sandstones Formation, Upper Salt Formation and Haloş Formation.

Gray Schlier Formation (Burdigalian - Early Langhian)

These deposits which are available for examination in the Porcului Brook and in the Reghiu Brook, are represented by a succession of detrital, clastic and authigenic rocks containing lenticular intercalations of evaporites. The detrital rocks are as follows: conglomerates including rather small elements consisting predominantly of green schists, silicolites and quartzitic aggregates. The authigenic matrix has a calcitic composition resulting from an autocimentation process. An accessory glauconitic cement may also be present alongside with the calcitic one. Siltic sandstones consist of angular and subrounded quartz, feldspars and micas included in a microcrystalline calcitic cement. Secondarily, collomorphous grains of glauconite as well as pyrite as secondary minerals may be present. On the bedding planes of these sandstones there may by unidentifiable carbonaceous tracks.

The siltic marls include frequent lenses of stratified white gypsum, phenomena of hydration leading to characteristic enterolithic folds. The gypsum deposits display three successive

generations. Primary gypsum has a fibrous structure, the fibers being oriented according to the bedding plane; secondary gypsum resulting from the hydration of primary anhydrite is distinguished by an altered rhythmicity and formation of false folds. Tertiary gypsum is washed out and deposited along fissures forming veins.

Răchitaşu Sandstones Formation (Langhian)

Consists of vitroclastic tuffs showing a rhyo-dacitic composition with various stages of transformation: bentonites, tuffitic sandstones and calcareous glauconitic sandstones of "Răchitaşu" type. This formation yielded the foraminiferous assemblage characteristic of the Early Badenian: *Praeorbulina transitoria, Orbulina suturalis, Candorbulina universa, Globigerina falconensis, G. bulloides, G. bulbosa, G. biloba* and *G. apertura.*

The nannofossil assemblage containing *Sphenolithus heteromorphus, Discoaster exilis* and *D. variabilis* (NN 5 Zone) also confirm this age.

Upper Salt Formation (Langhian)

It is in a tectonic contact with the tuffs and sandstones of Răchitaşu and has a diapiric structure piercing the overlying strata. Salt domes occur along the Fărcaşa Brook (left side of the Milcov River) as well as along both sides of the Reghiu Brook. The salt bodies are blackish grayish in colour and contain sharply ungraded elements including rolled pebbles (5-20 cm in diameter) and huge blocks (more than 3 m in diameter) of Burdigalian marly limestones and sandstones of "Răchitaşu" type. The matrix including these elements is argillaceous, brown grayish, sometimes mixed with recristallized gypsum elements.

Haloş Formation (Kossovian)

This formation is visible in the Milcov Valley, the Reghiu Brook as well as in the Reghişoru and Fărcaşa Brooks, displaying thicknesses of about 200 to 350 m.

Lithologically, this formation consists of sands, sands with local cementations, coarse sandstones and very rare levels of conglomerates containing subcentimetric elements. At the base of the formation was cited (from a level consisting of shales) a radiolarian association, characteristic of the Late Badenian: *Cenosphaera favosa, Spongodiscus mediterraneus, Rophalastrum moleus, Rophalodictium subacutum, Dictyryme pentagona* (Papaianopol et al. 1991).

The nannoplankton assemblage characterize the NN 6 Zone coresponding to the late part of the Badenian (Kossovian).

The Haloş Formation presents, as a rule, a tectonic contact with adjacent formations (faults delimiting the diapiric structure of the formation on the one hand and the Caşin-Bisoca fault system on the other).

MIDDLE - LATE MIOCENE

Sarmatian

The Sarmatian - Pliocene deposits from Bend Zone show numerous particular aspects. This sequence of deposits is located in the junction zone between the inner and outer slopes of the Carpathians Foredeep. Lithostratigraphic, this sequence is intercalated between the Miocene schlieren and the Plio-Pleistocene molasse (Cândeşti Beds). In the area bounded by Râmnicu Sărat Valley (in the south-west) and Trotuş Valley (in the north), the deposits under consideration reveal a very particular facies which enabled Macarovici et al. (1967) to separate them under the name of "Milcov Beds". Representing in this area the base of monoclinal sequence of the East Carpathian Bend Zone, the Sarmatian enters into a tectonic contact, owing to the Caşin-Bisoca fault, with the folded Neogene in the west. Some authors claimed the presence in this area (Râmnicu Sărat Valley) of the Early Sarmatian (as precocious as the Buglovian) (Mateescu 1927), whereas some others denied this interpretation showing, on the basis of molluscan associations, that the Volhynian ("Ervilia Beds") may occur (Saulea 1956, Macarovici et al. 1967, Andreescu & Papaianopol 1970). In the Andreiaşu-Reghiu area we couldn't detect the presence of the Early Sarmatian. The Sarmatian deposits of this perimeter allowed us to recognize two formations differing from each other in both age and lithologies. At the base we distinguished a marly sandstone formation (Late Bessarabian) followed without a sedimentary break by a sandstone marly formation (Chersonian).

Late Bessarabian (Marly sandstone Formation)

This formation consists of marls, fine to coarse-grained sandstones, microconglomerates, polygenic conglomerates and frequent intercalations of lumachelle limestones. In the framework of the formation a normal grain-gradation can be seen, the rocks showing the following succession of strata: conglomerates, coarse sandstones, fine sandstones, lumachelles and marls. Sometimes, the transition from sandstones to lumachellic limestones is gradual without a sharp separation between the two types of rocks.

One of us (Z.S.) collected from the marly sandstone Formation a molluscan fauna including the following species: *Mactra (Sarmatimactra) vitaliana, M. (Sarmatimactra) fabreana, M (Sarmatimactra) pallasi, M. (Podolimactra) subvitaliana,* characteristic of the Late Bessarabian.

Chersonian (Sandstone marly Formation)

The Late Sarmatian deposits follow, seemingly, without interruption of deposition in respect of the Middle Sarmatian sediments. They consist of an alternation of marly, clayey and sandstone strata with a "flysch"-like aspect. In addition, limestone microconglomerates and marls including lumachelles may be present. The basal part of the Chersonian contains abundant shells of *Mactra crassicolis* Sinz., *M. bulgarica elongata* Macarovici, *M. pallasi* Baily, whereas the upper deposits include calcareous sandstone shell banks with *M. caspia, M. crassicolis, M. bulgarica elongata, M. bulgarica bisocensis, M. intermedia, M. orbiculata, Pirenella sp.*

Along the Reghiu Brook, near the confluence of this and the Milcov River, a level approximately 4 m thick, containing *Hyriopsis* and *Planorbis* was identified, the presence of these

genera indicating a first time interval with dominance of fresh-waters towards the end of the Chersonian.

The upper limit of the Chersonian may be situated there where (after the disappearance of species of *Mactra*) polygenic conglomerate and hard andesite sandstones occur, these latter deposits being considered to represent the basal part of the Meotian.

The sandstone marly deposits, typically Chersonian, are overlain, without break of sedimentation, by a marly formation intercalated with sandstones. The age of this latter formation, devoid of molluscan fauna, is not yet clearly established. It is worth mentioning that this formation includes accumulations of mammalian remains.

Follows, conformably, the marly sequence of the Meotian which outcrops in the Milcov Valley about 250 m downstream of the confluence of the Reghiu Brook and Milcov River. The lithology of this formation consists predominantly of grayish blackish claycy marls and carbonaceous marls intercalated with thin layers of sandstones and coal. From the marls come a molluscan association containing *Psilunio muntenie, P. subrecurvus, P. sp.* which indicate the Meotian age of this sequence of deposits.

FIELD ITINERARY

Road log includes the following localities: Bucureşti - Urziceni - Buzău - Râmnicu Sărat - Focşani - Odobeşti - Reghiu - Andreiaşu de Jos - Reghiu - Odobeşti - Panciu - Focşani - Bucureşti.

The route will cross the Romanian Plain and the hill area reaching the Subcarpathians of the Bend Zone.

Departure from Bucureşti following the European highway E-60/85; before entering Urziceni the "Forest of Sineşti" can be seen, which represents a remnant of the old vast forest called "Codrul Vlăsiei"; an oil field (on a restricted area) will be traversed near this locality.

The town of Buzău is already situated within the inner folded zone of the Carpathian Foredeep. Follows the town of Râmnicu Sărat whose railway station, built by the Romanian engineer Anghel Saligny, is on the UNESCO list of monuments to be preserved. At Dumbrăveni, a locality 20 km distant from Râmnicu Sărat, was erected the equestrian statue of the Russian General Suvorov who defeated the Turkish army (1787-1792). The house of the great writer, Alexandru Vlahuţă, can also be visited. Following the European highway E-85 we reach Focşani, a town with a particular historical significance, whose center was crossed by the boundary separating the two Romanian principalities (Wallachia and Moldavia) before their unification (1859). We leave Focşani and follow the county highway reaching succesively Odobeşti, Mera, Reghiu and Andreiaşu de Jos (over a distance of about 35 km).

FIRST STOP: ANDREIASU DE JOS

Before entering the village, along the Porcului Brook, 500 m distant from the confluence of this brook and the Milcov River, located in the Gray Schlier Formation of the Burdigalian, there are upper surfaces of strata with numerous footprints of Palmipeds (Paucă 1942, 1958).

Till now, 35 vertebrate ichnospecies and 5 inrvertebrate ichnospecies are known from the red and grayish Formations of the Early Miocene molasse of the Subcarpathian zone. The footprints of vertebrates are predominant (87.5%) in contradiction to organic marks of invertebrates (12.5%). Footprints of vertebrates include, in an almost equivalent proportion, footprints of birds (51.43%) and footprints of mammals (48.57%). The distribution of bird footprints gives nearly equal percentages for Avipeda and Ardeipeda on the one hand and for Anatipeda and Gruipeda on the other, with a moderate predominance of the footprints of Charadriipeda. The footprints of mammals are represented dominantly by Artiodactypedids followed by Carnivoripedids, Perissodactypedids and Proboscipedids. Recently, tracks of arthropods *(Oniscoidichnus miocenicus, Talitrichnus panini)* and perforations by Cirripeds *(Zapfella sp.)*.

The presence in deposits delimited by the top of the red molasse and the bottom of the gray molasse of numerous intercalations of "red beds", greenish grayish marls and thin sandstones which preserved an astonishing variety of footprints of vertebrates (especially the birds and mammals) (Paucă 1942, 1958; Panin 1961, 1965; Panin & Avram 1962), tracks of invertebrates (Alexandrescu et al. 1986; Brustur & Alexandrescu 1993) alongside with mechanical structures (raindrop pits, desiccation cracks, ripple marks) show that these deposits accumulated in a predominantly continental environment the depositional processes being enhanced by rhythmic activity of current flows transporting rich suspensions of material, i.e. of "superficial turbidity currents" (Panin 1965). The markings of animal activity (vertebratichnia and invertebratichnia) can be allocated to the ichnofacies with *Scoyenia* (Brustur & Alexandrescu 1993).

SECOND STOP: REGHIU (the area called "La Scruntar") (Fig.1A)

This area comprises a thickness of deposits overlying in continuity of sedimentation the last level with *Mactra bulgarica*. The age of these deposits, as already stated, cannot be fixed owing to lack of paleontological evidence. The sequence of deposits under consideration consists mainly of marls, sandstone marls including intercalations of clays, sandstones and microconglomerates (Fig. 1 B, C).

The first section available for examination is located in the Reghiu Valley at approximately 15 m upstream from the confluence of the Milcov River and Reghiu Brook (Fig. 1 B) where there is a last intercalation of shelly limestones containing *M. bulgarica* and *M. crassicolis,* two species indicating the Late Chersonian. A sandstone level, 10 m distant from this lumachelle, is visible which consists predominantly of tuffitic andesite material. Follows a close succession of marls, sandstone marls, sandstones and clays which extends over about 50 m and continues along the valley with a clayey level with spotted (red, green, gray) aspect. Using the method of washing and screening of sediments, this level yielded some tooth fragments of micromammals. The section includes further an alternation of sandstones, standstone marls and gray marls, about 45 m thick. The upper part of this sequence of deposits represented by gray yellowish compact sandstones includes a packet of sandstone marl, greenish grayish in colour which supplied numerous remains of micromammals. A sample taken from these sandstones was analyzed for obtaining a nannoplankton association. The identified assemblage is constituted of various species of *Thorocosphaera* and *Scyphosphaera*. This species might correspond to the NN 10 zone (Dr. M. Mărunţeanu, personal communication) . This level is overlain by sandstones and only in a subordinate amount by marls and clays.

A second section (Fig. 1 C) containing macromammals is situated about 200 m upstream from the "La Scruntar" cliff. This fossiliferous site was cited by Ioniţă (1963) who collected the first mammalian remains. The fossil level corresponds to the upper portion of a greenish, tuffitic sandstone, 4 m thick. At the base, the deposit has a coarse structure forming in places microconglomerates; its upper part becomes gradually finer and constitutes a sandstone marl. The fossil accumulation, 1 m thick, is located towards the upper part of the section in both sandstone and marly zones.

A preliminary list of species identified includes the following species:

Choerolophodon pentelici (GAUDRY & LARTET)

Chilotherium cf. *sarmaticum* KOROTKEVICH

Aceratherium incisivum KAUP

Hipparion cf. *sarmaticum* LUNGU

Gazella cf. *schlosseri* PAVLOV

Microstonyx major (GERVAIS)

Cervus sp.

Palaeotragine g. et sp. indet.

Insectivora g. et sp.indet. 1

Insectivora g. et sp.indet. 2

Eomyidae g et sp. indet.

Remarks on the Miocene mammals of the East Carpathian Bend Zone.

Miocene mammalian remains are still poorly known in the area under consideration. In 1957, Grigore Alexandrescu discovered in the basin drained by the Putna River, at Valea Sării, a great fragment of a *Hipparion* skull including the endocranial cast. This material was assigned to *H. gracile* KAUP by Barbu & Alexandrescu (1959). The same authors mentioned at Colacu, a locality situated in the same area, some remains attributable to the following species: *Hipparion* sp., *Palaeoreas lindermayeri* WEITHOFER and *Rhinoceros schleiermacheri* KAUP.

Later, Macarovici (1967) referred the skull fragment from Valea Sării to *H. sebastopolitanum* BORISSIAK. In a revision undertaken by Forstén (1980), the specimen from Valea Sării was assigned to *H. proboscideum* STUDER.

The investigations carried out during 1957 -1958 by Ioniţă (1963) in the Milcov Valley have brought to light a mammalian association Late Chersonian in age including the following taxa:

Mastodon (*Trilophodon*) *pentelici* (GAUDRY & LARTET)

Aceratherium schlosseri WEBER

Aceratherium incisivum KAUP.

Sus major GERVAIS

Camelopardalis parva WEITHOFER

Gazella deperdita GERVAIS

Our researches in the same area and the excavations executed in the same fossiliferous site confirmed, for the most part, the determinations made by Ioniţă (1963). At the present state of knowledge, the fossil level supplying mammals at Reghiu may be considered to be Latest Chersonian in age. A similar mammalian asociation is known in the Extracarpathian area at Bacău (a town lying 110 km north of Focşani (Rădulescu & Şova 1987). This fauna was considered to be transitional from the Late Chersonian to the Early Meotian.

The Reghiu mammalian fauna suggests affinities with the Late Sarmatian Berislav fauna in the Ukraine (Korotkevich 1970). Acording to Gabunia (1981) the Berislav mammalian complex may be situated within the MN 10 zone (Late Vallesian), although some relationships to the Turolian fauna are already apparent. The Reghiu fauna might belong to the same broad time interval (including also the earliest part of the Meotian).

REFERENCES

Alexandrescu Gr., Dumitrică P., Brustrur T. (1986) A New Ichnospecies of Oniscoidichnus Brady in the Lower Miocene molasse from Vrancea (Carpathian Fore deep). *D.S. Inst Geol.Geofiz.*, 70-71, **3**: 9 - 18, Bucureşti.

Andreescu I., Papaianopol I. (1970) Biostratigrafia depozitelor sarmaţiene dintre văile Milcov şi Râmnicu Sărat. *Stud. Cercet. Geol geof. geogr. ser Geol*, 2, **15**: 449 - 512, Bucureşti.

Atanasiu I. (1945) Sarmatien du Plateau Moldave, *Analele Academiei, Memoriile Sect. Ştiinţ.*,3, XX/ 5: 293 - 327, Bucureşti.

Barbu V., Alexandrescu Gr. (1959) Über einen natürlichen Hirnhöhlenabdruck von Hipparion, *Rev. geol. geogr.*, IV/1: 91 - 100, Bucureşti.

Băncilă I. (1958) Geologia Carpaţilor Orientali, *Ed. Stiinţifică*, Bucureşti.

Brustur T., Alexandrescu Gr. (1993) Paleoichnological Potential of the Lower Miocene Molasse from Vrancea, (east Carpathian), *Rev. Roum. Geol.* **37**: 77-94, Bucureşti.

Dumitrescu I., Săndulescu M., Ştefănescu M., Bandrabur T. (1968) Harta geologică a României scara 1:200000, foaia 29, Covasna, IGG, Bucureşti.

Forstén A. (1980) Hipparion proboscideum Studer from Romania, *Ann. Zool. Fennici*, **17**: 159 - 160, Helsinki.

Gabunia L., (1981) Traits essentiels de l'évolution des faunes de Mammifères néogènes de la région mer Noire-Caspienne, *Bull. Mus. natn. Hist. nat. Paris*, 4-e sér. 3, section C., **2**: 195-204, Paris.

Ionesi B., Ionesi L. (1972) Asupra prezenţei Burdigalianului în unitatea pericarpatică din regiunea Viişoara - Brăteşti, An. Univ. "Al.I. Cuza", II, Geol. XVIII, Iaşi .

Ioniţă S. (1963) Zăcământul de mamifere de la Reghiu - Vrancea şi importanţa lui stratigrafică. *Asoc. Geol. Carp.-Balc.Congr. V*, III/1: 199 - 210, Bucureşti.

Korotkevich E. L. (1970) Mammals of Late Sarmatian Hipparion fauna at Berislav (in Russian). in *Environment and Fauna of the Past*, **5**: 3 - 121, Kiev.

Lubenescu V., Marinescu Fl., Pavnotescu V. (1974) Comentarii asupra faunei cu congerii din Basarabianul superior de la Valea Sării (depresiunea subcarpatică a Moldovei Meridionale), *D.S., IGG*, Bucureşti .

Lungu A.N. (1984) The Fauna with Hipparion from the Middle Sarmatian of Moldavia, (in Russian). *Publ. House "Ştiinţa"*, 1 - 157, Chişinău.

Macarovici N. (1960) Recherches géologiques dans le Sarmatien du Plateau Moldave, *An. Com. Geol.* XXIX-XXX, Bucureşti.

- **(1967)** Kritischer Überblick über Hipparion im Neogen von Rumänien, *Sitzungsber. Österr. Akad. Wiss., math-nat*, Kl., Abt.I, 176, **5/7**: 81 - 90, Wien.

- **Motaş C.I., Contescu I. (1967)** Caractères stratigraphiques et sédimentologiques des dépôts sarmato-pliocènes de la courbure des Carpates Orientales, *An. şt. Univ. "Al. I. Cuza"*, secţ. a II-a (şt. nat. geol. geogr.), XIII, Iaşi.

Marinescu Fl., Papaianopol I., Macalet R., Olteanu R., Mărunţeanu M., Pestea S., Demetrescu I. (1993) Atlasul paleontologic, Sarmaţian partea a III-a, tema A5, Mollusca (Bivalvia), *Arhiva IGR*, Bucureşti.

Panin N. (1961) Asupra unor urme organice şi mecanice din Miocenul de la confluenţa Putnei cu Zăbala, *Stud. Cerc. Geol.* VI, **1**: 63 - 73, Bucureşti.

- **(1965)** Coexistenţa urmelor de paşi de vertebrate şi cu mecanoglife în molasa miocenă din Carpaţii Orientali, *Rev. Rom.Geol.*, 9, **2**: 141 - 163, Bucureşti.

- **Avram E. (1962)** Noi urme de vertebrate în Miocenul Subcarpaţilor româneşti, *Stud.Cerc.Geol.*, VII, 3/4:455 - 484, Bucureşti.

Paucă M. (1942) Empreintes de pas de Palmipèdes dans l'Helvétien carpathique de Putna, *Bull. Soc.Géol.Roum.*, V: 98 - 87, Bucureşti.

- **(1958)** Le Miocène présarmatien de la région de Courbure des Carpates Orientales, *Ann. Com. Géol.*, XXIV-XXV, Bucarest.

- **(1975)** Contributions à la stratigraphie du miocène présarmatien, *Trav. Mus Hist. Nat. "Grigore Antipa"*, **XVI** : 343 - 365, Bucureşti.

Rădulescu C., Şova C. (1987) A preliminary note on a Late Miocene mammalian fauna from Moldavia (Romania), *Trav. Inst. Spéol. "E. Racovitza"*, **26**: 67 - 71, Bucureşti.

Ringstrom T. (1924) Nashörner der Hipparion-Fauna Nord-China, *Palaeont. Sinica*, Series C, vol I, fasc. 4, Geological Survey of China, Peking.

Sen S. (Coordinateur) (1994) Les gisements de mammifères du Miocène supérieur de Kimiklitepe, Turquie, *Bull. Mus. natl. Hist. nat.*, 4-e sér., **16**: 1 - 240, Paris.

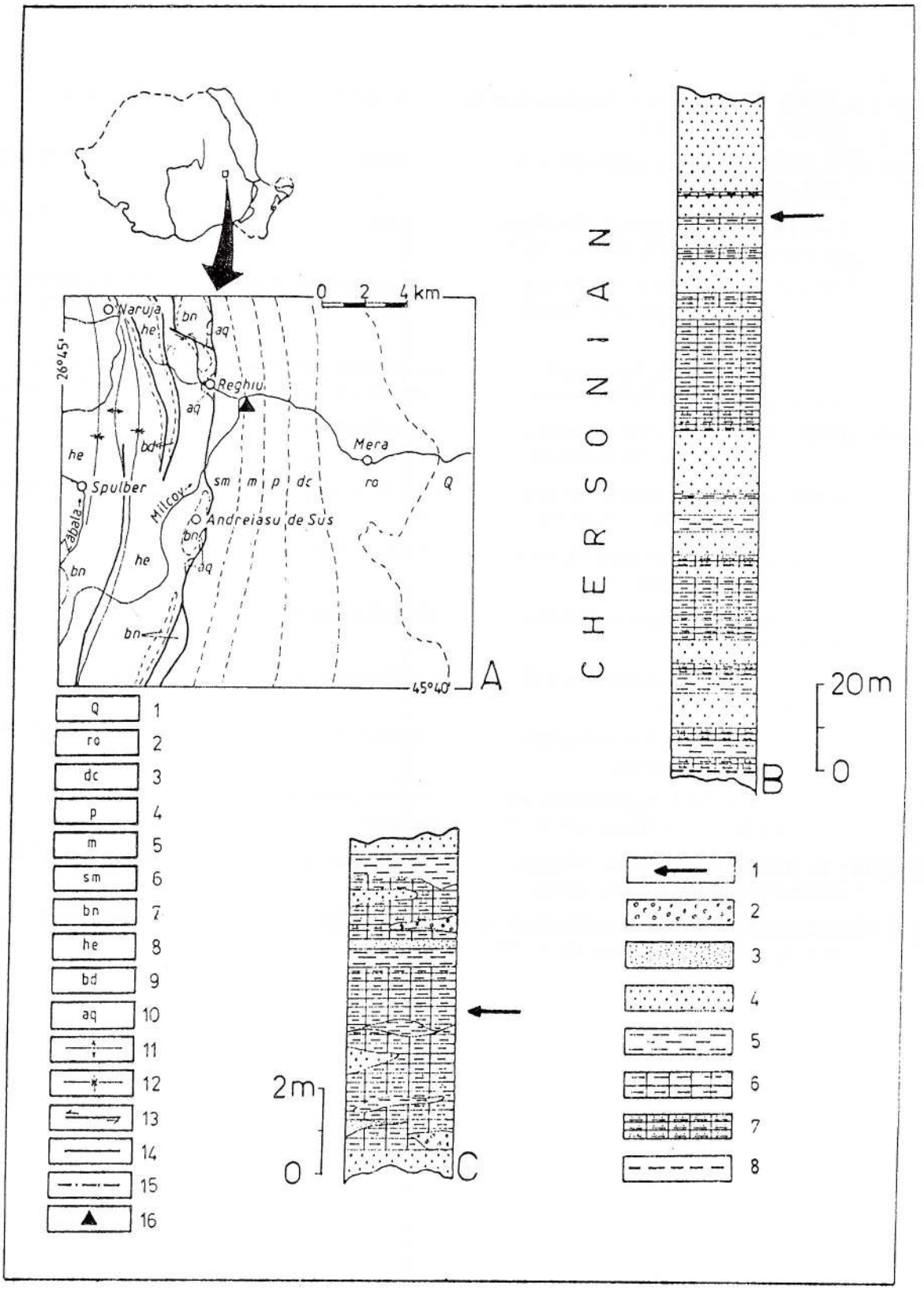


Fig. 1. Geographic location of the Reghiu - Andreiaşu area. Stratigraphic columns of the Late Sarmatian mammal fossiliferous deposits; A. The simplified geological sketch of the Reghiu - Andreiaşu area (after the geological map of Romania, (Covasna map)): 1 - Quaternary, 2 - Romanian, 3 - Dacian, 4 - Pontian, 5 - Meotian, 6 - Sarmatian, 7 - Badenian, 8 - "Helvetian", 9 - Burdigalian, 10 - Aquitanian, 11 - anticline axle, 12 - syncline axle, 13 - transcurrent fault, 14 - normal fault, 15 - diapiric contact, 16 - fossiliferous point; B, C - Stratigraphic columns of the fossil mammal occurrences: 1 - mammalian remains, 2 - microconglomerates, 3 - sands, 4 - sandstones, 5 - clays, 6 - marls, 7 - sandy marls, 8 - the last level with *Mactra bulgarica*.

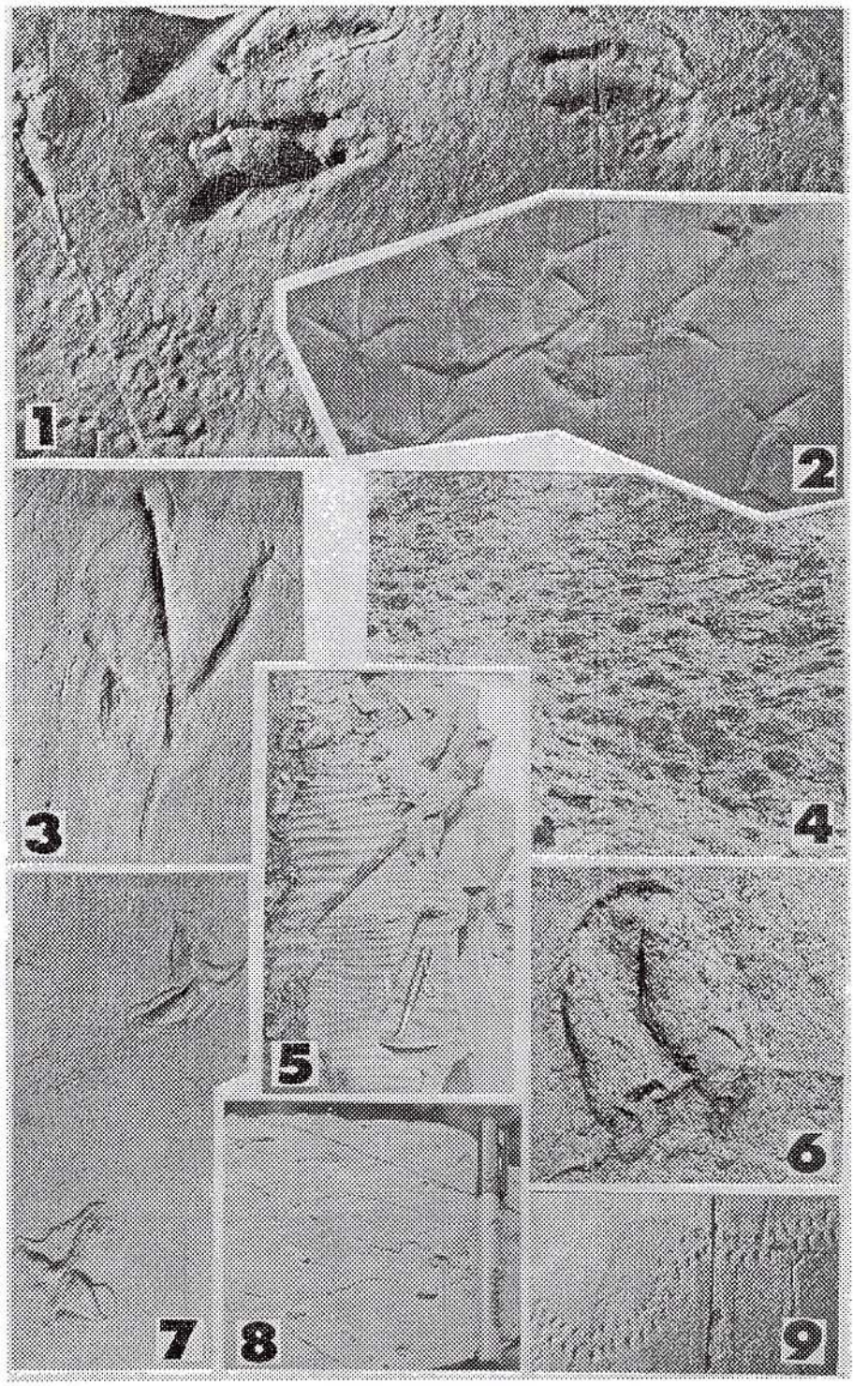


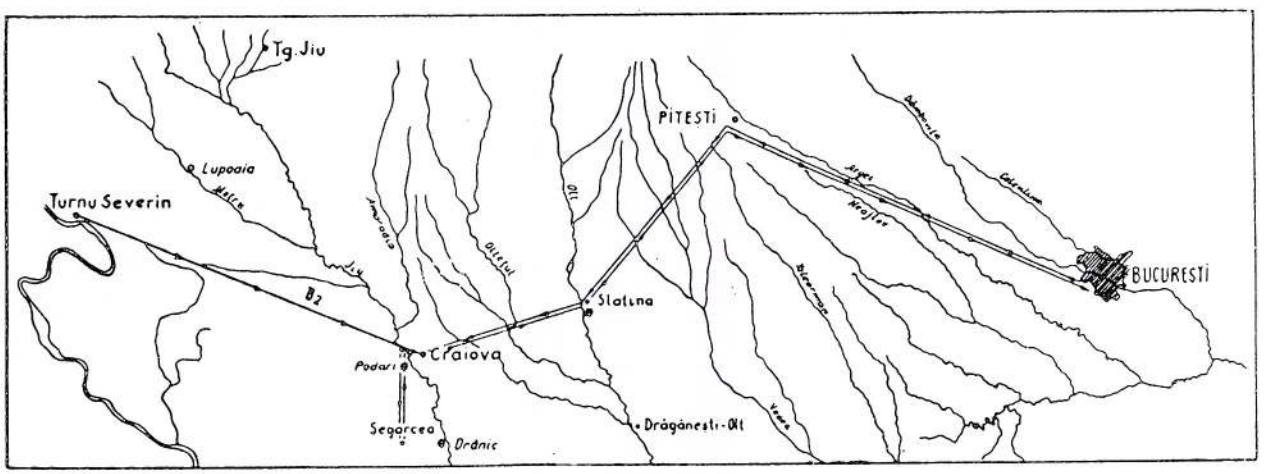
Fig. 2 Ichnofauna from the Reghiu - Andreiaşu area: 1 - *Pecoripeda gazella* VIALOV (Artiodactypedida), Red Formation, Boz valley; 2 - *Charadriipeda disjuncta* PANIN & AVRAM, Gray Formation, Boz valley; 3 - *Avipeda* indet., Red Formation, Boz valley; 4 - *Proboscipeda enigmatica* PANIN & AVRAM (Proboscipedidae), Red Formation, Boz valley; 5 - Ripple marks, Gray Formation, Putna valley; 6 - *Pecoripeda amalphaea* VIALOV, Gray Formation, Boz valley; 7 - *Charadriipeda minima* PANIN, Gray Formation, Boz valley; 8 - Mud cracks, Red Formation, Boz valley; 9 - *Oniscoidichnus miocenicus* ALEXANDRESCU, DUMITRICĂ & BRUSTUR (Isopoda), Red Formation, Boz valley.

GUIDEBOOK TO EXCURSION D (POST - CONGRESS)

UPPER NEOGENE FROM THE DACIC BASIN

by

Costin Rădulescu, Petre-Mihai Samson, Emanoil Ştiucă, Viorel Horoi



Excursion itinerary (D)

INTRODUCTION

The first important contributions to the knowledge of Pliocene micromammals of the Dacic Basin were the papers of Simionescu (1930, 1932) devoted to the description of the "classic" faunas from Măluşteni (MN 15a) and Bereşti (MN 14) (southern Moldavia).

Faunal investigations carried out since 1977 by the Paleontological Section of the Speological Institute on the fluviolacustrine deposits of the Dacic Basin supplied small mammal accumulations in several sites situated in the valleys of the Olt and Jiu Rivers and their tributaries (Oltenia). Studies undertaken in the Slatina area (Olt Valley), based on superposition of layers containing associated micromammals (MN 16b - MN 17) and molluscs, provided the first biostratigraphic framework, strengthened by magnetic polarity studies, concerning the subdivisions of Late Pliocene deposits of the Dacic Basin as well as the establishment of the Plio - Pleistocene boundary above the Olduvai normal subchron (Feru et al. 1978, 1979, Andreescu et al. 1981).

Subsequent fossil collecting at Lupoaia Quarry (Motru Valley) supplied a small mammal association (MN 15a) including a new species of arvicolids named *Mimomys rhabonensis* RĂDULESCU, SAMSON & ŞTIUCĂ, 1989. On the basis of paleomagnetic determinations (Andreescu et al. 1986), this association was situated within the Cochiti normal event of the Gilbert epoch (Rădulescu et al. 1989). During 1992-1994, excavations were made at Podari and Drănic, two fossil localities in the valley of the Jiu River. The micromammal-bearing level at Podari (MN 16a), which will be further discussed below, can be situated within the Middle Gauss subchron. At Drănic, a sequence of Pliocene deposits yielded, in superimposed faunal levels, a succession of four small mammal assemblages (Drănic - 0 to Drănic - 3) (from MN 15 to MN 16a) spanning a time interval of about 0,7 M.Y. including part of the Cochiti event, the Late Gilbert subchron and the Gilbert/Gauss boundary (Rădulescu, Samson, Ştiucă, Enciu & Popescu 1993 a, b and new data).

Excavations undertaken at Ciuperceni (Terzea & Boroneanţ, 1979) yielded small mammal faunas attributable to the MN 14 (Ciuperceni - 1) and MN 15 (Ciuperceni - 2) zones. The *Mimomys* specimens at Ciuperceni - 2, identified as *M. occitanus* THALER (Terzea 1981), are likely to represent, taking into account their medium-sized molars and dental features, an advanced stock belonging to *M. moldavicus* KORMOS.

SUCCESSION OF THE PLIOCENE SMALL MAMMAL ASSOCIATIONS OF THE DACIC BASIN

The Pliocene small mammals are known mainly from two areas: southern Moldavia, representing the northeastern extremity of the Dacic Basin and Oltenia which constitutes the western part of the same basin. It is worth mentioning that the two past decades have seen an acceleration of investigations undertaken mainly in Oltenia on fossiliferous levels including both micromammals and molluscs. At Slatina (Olt Valley), recent paleomagnetic determinations

provided evidence for the placement of the Neogene/Quaternary boundary (Andreescu et al. 1981), whereas mammalian associations allowed correlations with MN zones to be made.

In what follows, we will try to outline, in ascending stratigraphic order, the most significant fossiliferous sites supplying small mammals of the Dacic Basin.

EARLY PLIOCENE - EARLY ROMANIAN (SIENSIAN)

(MN 14 and MN 15)

Bereşti (code Br)

From this locality is known the earliest micromammalian assemblage of the Dacic Basin. Revisions of some species of macro- and micromammals were undertaken by Rădulescu et Samson (1967 a, b, 1989 a, b), Rădulescu et al. (1992), Rădulescu et Samson (1995), Samson et Rădulescu (1973).

The microfauna is characterized by the high frequency of lagomorphs (especially the ochotonids), presence of spalacids and small-sized cricetids (*Moldavimus* SAMSON et RADULESCO, 1973, syn. *Odessamys* TOPACHEVSKI et SKORIK, 1992); it is worth emphasizing that arvicolid rodents are completely lacking. This absence is considered important, the accumulation of fossil remains at Bereşti antedating the first appearance of the representatives of the genus *Mimomys* in the Dacic Basin.

The list of small mammals includes the following taxa: *Desmana tamutriensis* RĂDULESCU, SAMSON et ŞTIUCĂ, *Talpa neagui* RĂDULESCU et SAMSON, *Castor praefiber* DEPÉRET, *Zamolxifiber covurluiensis* (SIMIONESCU), *Romanocastor filipescui* RĂDULESCU et SAMSON, *Pliospalax macoveii* (SIMIONESCU), *Microspalax odessanus* TOPACHEVSKI, *Cricetulus (Moldavimus) simionescui* SCHAUB, *Trischizolagus dumitrescuae* RĂDULESCU et SAMSON, *Ochotona ursui* SIMIONESCU, *Pliolagomys* sp.

The Bereşti fauna is considered to correspond to the Late Dacian and respectively to the second half of the MN 14 zone. An equivalent of the Bereşti faunal assemblage seems to be represented by the still imperfectly known Sagaidak faunal complex of the Republic of Moldova (Gabunia et al. 1986) and the earlier levels of the Kuchurgan mammalian fauna of the Ukraine.

The dominance of the lagomorphs as well as the occurrence of spalacids and *Cricetulus*-like forms appear to correspond to a relatively drier, open environment. Associated desman and castorids indicate, however, the proximity of more humid terrain and body of water.

Măluşteni (code Ml)

The small mammals of this locality define a biostratigraphic level characterized by the first appearance of representatives of the genus *Mimomys* (*M. moldavicus*) (Kormos 1932, Rădulescu et Samson 1989 a).

The following micromammals were identified there: *Erinaceus* sp., *Desmana amutriensis, Talpa neagui, Pliopetaurista* sp., *Castor praefiber, Zamolxifiber covurluiensis, Prospalax rumanus* SIMIONESCU, *Pliospalax macoveii, Mimomys moldavicus, Trischizolagus dumitrescuae, Ochotona ursui, Pliolagomys* sp.

The fauna is indicative of more humid conditions suggesting a landscape with alternating patches of woodland and open zones.

In the biostratigraphic scheme of the Dacic Basin, Ml may be situated at the very beginning of the Romanian stage (Siensian). The occurrence of a primitive *Mimomys* species indicates that the fossil locality belongs to the MN 15a subzone. *M. moldavicus* was also described from the Late Kimmerian (Chumeshti horizon) of the Republic of Moldova (Alexandrova 1986). Judging from the dental similarity of *Mimomys* forms, Ml seems to be equivalent to Ptolemais-3 (Greece) (van de Weerd 1978).

Jiu Valley

Lupoaia Quarry (code Lp/VIII)

The small mammal association recovered from the clayey deposits at the base of the coal layer VIII (Rădulescu et al. 1989) in the Lupoaia coal Quarry (Motru Valley, Oltenia) represents a subsequent time interval in the evolution of fauna of the Dacic Basin.

The following taxa were recognized: *Desmana amutriensis* (type locality), *Apodemus dominans* KRETZOI, *Mimomys rhabonensis*, *Chiroptera* g. et sp. indet. (RĂDULESCU et al. 1989).

The Lp/VIII fossiliferous level is distinguished by the first appearance of the large-sized *M. rhabonensis* in the Dacic Basin. The scarcity of dental remains could explain the absence of the middle-sized *M. moldavicus*, known from Măluşteni. The occurrence of the murid *Apodemus dominans* marks the earliest record of this taxon in the Dacic Basin.

Although the fauna is still poorly documented, the small mammals are indicative of a local humid environment developed under temperate conditions.

The molluscan fauna is characteristic of the NSM 10 - *Viviparus bifarcinatus* zone, NSM 10a - *Jazkoa sturdzae* subzone (Andreescu 1982, Andreescu et al. 1986).

The paleomagnetic determinations (Rădan S. in Andreescu et al. 1986) indicated a normal polarity, interpreted as corresponding to the Cochiti event (4.29 - 4.18 M.Y.) of the Gilbert epoch. We mention that the limit between the Late Dacian (Parscovian) and the Early Romanian (Siensian) is placed within the Cochiti event (Andreescu 1982, Andreescu et al. 1985, Andreescu et al. 1986).

For the Lp/VIII level an equivalence to the first half of the MN 15a subzone was suggested (Rădulescu et al. 1989). Compared with *M. occitanus* THALER from Sète (France) (Chaline 1974) situated within MN 15b subzone, *M. rhabonensis* from Lp/VIII appears to possess a more primitive dental morphology.

Drănic (code Dr)

The sections and micromammals from Drănic-0 to Drănic-2 (Early Romanian, MN 15a,b) and from Drănic-3 (transition Early/Middle Romanian, MN 15b/MN 16a) will be further discussed in detail below (see presentation of outcrops and their paleontological content) (Stop 1).

MIDDLE PLIOCENE - MIDDLE ROMANIAN (PELENDAVIAN)

(MN 16a)

Podari (code Pd)

Associated to numerous molluscs, a rich and various micromammalian fauna was collected at Podari. This fauna will be presented in a subsequent paragraph (Stop 2).

LATE MIDDLE AND LATE PLIOCENE - LATE ROMANIAN (VALACHIAN)

(MN 16b and MN 17)

Olt Valley

The fossil localities which yielded in superimposed sections small mammal remains are situated in the Olt Valley, between Milcovu din Vale in the south and Cherleştii-Moşteni in the north, over a distance of about 15 km. The most important sections were studied near Slatina where the outcrops contain a succesion of three fossiliferous levels in superposition.

Milcovu din Vale-1 (code MV-1)

Remains of micromammals associated with molluscs were collected from the layer 3 of the excavation carried out at this site (Feru et al. 1979). The small mammals include only a limited number of rodent species, as follows: *Trogontherium cf. minus, Dolomys milleri* NEHRING, *Mimomys* ex gr. *stehlini* KORMOS / *minor* FEJFAR.

The small mammal association is distinguished by the occurrence of mimomyian forms identified as *M.stehlini / minor* possessing molars with crowncementum. The number of species is reduced, the fauna of this interval being drastically impoverished in comparison with the Podari association.

The rich molluscan fauna belongs to the earliest part of the Late Romanian (Valachian) corresponding to the NSM_{12} - *Ebersininaia milcovensis - Rugunio riphaei* zone, NSM_{12a} - *E. milcovensis* subzone (Andreescu et al. 1981).

Paleomagnetic determination showed a normal polarity indicating that MV-1 may belong to the latest part of the Gauss epoch.

Judging from the evolutionary stage of arvicolids, MV-1 can be placed within the MN 16b subzone, characterized by *Mimomys* species whose molars contain cement in the re-entrant angles. MV-1 appears to be broadly equivalent to Hajnacka (Czech Republic). According to Fejfar et al.(1990), this latter fossil locality, distinguished by normal polarity, may also correspond to the latest part of the Gauss epoch. Nikiforova et al. (1986) suggest the equivalence between MV-1 and Veselovka (presence of *Mimomys* ex gr. *minor* and *Dolomys*) of the biostratigraphic scheme of Eastern Europe.

Slatina-1 (code Sl-1)

Layer 14 of the sequence of deposits at Slatina yielded a micromammalian association containing the following species: *Galemys kormosi* SCHREUDER, *Apodemus sp., Dolomys milleri, Mimomys minor.* The faunal association, although relatively rich in specimens, includes a limited number of species with *D. milleri* as dominant form. The fauna is obviously impoverished (as is that from MV-1) and we consider that this small number of species can only partly be attributed to lack of data. Perhaps a noticeable change in the environment should be taken into consideration, a climatic depression being responsible for the low diversity of the small mammals.

The molluscan species associated to micromammals belong to the NSM_{12c} - *Unio kuyalnicensis* subzone (Andreescu et al. 1981).

On the basis of the reversed magnetic polarity, Sl-1 was situated within the Early Matuyama subchron.

The evolutionary stage of arvicolid species suggests that Sl-1 could be placed within the second half of the MN 16b subzone. The dental similarities of *Dolomys* forms are indicative of an equivalence to the khaprovian fauna of Kryjanovka in the Ukraine (Shevchenko 1965).

Slatina-2 (code Sl-2)

The fossiliferous level designated Sl-2 corresponds to the layer 17 in the sequence of deposits at Slatina. The small fauna consists of the following elements: *Talpa fossilis* PETÉNYI, *Desmana nehringi, Beremendia fissidens, Apodemus* sp., *Dolomys ferui* RĂDULESCU & SAMSON, *Mimomys* cf. *livenzovicus* ALEXANDROVA, *Borsodia* sp., *Leporid* cf. *Hypolagus brachygnathus* KORMOS.

Compared with the preceding fauna (Sl-1), the association from Sl-2 contains a greater number of species. The increase in diversity of insectivores and rodents is, very probably, correlated with a shift to a warmer climate. The most significant faunal events concern the decline of *Dolomys* (documented by an advanced species *D. ferui*) and the increase of specimens of *Mimomys* which become dominant in the association. The first appearance of a species of *Borsodia* (considered as an immigrant with steppe affinities) in The Dacic Basin is coincident with this biostratigraphic level.

The associated molluscs are characteristic of the NSM_{12d} - *Bogatschevia tamanensis - Rugunio riphaei* subzone (Andreescu et al. 1981).

Paleomagnetic determinations indicated a reversed polarity. Sl-2 may be placed, therefore, within the later part of the Early Matuyama subchron, prior to the Olduvai event.

As a whole, the Sl-2 small mammals correspond to a more advanced evolutionary level which seems to cover an interval of the MN-17 zone. An equivalence between Sl-2 and the Ferladanian horizon of the khaprovian faunal complex in Eastern Europe appears to be justified by the dental features of the rodent species present.

Cherleştii - Moşteni (code CM)

Situated in the Olt Valley at about 10 km north of Slatina, CM yielded the following small mammals: *Desmana nehringi, Trogontherium* cf. *minus, Allactaga* sp., *Apodemus* sp., *Dolomys ferui* (type locality), *Mimomys* ex gr. *pliocaenicus* F. MAJOR, *M.* cf. *livenzovicus, Borsodia* sp.

The faunal association is distinguished by the drastic decline of *Dolomys* (this locality registered the last appearance of the genus in the Dacic Basin) and the presence, for the first time in the area under consideration, of a *Mimomys* form related to the phyletic lineage *M. polonicus* KOWALSKI - *M. pliocaenicus*. The immigration in the Dacic Basin of a species of *Allactaga* showing affinities with the Anatolian representatives of the genus (*A. euphratica* THOMAS) is indicative of a faunal dispersal from Eastern Mediterranean area to the north reaching the western portion of the Dacic Basin. In a previous paper (Feru et. al. 1978) we considered the species of *Allactaga* as bellonging to an immigrant (*A. ucrainica* GROMOV & SHEVCHENKO) coming from the steppe area of Eastern Europe.The examination of M3/ showed, however, that the species from CM is closely related to Eastern Mediterranean forms of the genus.

The molluscs collected at CM reveal many similarities with Sl-2 and are indicative of the NSM_{12d} subzone (Andreescu et. al. 1981).

Taking into account the presence of *M. pliocaenicus* group and *Allactaga* sp., the micromammalian fauna at CM seems to be somewhat later than Sl-2. As a whole, the association of CM may be situated within a later episode of the MN 17 zone.

Slatina - 3 (code Sl-3)

The third fossiliferous level of the section at Slatina yielded some sparse remains of small mammals including *Trogontherium dacicum* RĂDULESCU (type locality) and *Mimomys* sp. (of the *minor - coelodus* KRETZOI lineage).

It is interesting to note, at this biostratigraphic level, the appearance of *Unio apscheronicus* (unionids of boreal type) which marks the transition between the Neogene and the Quaternary in the regional biostratigraphic scheme. Paleomagnetic data indicated a reversed polarity interpreted, taking into account the stratigraphic and faunal context, as the Olduvai event.

The Pliocene faunal succesion at Slatina is overlain by erosive sandy deposits belonging to the Early Pleistocene. At Izvoru (near Slatina) and at Drăgăneşti - Olt (south of Slatina), Early Pleistocene sequences of deposits yielded rich small mammal associations. The principal small mammal fossil localities of the Dacic Basin and their most likely correlations are presented in Fig. 1.

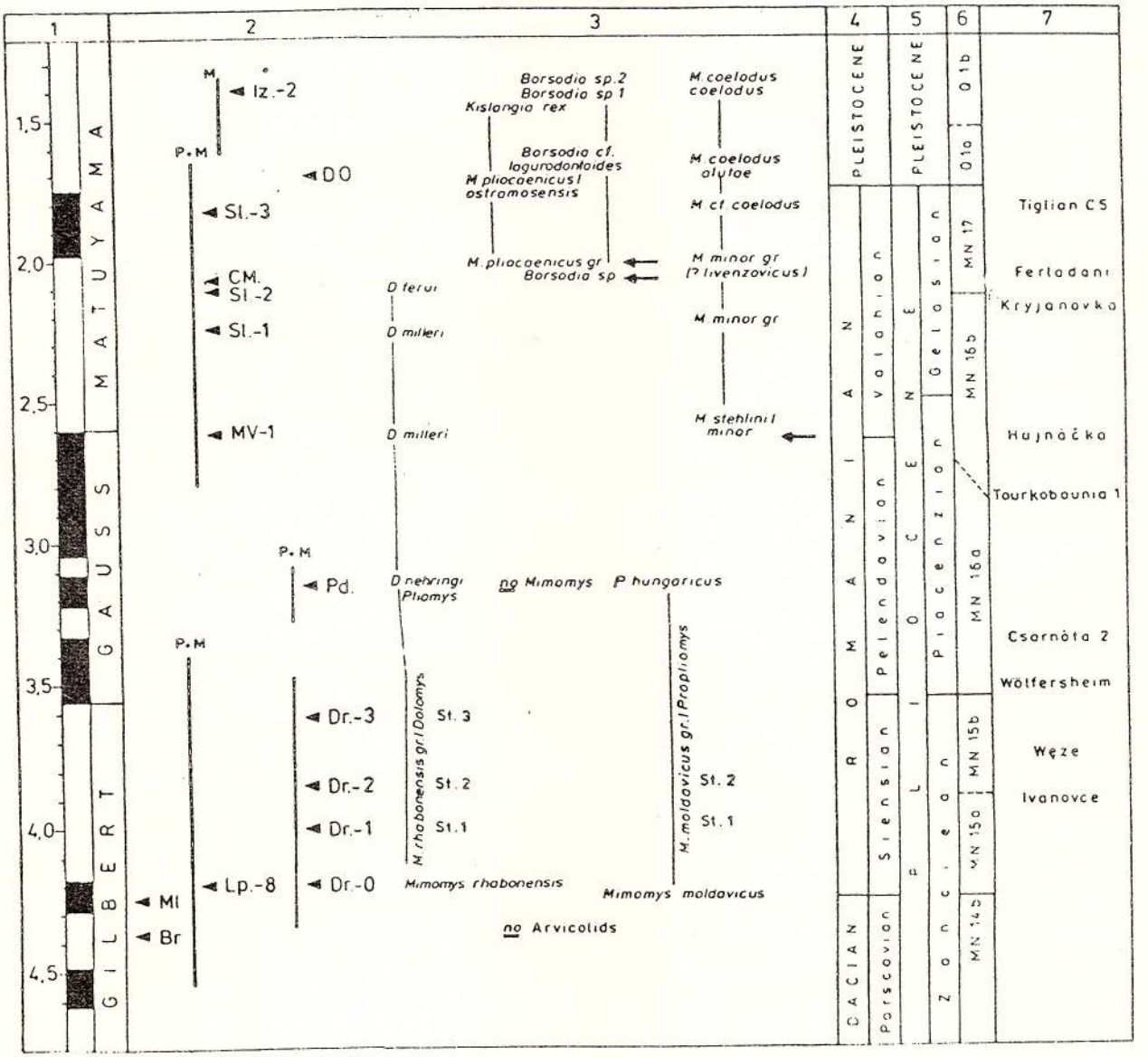


Fig.1. Pliocene biostratigraphy (micromammals) of the Dacic Basin: 1- magnetic polarity time scale, 2 - fossil localities (see text), 3 - index taxa (arvicolids), 4 - Central Paratethys stages, 5 - Mediterranean stages, 6 - Mediterranean Neogene mammal zones, 7 - Equivalent mammal localities. Arrows = immigrations, P = paleomagnetic determinations, M = molluscan faunas.

DESCRIPTIONS OF OUTCROPS

EARLY ROMANIAN (SIENSIAN) AND EARLY MIDDLE ROMANIAN (PELENDAVIAN) AT DRĂNIC

(Fig.2).

The road log follows the highway from Craiova to Podari (a locality on the outskirts of Craiova), then south to Segarcea (the most important town in the area, well-known for its wineries and distilleries) and then southeast to Drănic. The fossiliferous deposits are outcropping along the right side of the Jiu River at about 3 km east of Drănic (10 km southeast of Segarcea). The exposures are visible over a distance of more than two km, the thickness of sections varying between 20 and 40 m. The paleontological investigations identified several fossiliferous levels yielding molluscan accumulations associated with mammalian remains. As the outcrops are sometimes obscured by vegetation or covered by colluvial accumulations, four lithostratigraphic columns forming a succession of deposits were chosen for study. From S to N they are as follows: Drănic southernmost profile (code Dr -SS), Drănic south (code Dr -S), Drănic - intermediate profile (Dr - X), Drănic northernmost section (code Dr - N).

STRATIGRAPHY

Generally, the sections consist of lacustrine, fluvial and swamp deposits displaying a complex mixture of lithologies including fine yellowish sands, yellowish (or greenish) gray silts, greenish gray clays and carbonaceous clays. If in the basal part of outcrops the sequence of deposits is more continuous, showing a gradual transition from coarser terms to finer sediments (e.g. Fig. 2 column at Dr-SS), in the upper part of profiles the sequences of layers are less thick, some lithologic terms being absent; at the same time, the limits between strata become more marked. The successions of strata forming cycles are separated by erosional episodes more or less important. At Dr.-SS, the lateral development of the basal deposits was dissected by erosional processes which allowed the deposition of the subsequent sedimentary cycle 6 m deeper. As a rule, every cycle begins with pebbles (attaining 15 cm in maximal diameter), marking a disconformity with regard to the underlying finer sediments (greenish gray or black carbonaceous clays).

The fossiliferous levels are, for the most part, associated with arenites. At Dr-SS, the first (deepest) fossiliferous level situated at an elevation of 57 m above sea level is placed at the top of a sequence of sands with oblique lamination. The following level with micromammals (in ascending order), Dr-1SS (70 m elev. a.s.l.) is included in the sand layers which eroded the basal deposits. At Dr-S, the first fossil site (Dr-1S), equivalent to Dr-1SS, is located at an elevation of 64 m a.s.l. and was laid down discordantly on carbonaceous black clays. The second fossiliferous level (Dr-2S, 72 m elev. a.s.l.) corresponds to greenish gray silts containing numerous pellicles of iron hydroxide; one meter above there is the fossiliferous level Dr-2SS which is developed in similar sediments, the whole sequence being overlain by greenish clays with gypsum crystals. The uppermost level with micromammalian remains (75 m elev. a.s.l.) is located in a sandy sequence of deposits disconformably overlying a succesion of greenish gray clays. This level is distinguished by great accumulations consisting almost exclusively of gastropods.

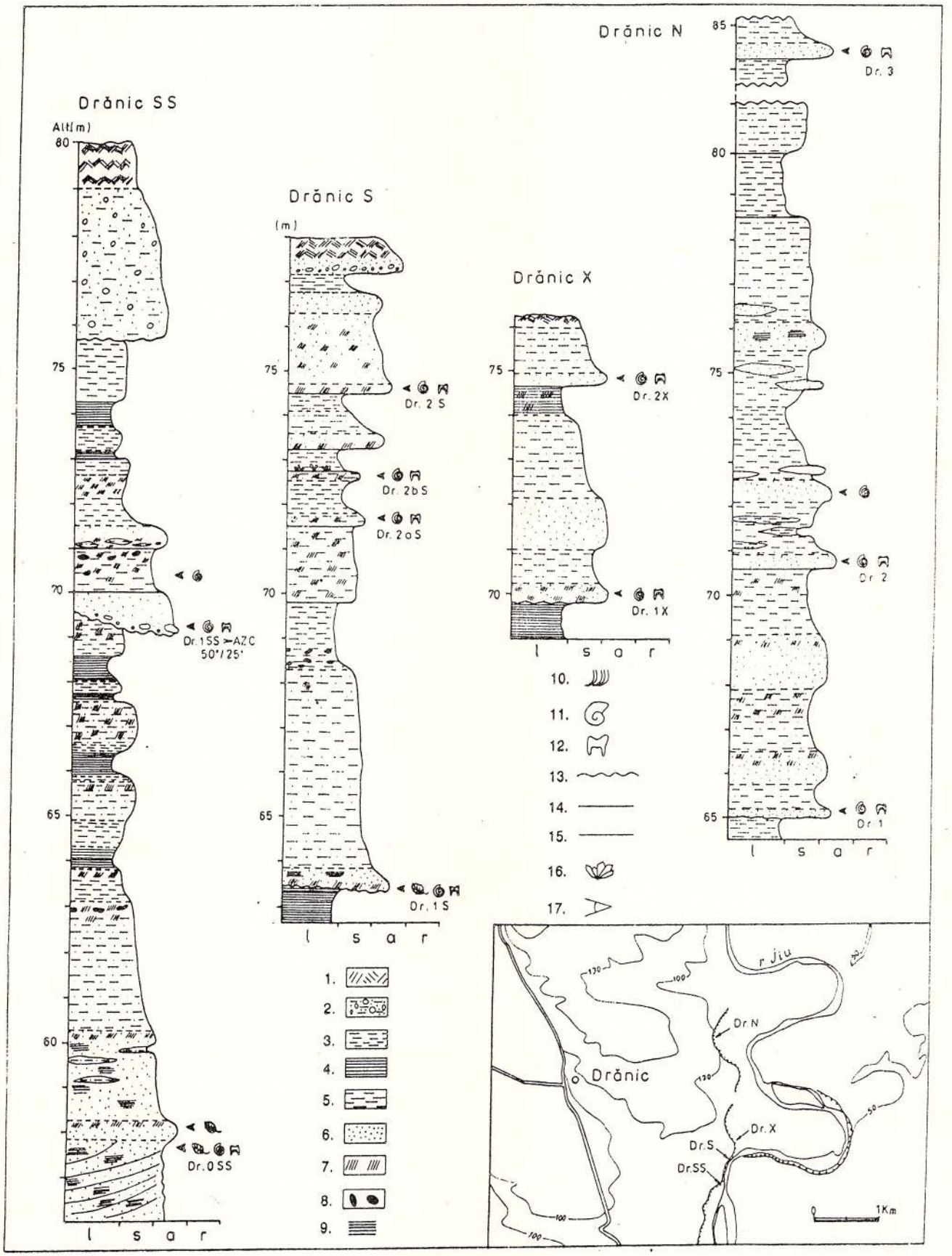


Fig. 2. Lithostratigraphic sections at Drănic. Dr. 0 - 3 fossiliferous levels: 1- soil, 2 - colluvial deposits, 3 - greenish bluish gray clays, 4 - black clays (carbonaceous), 5 - yellowish greenish gray clays, 6 - sands, 7 - pellicles of iron oxides, 8 - concretions of iron oxides, 9 - parallel laminations, 10 - oblique laminations, 11 - mollusca, 12 - micromammals, 13 - angular unconformity, 14 - sharp limit, 15 - transitional limit., 15 - gypsum crystals, 17 - position.

At Dr-X, where the deposits have a relatively reduced thickness, the lower fossiliferous level (Dr 1X, 70 m elev. a.s.l.) consists of rather compact yellowish sands and fine sands overlying with a disconformity a sequence of black carbonaceous clays. The upper fossiliferous level corresponds to a repetitive cycle, but is characterized by the occurrence of numerous gastropod remains. In the profile studied at Dr-N., three superimposed fossiliferous levels were documented: Dr-1N fauna (65 m elev. a.s.l.) was included in a sequence of sands which eroded layers of carbonaceous black clays. The following level with micromammals, Dr-2N, (71 m elev. a.s.l.) containing dominantly gastropods remains, was intercalated with layers of sands and silts. The third uppermost fossiliferous level (Dr-3, 85 m elev .a.s.l.) was included in yellowish gray fine sands overlying greenish clays.

TENTATIVE RECONSTRUCTION OF THE SEDIMENTARY CONDITIONS

The sections including Romanian deposits show a cyclicity of sedimentation, every "ideal" depositional cycle consisting of the following lithologic units: yellowish gray fine sands, displaying sometimes parallel or oblique lamination, gray silts, greenish gray clays and carbonaceous black clays. The most complete sequence of sediments may be seen at Dr-SS. The limits between the lithologic terms are gradual and, as a whole, an asymmetric, complete and continuous rhythm with a normal grain-gradation, complete and continuous can be recognized. The later cycles appear to be comparatively less developed, the absence of certain lithologic terms being noted.

The depositional rhythms become, therefore, from bottom to top of the section less complete (even though they are continuous or discontinuous) and the grain-gradation is distinguished by discontinuity. Within separate sequences the limits between layers are gradual, whereas the rhythms have sharp (or erosive) boundaries. In some case, the deposits which open a cycle, represented generally by poorly sorted arenites, may fill erosion channels. The fossiliferous levels containing small mammal remains are almost wihtout exception correlated to this type of sediments. In addition, there is a considerable lateral variation of deposits reflecting frequent changes of facies. Siltic and arenitic sediments contain pellicles of iron oxides and hydroxides. The presence of gypsum crystals (up to 5 cm in length) is another peculiar feature of the sections at Drănic.

All these observations indicate, during the Romanian, the presence in the area under consideration of a lake with oscillating water level evolving, in broad lines, toward a predominantly marshy facies not without several returns to previous deep-water conditions.

The presence of erosion channels and poorly sorted deposits is indicative of a shallow water zone near the shore. Accumulations of mammalian remains also plead for such a proximity. The frequent lateral variation of deposits produces evidence for a rather sinuous shoreline. It appears that especially during the lying down of the upper sequences of sediments, the area studied included immerse zones alternating with emerged ones.

At the base of the sections this cyclic water oscillation is better documented including sediments laid down by bottom streams of low-energy (fine sands) and culminating with carbonaceous black clays, characteristic of marshy sedimentation, whereas the upper parts of the same stratigraphic columns are distinguished by a more irregular cyclic deposition, the sequences

of deposits showing frequent discontinuities and diminishing thicknesses; at the same time, the occurrence of the black clays is obviously more reduced. As a whole, the sedimentation was characterized during its first part by prevailing processes of oxidization (pellicles of iron oxides and hydroxides) which were replaced, in a later interval, in function of local conditions, by dominantly phenomena of reduction (presence of gypsum crystals and pellicles of sulphur).

The lake, at least during the later phases of the Early Romanian, had zones with variable but rather superficial body of water which may have expanded and contracted several times in response to climatic fluctuations. A system of disseminated "isles" with transitory existence (determined by the general evolution of sedimentation under varying enviromental conditions) is also conceivable.

PALEONTOLOGY (MICROMAMMALS)

Early Romanian (Siensian)

The fossiliferous levels at Drănic can be grouped into four main faunal units which yielded micromammalian remains in association with molluscan faunas. The species composition of small mammal communities, indicated in ascending chronological order, is as follows:

Drănic-0 (code Dr-0)

Dibolia sp., Desmanella sp., Desmana cf. amutriensis RĂDULESCU, SAMSON, ŞTIUCĂ, *Allosorex stenodus* FEJFAR, *Blarinoides mariae* SULIMSKI, *Sorex minutus* LINNAEUS, *Trogontheriinae* g. et sp. indet., *Apodemus dominans, Mimomys rhabonensis, Mimomys moldavicus* -group, *Leporidae* g. et sp. indet.

Remarks on micromammals - The association includes six insectivores, among which a species of the very rare genus *Allosorex*. The arvicolid rodents appear to represent a large-sized form, assigned to *M. rhabonensis* (in which mimomyian and dolomyian features are associated) and a medium-sized form, attributable to *M. moldavicus* (this latter displaying propliomyian tendencies).

Mollusca - *Viviparus bifarcinatus* (BIELZ) - NSM 10 zone, *Jazkoa sturdzae* (COB.) - NSM 10a subzone (Andreescu 1982, Enciu & Andreescu 1990).

Paleomagnetism: - Dr-0 may be situated within the Cochiti normal event of the Gilbert epoch, taking into account the primitive stage of evolution of arvicolid large-sized species which is very similar to *M. rhabonensis* from Lp/VIII, where the normal polarity was interpreted as Cochiti event (Andreescu et al. 1986, Rădulescu et al. 1989).

Correlations - The small mammals suggest a relationship to Lp/VIII. *Allosorex* is recorded here for the first time in the Dacic Basin. It is worth remembering that *Allosorex* is known at present from the Czech locality of Ivanovce (type locality for the species *A. stenodus*) and Dr-0. The fauna as a whole can be situated whithin MN 15a subzone (Mein 1990).

Drănic-1 (code Dr-1)

Dr-1 faunal assemblage includes three fossiliferous levels separated between them, seemingly, by short time intervals. Althought we distinguished a lower, a middle and an upper level, we must emphasize that the species identified display a similar stage of morphological evolution. The arvicolids are considered representatives of the first stage of phyletic lineages leading on the one hand from *M. rhabonensis* to *Dolomys nehringi* Kretzoi (large-sized forms) (see Figs. 3 - 4 illustrating successive transitional stages) and from *M. moldavicus* to *Propliomys hungaricus* (middle - sized forms) on the other.

The three fossil levels yielded the following species:

Dr-1 (lower level, Dr - 1S) - *Dibolia* sp., *Desmanella* sp., *Desmana* cf. *amutriensis, Mimomys rhabonensis* gr. / *Dolomys* (stage 1), *M. moldavicus* gr./ *Propliomys* (stage 1), *Trischizolagus* sp.

Dr-1 (middle level, Dr-1X) - *Mioechinus* sp., *Apodemus dominans, Orientalomys* sp., *Mimomys rhabonensis* gr. / *Dolomys* (stage 1), *M. moldavicus* gr./ *Propliomys* (stage 1).

Dr-1 (upper level, Dr-1N) - *Desmana* cf. *nehringi* KORMOS, *M. rhabonensis* gr. / *Dolomys* (stage 1), *M.moldavicus* gr. / *Propliomys* (stage 1).

Remarks on micromammals - First record among insectivores of a primitive erinaceid showing affinities with *Mioechinus*. Presence of a particular desman species (*D.* cf. *nehringi*), very probably a northern immigrant, taking into account the occurrence of these species in Pliocene karst deposits of Poland: Podlesice (MN 14), Weze (MN 15) and others (Rzebik-Kowalska, 1971). First appearence of a species of the genus *Orientalomys*, known from the southwestern Ukraine ("Odessa Catacombs"), Greece (de Bruijn & van der Meulen, 1975) and Anatolia (Sen, 1977). The immigration of *D. nehringi* interpreted as a northern guest into the Dacic Basin might indicate a shift to cooler climatic conditions. The presence of *Orientalomys* could be coincident with an increase in continentality.

Mollusca - NSM 10a subzone.

Paleomagnetic data - Judging from the general faunal context, Dr-1 may be situated at the beginning of the Late Gilbert subchron.

Correlations - The Dr-1 faunal assemblage may be situated within the last part of the MN 15a subzone. Equivalent micromammalian faunas are known from the "Odessa Catacombs" (Ukraine), the Budei horizon (Kuchurgan superhorizon) of the Republic of Moldova (Nikiforova & al., 1986). The micromammals from Calta (Anatolia) (Sen, 1977) can also represent an equivalent of Dr-1.

Drănic-2 (code Dr-2)

The micromammalian assemblage includes two superimposed fossiliferous levels. A third faunal level, rich in moluscs, yielded only sparse remains of microvertebrates and will be not discussed here.

Drănic-2 (lower level, Dr-2N) - *Dibolia* sp., *Galemys sulimskii*, RÜMKE, *Desmana nehringi, Deinsdorfia* cf. *kordosi* REUMER, *Zamolxifiber* cf. *covurluiensis, Apodemus dominans, Micromys*

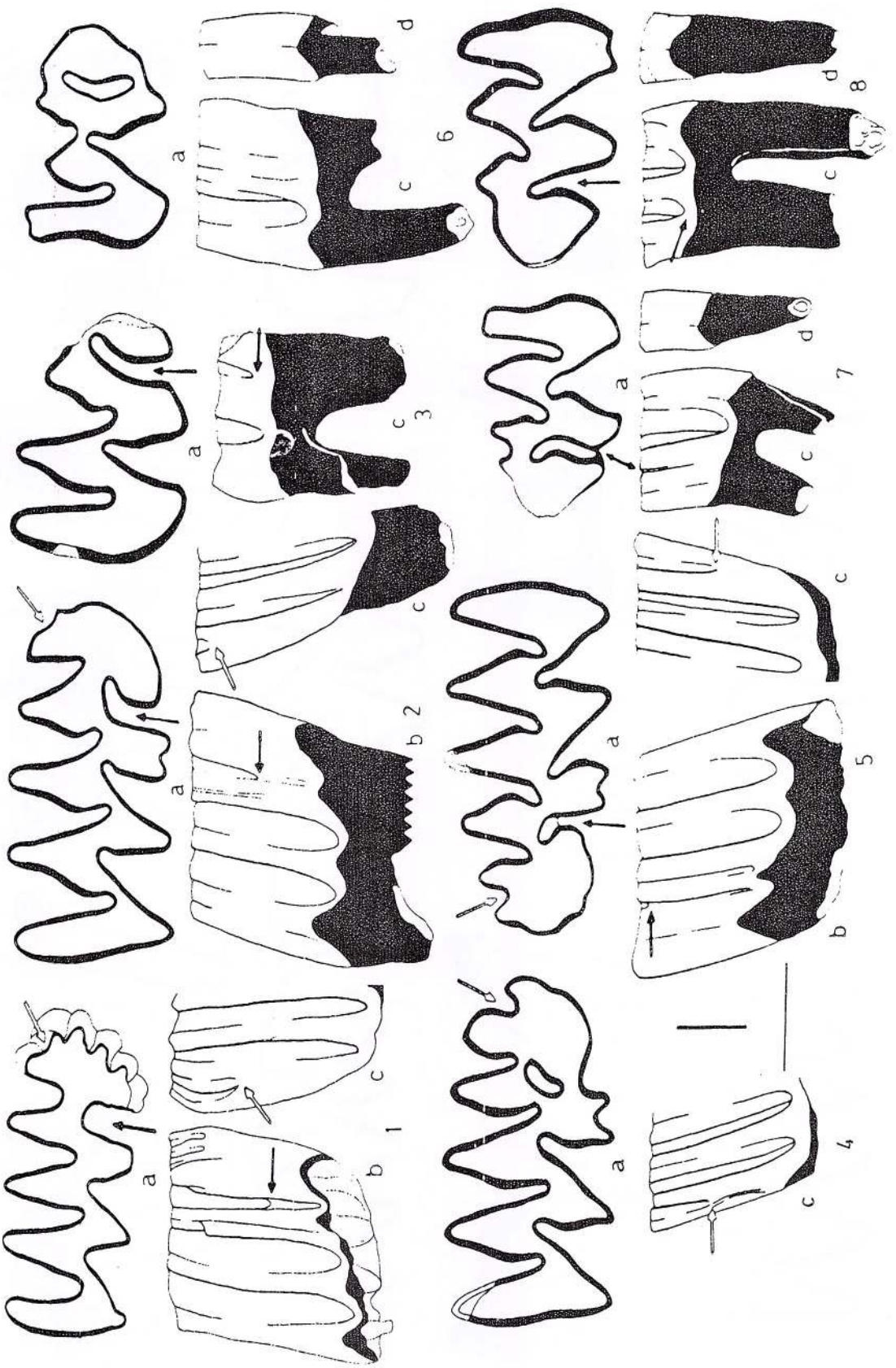


Fig. 3. *Mimomys rhabonensis*: 1 - R M/1(Dr-0). *M. rhabonensis / Dolomys* (stage 1): 2 - R M/1, 3 - L M3/ (Dr-1). *M. rhabonensis / Dolomys* (stage 2): 4 - R M/1, 5 - L M/1, 6 - L M3/, 7 - R M3/, 8 - R M3/ (Dr-2). a - occlusal, b - external, c - internal, d - posterior views; solid arrow indicates the appearance of the enamel islet, open arrow indicates the presence of a fifth lingual re-entrant angle. Scales equal 1mm.

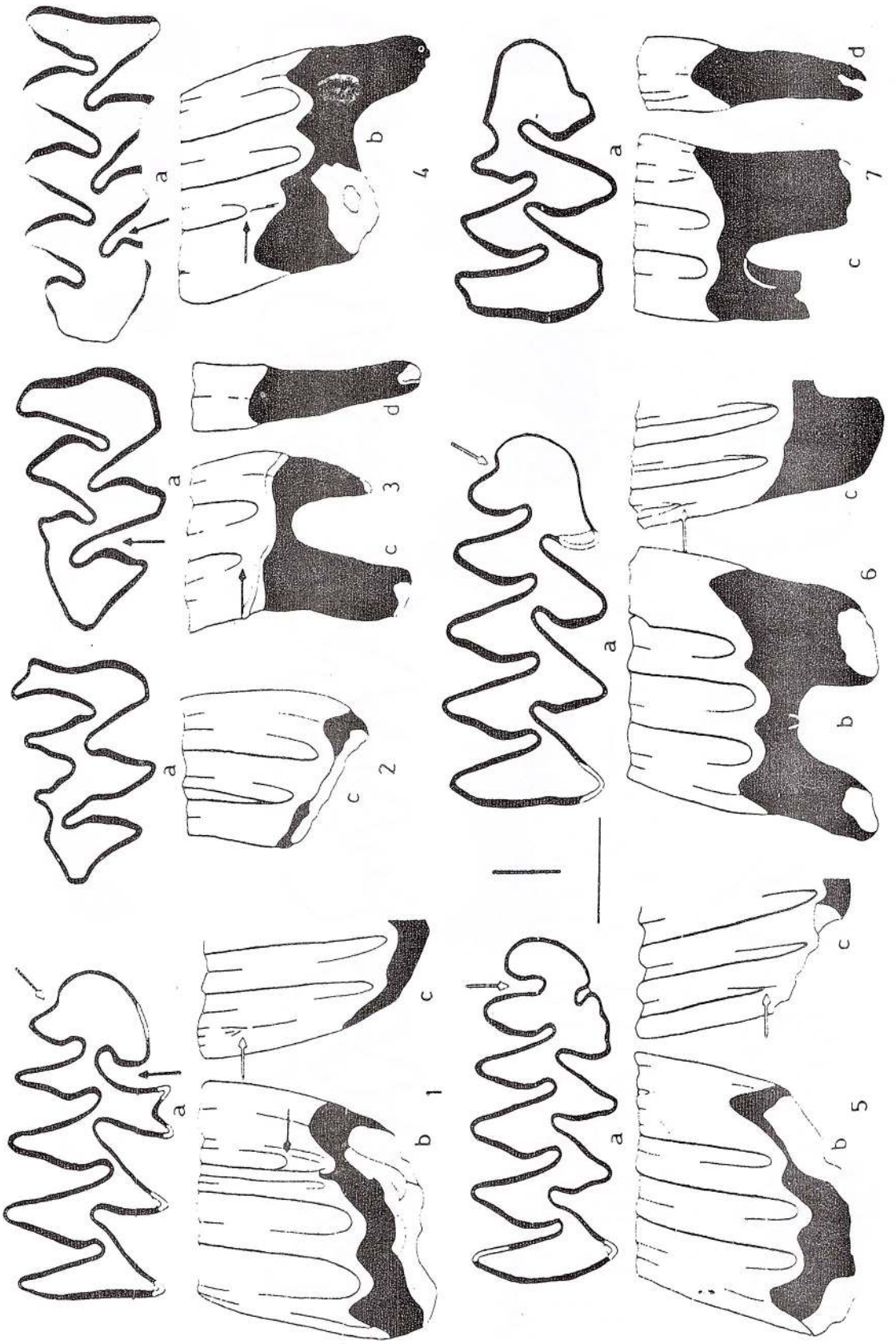


Fig. 4. *M. rhabonensis* / *Dolomys* (stage 3): 1 - R M/1, 2-3 - R M3/ (Dr-3), *Dolomys nehringi*: 4 - L M/1, 5-6 - R M/1, 7 - L M3/ (Pd.). Legend (see Fig. 3)

praeminutus KRETZOI, *Trilophomys* sp., *Mimomys rhabonensis* gr. / *Dolomys* (stage 2), *M. moldavicus* gr. / *Propliomys* (stage 2).

Remarks on micromammals - It is worth noting the appearance of species of genera *Galemys* and *Deinsdorfia* showing a diversification of insectivores. Occurrence of a small-sized murid *Micromys praeminutus*. The two arvicolid phyletic lineages discussed above are distinguished by more marked morphological features (e.g. the large-sized form possesses a supplementary re-entrant lingual angle in M/1) and frequently M3/ is of dolomyian type); the middle-sized *Mimomys* specimens appear transitional to *Propliomys*.

Mollusca - the species identified in the two levels associated with micromammals belong to the NSM 10b subzone. We mention the occurrence at Dr-2 of *Psilunio sanderbergeri* (NEUM.) (Andreescu 1982, Enciu & Andreescu 1990) which appears to characterize the second part of the Late Gilbert subchron as shown by investigations carried out in the south of the Republic of Moldova (Nikiforova et al. 1986).

Paleomagnetic data - Both lines of evidence (mollusca and micromammals) indicate a location of Dr-2 within the second half of the Late Gilbert subchron.

Correlations - According to the morphology of the two arvicolid phyletic lines, Dr-2 may be situated wihtin the MN 15b subzone. Compared with M/1 and M3/ in *Mimomys occitanus* THALER from Sète (France)(MN 15b), the homologous specimens of *M. rhabonensis* gr. show a similar evolutionary stage as regards linea sinuosa. In our opinion, Dr-2 corresponds to a time interval toward the end of the Late Gilbert subchron. The Lucheshti horizon (Kuchurgan superhorizon), containing micromammals characteristic of the Moldavian faunal complex of Eastern Europe appears to be an equivalent of the Dr-2 fauna. The micromammals of karst deposits from Weze (Poland) seems to be somewhat later than Dr-2.

Early Middle Romanian (Pelendavian)

Drănic - 3 (code Dr-3)

The uppermost fossiliferous level of the sequence of deposits discussed above yielded micromammalian remains in association with a molluscan fauna including a number of sculptured unionids which indicate the beginning of the Middle Romanian (Andreescu 1982, Enciu & Andreescu 1990).

The micromammals are represented by the following species: *Deinsdorfia* cf. *kordosi, Blarinoides mariae, Castor praefiber, Zamolxifiber* cf. *covurluiensis, Apodemus dominans, M. rhabonensis* gr. / *Dolomys nehringi* (stage 3), *M. moldavicus* gr. / *Propliomys hungaricus* (poorly documented).

Remarks on micromammals - Although the number of specimens is relatively reduced, the phyletic lineage leading from *M. rhabonensis* to *D. nehringi* is distinguished by a dominance of *Dolomys* morphotype, especially in M3/ which is better documented (morphological stage 3) (Fig. 4, 2-3).

Mollusca - Judging by the new material collected, the Dr-3 molluscan fauna appears to represent the base of the NSM 11a subzone - *Rugunio lenticularis* (SABBA) / *Rytia brandzae* SABBA (Andreescu 1982, Rădulescu et al. 1990 a,b).

Correlations - The Dr-3 fauna seems to span the Gilbert/Gauss boundary which marks the transition from the Early to Middle Romanian (Andreescu 1982). The boundary between these two paleomagnetic epochs was registered in the upper part of the Lucheshti horizon in the biostratigraphic scheme of Eastern Europe on the basis of studies carried out in the Republic of Moldova (Nikiforova et al. 1986). According to the above biostratigraphic scheme, the first sculptured unionids were found in the Kishlitsa horizon which corresponds to the beginning of the Gauss magnetic epoch.

MIDDLE ROMANIAN (PELENDAVIAN) AT PODARI

The exposure at Podari, owing to its very rich molluscan faunas was included (14-th Stop, Fig.15) in the Excursion **B2** (post-Congress) (UPPER NEOGENE FROM THE DACIC BASIN).

The presence of micromammals at Podari was mentioned by Feru et al. (1979). Intensive fossil collecting by paleontological team of the Speological Institute has confirmed the occurrence of a unique fossil level containing an unusually rich small mammal fauna associated with abundant molluscan species (Rădulescu et al. 1993 a, b)

The studied exposure, about 20 m thick, is situated on the right side of the Jiu River, representing a disused local sand pit.

STRATIGRAPHY

The basal part of the sequence of deposits in no more exposed, but it consisted of graysh-bluish clay overlain by an erosive sequence of sands (approximately 14 m thick) intercalated with cross-bedded gravels (Bandrabur 1971, Feru et al. 1979). The higher part of this latter sequence is still available for examination, being constituted of middle to coarse sands including numerous shells of *Viviparidae.* An upper premolar of a deer (*Cervidae* g. et sp. indet.) was found in this succession of sandy deposits.

The overlying sediments consist of a series of clays and sandy clays, 5-6 m thick, including a level with very numerous molluscan remains. The same level, as already mentioned, yielded the richest Pliocene micromammalian association of the Dacic Basin. The fossiliferous level presents considerable lateral variation not only in sedimentology, but also in the frequency of molluscan species. At the entrance of the pit (south-southwest), the fossiliferous level contains predominantly lamellibranchiates in a sandy-clayey matrix, whereas in the opposite direction (north-east), specimens of gastropods *(Viviparidae)* become more frequent, included in a sandy sediment (containing sometimes polyhedric pebbles).

PALEONTOLOGY

Micromammals - The list of species includes nine insectivores, nine rodents and one ochotonid lagomorph: *Mioechinus* sp. *Desmaninae* indet. (very large-sized form), *Galemys kormosi* (SCHREUDER), *Desmanella* sp., *Sorex minutus* LINNAEUS-group, *Petenyiella gracilis* (PETÉNYI), *Beremendia fissidens* KORMOS, *Blarinoides mariae, Talpa* sp., *Trogontherium* cf. *minus* NEWTON, *Driomymus eliomyoides* KRETZOI, *Pliospalax* ex gr. *macoveii* (SIMIONESCU), *Apodemus dominans, Orientalomys* cf. *similis* (ARGYROPOULO & TOPACHEVSKY), *Micromys praeminutus, Dolomys nehringi*, *Propliomys hungaricus* (KORMOS), *Pliomys* sp., *Ochotonoides* sp.

Remarks on micromammals - The faunal association is distinguished by a marked specific diversity .The micromammals include forms with southern (*Desmanella* sp.) and/or southeastern affinities (*Pliospalax, Orientalomys*). It is worth noting the absence of representatives of the genus *Mimomys.* The dominant species among arvicolids is *D. nehringi,* followed by *P. hungaricus* and *Pliomys* sp.

The southeastern Mediterranean influence in the Podari fauna suggests the occurrence of a warm-temperate interval at the end of the Middle Gauss subchron.

Molluscan fauna - The molluscs associated with mammalian remains are characteristic of the NSM $_{11}$ - *Rugunio lenticularis* - zone, MNS $_{11c}$ - *Rytia bieltzi* subzone (Andreescu 1982).

Paleomagnetic data - The determination of paleomagnetic polarity (undertaken by Dr. V. M. Trubikhin, Moscow) indicated a reversed polarity for the clays at the base of the outcrops and a normal polarity for the overlying sands. Judging by the evolutionary stage of the arvicolid species, the episode documented at Podari may correspond to the Middle Gauss subchron (3.22 -3.11 M.Y.).

Correlations - Although the age of the Podari fauna requires further studies, the fossiliferous level with micromammals can be situated within the MN 16a subzone (equivalent for the most part of the Csarnotian of Hungary). Dental morphology of arvicolid species suggests that Podari is somewhat later than Csarnóta - 2 (Hungary) (Kretzoi 1962). The Tourkobounia - 1 fauna (Greece) (de Bruijn & van der Meulen 1975), including *Mimomys* molars with cement, can be referred to the beginning of the MN 16b subzone, postdating the Podari small mammal association.

REFERENCES

Andreescu I. (1971) Contribuţii la stratigrafia Dacianului şi Romanianului din zona de curbură a Carpaţilor Orientali. *D.S. Inst. Geol.*, LVIII / 4: 131 - 155, Bucureşti.

- **(1981)** Middle-Upper Neogene and Early Quaternary chronostratigraphy from the Dacic Basin and correlations with the neighbouring areas. *Ann. Géol. Pays Hellén.*, H. Ser., 4: 129 - 138. Athens.

- **, Rădulescu C., Samson P., Tschepalyga A., Troubikhine V. M. (1981)** Chronologie (Mollusques, Mammifères, Paléomagnétisme) des formations plio-pléistocènes de la zone de Slatina (Bassin Dacique) Roumanie. *Trav. Inst. Spéol. "E. Racovitza"*, **20** : 127 - 137, Bucarest.

- **(1982)** Biocronologia şi cronostratigrafia Pliocenului superior şi Pleistocenului inferior din Bazinul Dacic, *An. Univ. Buc. ,Geol.* XXXI, 55 - 66, Bucureşti.

- **, Ţicleanu N., Pană I.,Pauliuc S., Pelin M., Barus T. (1985)** Stratigraphie des dépôts pliocènes à charbons - Zone est d'Olténie (secteur Olt - Jiu). *An. Univ. Buc.*, XXXIV, 87 - 96, Bucarest.

- **, Rădan S. & Rădan M. (1986)** Magnetostratigraphy of the Dacian - Romanian deposits of the Lupoaia Quarry. *D.S. Inst. Geol. Geofiz.* 70 - 71, 4 (1983 - 1984): 219 - 226, Bucureşti.

Bandrabur T. (1971) Geologia Câmpiei Dunărene dintre Jiu şi Olt. *Inst. Geol. St. Tehn. Econ.*, J, 9: 1 - 146, Bucureşti.

Bruijn, H. de & Meulen A. J. van der (1975) The Early Pleistocene Rodents from Tourkobounia I (Athens, Greece). *Kon. Ned. Acad. Wetensch., Proc.*, Ser. B, 78, 314 - 338, Amsterdam.

Cande S. C. & Kent D. V. (1992) A New Geomagnetic Polarity Time Scale for the Late Cretaceous and Cenozoic. *J. Geophys. Research*, 97, B 10 : 13917 - 13951, La Jolla, California.

- **& Kent D. V. (preprint)** Revised calibration of the Geomagnetic polarity scale for the Late Cretaceous and Cenozoic. *J. Geophys. Research* (9 p.), La Jolla, California.

Cârâc D. (1959) Zăcămintele de lignit dintre Motru şi Coşuştea. *Com. Geol., St. Tehn. Econ.*, A / 4, 11 - 54, Bucureşti.

Cita M. B., Rio D. & Sprovieri R. (preprint) The Pliocen Series: Chronology of the type Mediterranean record and standard Chronostratigraphy. *Palinology* (27 p.).

Chaline J. (1974) Un nouveau critère d'étude des Mimomys et les raports de Mimomys occitanus - Mimomys stehlini et de Mimomys polonicus (Arvicolidae, Rodentia). *Acta zool. cracov.* 19, 16: 337 - 355, Kraków.

Enciu P. & Andreescu I. (1990) Stratigraphy of the Pliocene - Pleistocene deposits in the south-western part of the Dacic Basin (Jiu - Desnăţui sector). *D.S. Inst. Geol. Geofiz.*, 74, 4 (1987) : 141 - 156, Bucureşti.

- **, Crăciun P. (1994)** Hydrogeochemical Characteristics of the Pliocene - Quaternary Formations of South - Western Oltenia and their vulnerability to pollution. *Proceedings of the International Hydrogeological Symposium*, 186 - 195, Bucharest University Press.

- **, Macaleţ R., Pătruţoiu I., Macaleţ V. (1994)** Contribuţii la cunoaşterea geologiei formaţiunilor pliocene din sudul Câmpiei Olteniei. *Inst. Geol. Rom., Journal of Stratigraphy*, 76, 85 - 93, Bucureşti.

Fejfar O. (1966) Die plio-pleistozänen Wirbeltierfaunen von Hajnacka und Ivanovce (Sowakei), CSSR V. Allosorex stenodus n.g. n.sp. aus Ivanovce *A. N. Jb. Geol. Paläont. Abh.*, 123, 3: 221 - 248, Stuttgart.

- **, Heinrich W.-D. & Heintz E. (1990)** Neues aus dem Villafranchium von Hajnacka bei Filatovo (Slowakei, CSSR). *Quartärpal.*, 8: 47 - 70, Berlin.

Feru M., Rădulescu C. & Samson P. (1978) Biostratigraphie (Micromammifères) des dépôts plio-pléistocènes de la zone de Slatina (dép. d'Olt). *Trav. Inst. Spéol. "E. Racovitza"*, **17**: 117 - 134, Bucureşti.

- , **Rădulescu C. & Samson P. (1979)** Biostratigraphie (Micromammifères) des dépôts plio-pléistocènes du domaine gétique de la Dépression valaque. *Trav. Inst. Spéol."E. Racovitza"*, **18**: 141 - 169, Bucureşti.

- , **Rădulescu C. & Samson P. (1983)** Succession des Mammifères plio - pléistocènes dans le Bassin dacique (Roumanie). *An. Inst. Geol. Geofiz.*, **59**: 161 - 168, Bucureşti.

Gabunia L.K., Vekua A.K. & Alexeeva L.I. (1986) Pliocene terrestrial theriocomplexes of the Black - Caspian region. *The continental Upper Pliocene of the Black - Caspian region (in Russian). Acad. Sc. USSR, Geol. Inst.* : 90 - 106, Moskow.

Hilgen F.J. (1991) Extension of the astronomically calibrated (polarity) time scale to the Miocene / Pliocene boundary. *Earth Planet. Sci. Lett.*, **107**: 349 - 368, Amsterdam.

Jipa D. (1994) Studiul fenomenului de sedimentare laterală după exemple din Carpaţii Româneşti. *Rezumatul tezei de doctorat*, 18 p., Univ. Bucureşti.

Kormos T. (1932) Neue pliozäne Nagetiere aus der Moldau. *Palaeont. Z.*, **14**, 3, 193 - 200, Berlin.

Kretzoi M. (1962) Fauna und Faunenhorizont von Csarnóta. *Jbr. ung. Geol. Anst.* (1959): 297 - 395, Budapest.

Lubenescu V. (1985) Viviparidae du Bassin Dacique. *Mémoires*, XXXII, 77 - 127, Inst. Geol., Bucarest.

Marinescu F. & Marinescu J. (1962) Încercări de orizontare a Tortonianului dintre Dunăre şi valea Coşuştea (Oltenia de V). *D. S. Com. Geol.*, **47** (1959 - 1960); Bucureşti.

- **(1978)** Stratigrafia Neogenului superior din sectorul vestic al Bazinului Dacic. *Ed. Acad. RSR*, 1-155, Bucureşti.

Mein P. (1975) Résultats du Groupe de Travail des Vertébrés: Biozonation du Néogène méditerranéen à partir des Mammifères. *Senes J. (Ed.), Report on Activity of the RCMNS Working Groups* (1971 - 1975): 78 - 81, Bratislava.

- **(1990)** Updating of the MN Zones, in: Lindsay R.H. et al. (Eds.), *European Neogene Mammal Chronology*. Plenum Press: 73 - 90, New York.

Meulen van der A.J. & Kolfschoten van T. (1988) Review of the Late Turolian to Early Biharian mammal faunas from Greece and Turkey. *Mem. Soc. Geol. It.*, **31** (1986): 201 - 211, Pisa.

Nikiforova K.V., Alexandrova L.P., Troubikhin V. M. & Tchepalyga A. L. (1986) Correlation of Pliocene and Eopleistocene deposits of the European part of USSR and Romania. *The continental Upper Pliocene of the Black - Caspian region (in Russian). Acad. Sc. USSR, Geol. Inst.* : 5 - 17, Moskow.

Pană I., Enache C. & Andreescu I. (1981) Fauna de moluşte a depozitelor cu ligniţi din Oltenia, *Inst. Cercet. Ing. Tehn. Proiect. Min., I. P. Oltenia*, 1 - 276, Craiova,

Papaianopol I. (1989) L'étude des unionidés du Romanien inférieur de la zone des plis diapirs externes de Muntenia orientale (Bassin Dacique). Mémoires, XXXIV, 5 - 49, Inst. Geol., Bucarest.

Rădulescu C. & Samson P. (1987) Dolomys (Arvicolidae, Rodentia, Mammalia) in the Dacic Basin (Romania), *Trav. Inst. Speol. "E. Racovitza"*, **26**: 45 - 54, Bucarest.

- **& Samson P. (1989 a)** Contributions to the knowledge of the mammalian faunas from Măluşteni and Bereşti (Romania), Order Rodentia, Family Arvicolidae. *Trav. Inst. Spéol. "E. Racovitza"*, **28**: 43 - 56, Bucarest.

- **& Samson P. (1989 b)** Contributions to the knowledge of the mammalian faunas from Măluşteni and Bereşti (Romania), Order Insectivora, Family Talpidae. *Misc. Speol. Rom.*,**1**: 303 - 311, Bucureşti.

- , **Samson P. & Ştiucă E. (1989)** Pliocene (Lower Romanian) micromammals in the Dacic Basin. *Misc. Speol. Rom.*, **1**: 313 - 326, Bucureşti.

- , **Samson P., Ştiucă E., Enciu P. & Popescu A. (1993 a)** New fossil mammal associations of the Jiu valley. A contribution to the Early and Early Late Pliocene biostratigraphy of the Dacic Basin, Romania. *Trav. Inst. Speol. "E. Racovitza"*, **32**: 95 - 105, Bucarest.

, **Samson P., Ştiucă E., Enciu P. & Popescu A. (1993 b)** Sur la découverte de nouvelles associations de micromammifères dans le Pliocène d'Oltenie. Implications paléobiogéographiques. *An. Univ. Bucureşti, Geol.*, **42**: 69 - 78, Bucureşti.

Rzebik - Kowalska B. (1971) The Pliocene and Pleistocene Insectivores (Mammalia) of Poland, I. Erinaceidae and Desmaninae. *Acta zool. cracow.* **14**, 9: 435 - 461, Kraków.

Samson P.-M. & Rădulesco C. (1973) Les faunes de micromamifères et la limite Pliocène - Pléistocène en Roumanie. *Trav. Inst. Spéol. "Emile Racovitza"* **12**: 191 - 228, Bucarest.

Sen S. (1977) La faune de Rongeurs pliocènes de Calta (Ankara, Turquie). *Bull. Mus. Nat. Hist. Nat.*, 3e ser. n. 465, *Sciences de la Terre*, **61**, 89 - 171, Paris.

Shackleton N. J. & Opdyke N.D. (1977) Oxygen-isotope and palaeomagnetic evidence for early Northern Hemisphere glaciation. *Nature*, V. 270. No. 5634, 216 - 219.

- , **Hall M.A. & Pate D. (preprint)** Pliocene stable isotope stratigraphy of site 846. *Proc. ODP*, 138, 2 (42 p.).

Schevchenko A.I. (1965) - Key complexes of small mammals from Pliocene and Lower Anthropogen in the South - Western part of the Russian plain. *Stratigraphic importance of small mammalian anthropogen fauna, Acad. Sc. USSR, Geol. Inst.*, 7 - 59, Moscow.

Simionescu I. (1930) Vertebratele pliocene de la Măluşteni (Covurlui) (in Romanian). *Acad. Rom., Publ. Fond. "Vasile Adamachi"*, **9**, 49: 1 - 69, Bucureşti.

- **(1932)** Les Vertébrés pliocènes de Bereşti. *Bull. Soc. Roum. Géol.* 1: 215 - 228, Bucureşti.

Terzea E. & Boroneanţ V. (1979) Découvertes d'une faune de Mammifères Pliocènes á Ciuperceni (dép. de Teleorman). Remarques sur deux espèces inconnues en Roumanie. *Trav. Inst. Spéol. "Emile Racovitza"*, **18**, 171 - 184, Bucureşti.

- **(1981)** Remarques sur la biostratigraphie du Pliocène du sud de la Plaine Roumaine (zone de Turnu - Măgurele). *Trav. Inst. Speol. "Emile Racovitza"*, **20**, 113 - 126, Bucarest.

Translation and language review by:
Adriana Năstase
Costin Rădulescu

Editorial Staff:
Gabriela Ioane
Viorel Horoi
Emanoil Ştiucă

Illustration:
Paraschiv Toader