Quaternary International 284 (2013) 15–29

Contents lists available at SciVerse ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

New developments in the Upper Pliocene–Pleistocene stratigraphic units of the Dacian Basin (Eastern Paratethys), Romania

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ARTICLE INFO

Article history:
Available online 9 February 2012

ABSTRACT

As a result of multidisciplinary investigations carried out, in the last two decades, the knowledge of the Pliocene and Quaternary stratigraphy from Dacian Basin has increased considerably. New lithostratigraphic units were revealed, for example: Trajkovo Fm (Romanian), Vlădeni Fm, Vânători Fm (Pleistocene), and other units have been reassessed: Izvoarele Fm, Tuluceşti Fm (Romanian). A new biozonation based on molluscan fauna from the Late Pliocene (*NSM11*, *NSM12*) and Pleistocene (*QM1-QM9*) deposits made possible a more accurate subdivision and cronostratigraphical assignments and correlations. Many localities with Romanian mammal associations (Lupoaia, Drănic, Podari, Tetoiu, Leu etc.) were reviewed, adding new taxa in the faunal list, with implications for accurately establishing host deposit ages. These studies, together with bio-magnetostratigraphic investigations led to revision of the Romanian Stage boundaries and subdivisions (Pelendavian, Valahian) and to outline several new Pleistocene chronostratigraphic units: the Argedavian, Dinogetian, Ilfovian stages and Milcovian, Uzunian, Netindavian, Musaisian substages. Finally, one major achievement consisted in the Pliocene/Pleistocene boundary relocation in the Dacian Basin, in agreement with its new position at ~2.6 Ma in the Mediterranean realm.

1. Introduction

The western sector of the eastern Paratethys, in Sarmatian, has been represented by three main gulfs: Volhynian, Dacian and Thracian. Both the Volhynian and Thracian gulfs disappeared at the end of the Sarmatian (Andreescu, 1984).

Bordered to the north by the Carpathian and to the south by the Balkan orogenic structures, the Dacian Gulf represented in the Sarmatian-Pleistocene time span one of the most spectacular and interesting sedimentation area of the Paratethys. The uniqueness of the Dacian Gulf consisted, first of all, in its superposition on several major structural units, respectively: southwestern area of the East-European Platform; the Eastern Carpathians (the intramountainous Comăneşti Basin); northwestern area of the Scythian Platform; the northwestern dippiest part of the North Dobrogea Orogene; the Carpathian Foredeep (including both Walachian and Getic depressions); Pre-Balkans Foredeep and Moesian Platform. The fingerprint of this structural diversity can be observed in the physiography, as a result of tectonic and sedimentary evolution started in the Sarmatian.

Another peculiarity of the Dacian Gulf was its function as "intermittent passageway" between the Euxinian and Pannonian basins, with major consequences on the three Paratethys basins' paleogeography, including the distribution of terrestrial and aquatic biota. This gulf linking the Central and Eastern Paratethys acted as a distinct sedimentary basin. In the Pliocene, the Dacian Basin was the western branch of the Eastern Paratethys, while the Pannonian Basin was the still remaining Central Paratethys (Fig. 1).

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doi:10.1016/j.quaint.2012.02.009

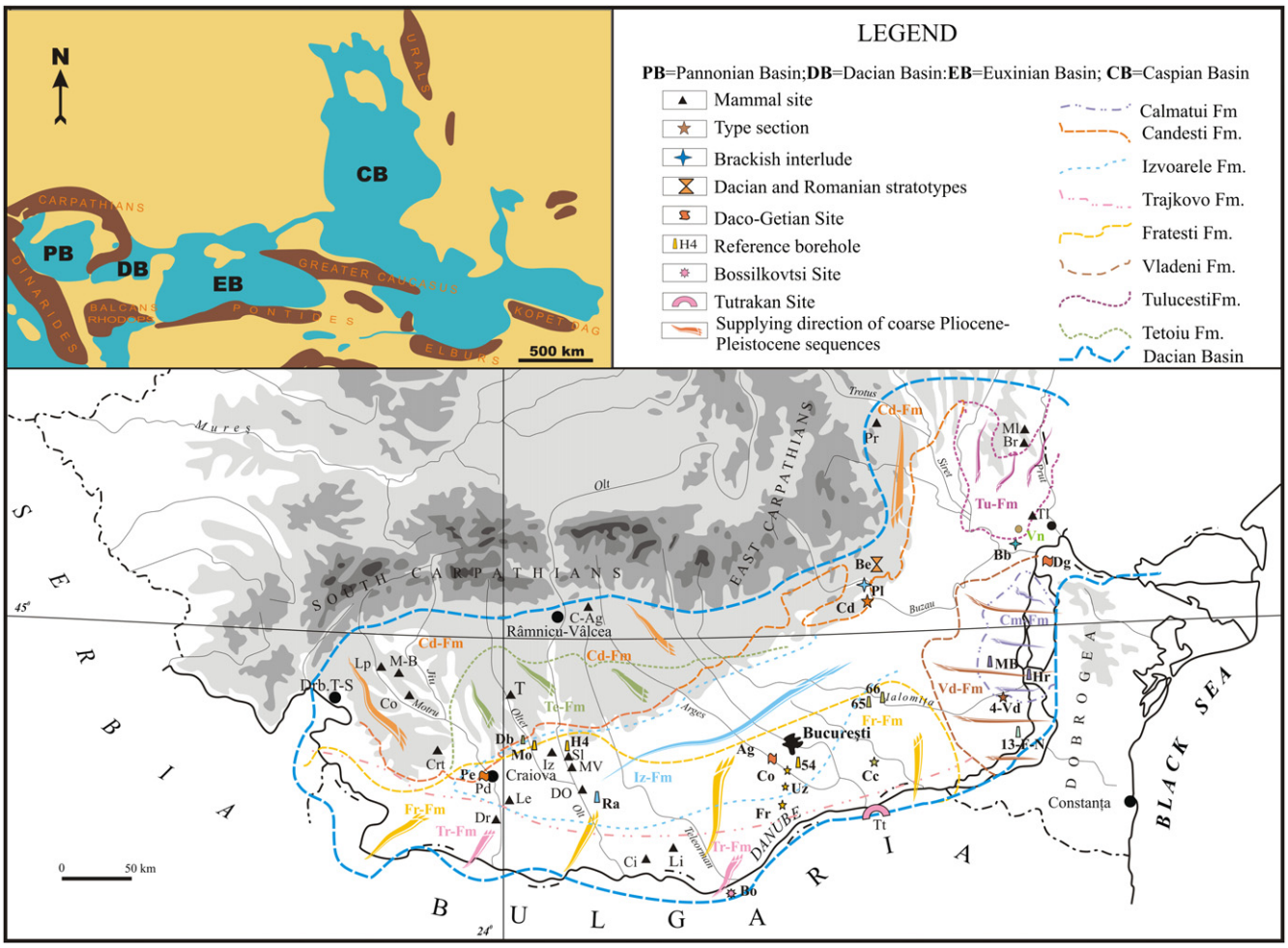

Fig. 1. The Dacian Basin in the frame of the Paratethys realm during the Romanian-Pleistocene. Explanations: PB = Pannonian Basin (Romanian Age); DB = Dacian Basin (Romanian-Pleistocene); EB = Euxinian Basin (Kujalnikian Age); CB = Caspian Basin (Akchagylian Age). Abbreviated Mammal sites in the Dacian Basin: Br = Beresti; Bo = Bossilkovtsi; C–Ag = Curtea de Arges; Ci = Ciuperceni; Co = Covrigi; Crt = Cernătesti; DO = Drăgănesti-Olt; Dr = Drănic; Iz = Izvoru; Le = Leu; Li = Lisa; Lp = Lupoaia; M-B = Mătăsari – Brădetu; Ml = Mălusteni; MV = Milcovu din Vale; Pd = Podari; Pr = Pralea; Sl = Slatina; T = Tetoiu; Tl = Tulucesti; Type sections: Bb = Barbosi-Babele Fm; Be = Beceni (Dacian and Romanian stages); Cd = Cândesti; Cd–m = Cândesti Fm; Cm–Fm = Călmătui Fm; Cc = Coconi Fm; Co = Copaceni Site; Fr=Frătesti Site; Fr–Fm = Frătesti Fm; Iz-Fm = Izvoarele Fm; Pl = Plescoi (Pelendavian-Valahian boundary); Te–Fm = Tetoiu Fm; Tr–Fm = Trajkovo Fm; Tt = Tutrakan Site; Tu = Tulucesti Fm; Uz = Uzunian Site; Vd–Fm = Vlădeni Fm; Vd = Vlădeni Site (F4-Vlădeni Borehole); Vn = Vânători Site; Drill sites: Ra = Radomiresti; Db = 63104/1H-Dobretu; 13-F-N = 13-Fetesti-North; H4 = H4-Slatina; 54 = 68901/54-Berceni; 65 = H65-Fierbinti; 66 = H66-Urziceni; Hr = 8521-Hârsova; M-B = 3505-Mihai Bravu; Mo = 60160-Morunglav. *Ancient Daco-Getian sites*: Ag = Argedava Fortress and Capital; Dg = Dinogetia Fortress; Pe = Pelendava Fortress.

2. Geological setting

According to the present status of the Miocene/Pliocene boundary, in the Dacian Basin, the Early Pliocene roughly corresponds to the Dacian Stage (~5.3–3.7 Ma). In this case, the Late Pliocene is represented by the Romanian Stage (Andreescu, 1972, 1981, 1983).

The stratotype sections of both the Dacian and Romanian stages had been established (Andreescu, 1972) in the northeastern Dacian Basin, in the bend zone of the Eastern Carpathians (Fig. 1). Since then, the meaning of the Dacian and Romanian, i.e. their lower and upper boundaries and subdivisions, changed as a result of a significant improvement of the Pliocene paleobiologic data and intensive development of the magnetobiostratigraphic investigations.

It is beyond the aim of this contribution to exhaustively review the development of the Upper Pliocene-Pleistocene litho-bio-chronostratigraphy of the Dacian Basin. More pertinent information on the subject may be found in Andreescu (1972, 1981, 1982, 1983); Andreescu et al. (1981, 1985, 1992a, 1992b, 1993); Ghenea et al. (1982); Alexeeva et al. (1983); Papaianopol et al. (1987, 2003); Enciu (2007). However, some points are:

- two faunal groups, namely molluscs and mammals, are basically involved in the biochronology of the Pliocene-Pleistocene in the Dacian Basin;
- a biochronologic scale based on the Sarmatian-Pleistocene molluscs, including 14 biozones, 12 for the Late Neogene (*NSM1…NSM12*) and two for the Early Pleistocene (*QM1, QM2*), has been proposed (Andreescu, 1981, 1983);
- according to that biozonation, the subzone *NSM8c-Pachydacna mirabilis* and *NSM9-Pachyprionopleura haueri-Pachyprionopleura neumayri* zone are referred to the Dacian, whereas the Romanian included three zones: *NSM10-Viviparus bifarcinatus* (with two subzones: *10a-Jazkoa sturdzai* and *10b-Psilunio sibinensis*); *NSM11-Rugunio lenticularis* (with four subzones: *11a-Rytia brandzai*; *11b-Pristinunio pristinus*; *11c-Rytia bielzi; 11d-Cuneopsidea iconomianus*) and *NSM12-Ebersininaia milcovensis-Rugunio riphaei*, separated also in four subzones:*12a-E. milcovensis-Viviparus turritus*;

12b-Ebersininaia geometrica-Bogatschevia pretamanensis; *12c-Unio kujalnicensis* and *12d-R. riphaei-Bogatschevia tamanensis*, whereas the *QM1-Unio apscheronicus* and *QM2-Bogatschevia sturi* zones occurred in the Early Pleistocene;

- subsequently, during the last 30 years, the status of numerous Pliocene–Pleistocene moluscan key taxa has been revised, and many new important ones have beennoted in the Dacian Basin. These significant gains led to successive revisions of the biochronologic scales (Andreescu, 1983, 2008, 2009a, 2009b; Andreescu et al., 1985, 1992a, 1992b, 1993, 1998). The most recent version of the improved Pliocene-Pleistocene zonation is rendered in Fig. 3.

On the other hand, concerning the Pliocene-Pleistocene mammal faunas, especially those from the central Dacian Basin (Teleorman-Olt interfluve) and western sector (Olt-Jiu interfluve) (Fig. 1), among the notable achievements the following are to be mentioned:

- detection of numerous large and small mammal remains in the southern area of the central part of the Dacian Basin (Terzea and Boroneanţ, 1979; Terzea, 1981, 1997, 2004);
- establishment of a high resolution biostratigraphy of the Pliocene-Pleistocene deposits based on the mammal faunas in the Olt-Jiu-Motru area (Feru et al., 1977, 1978, 1979; Andreescu et al., 1981; Rădulescu and Samson, 1986, 1990, 1995, 2001; Rădulescu et al., 1989, 1993, 1995, 1997, 1999, 2003; Ştiucă et al., 2003, 2004; Popescu, 2004; Enciu, 2007; Codrea and Diaconu, 2007) and correlation with the Late Neogene–Early Quaternary molluscan zones (Fig. 4).

Consequently, the present study has been elaborated based on several significant achievements regarding the upper Pliocene-Pleistocene stratigraphy in Romania, acquired as a result of integrated pluridisciplinary investigations carried out during the last three decades.

3. Material and methods

Referring to the last three decades, the most important investigation fields of the Pliocene–Quaternary included detailed mapping of the already well known, classical sections exposed on both the northern basin sector, i.e. in the Carpathian Foredeep, and southeastern one, namely on the Moesian Platform. The same systematic research program has been applied to the numerous extensive lignite quarries from the western Dacian Basin.

A manifold approach to investigation (macro, micro-faunal, macro, micro-floral, mineralogical, magnetostratigrafic, coal generation etc.) involved thousands of coal and hydrogeological boreholes, drilled especially in the central-southern basin areas, where habitually outcrops are sparse or lacking. A direct consequence of this impressive new data gathering consisted in the application, for the first time in Romania, of the sequential analysis of the Upper Neogene deposits, based essentially on the mechanical cores and geophysical logs. Consequently, between 1990 and 2000, the systems and depositional environments of the Pliocene deposits from the western Dacian Basin were studied. Subsequently, the subtle genetic relationships between the siliciclastic sequences and coal generation factors involved in exploration, exploitation and economic coal use have been emphasized. Development of sedimentogenetic models in the Danube-Motru sector (Andreescu et al., 1992a, 1992b, 1993) allowed their implementation in the western sector of the Dacian Basin (Ţicleanu and Andreescu, 1988; Ţicleanu et al., 1988; Andreescu et al., 1994, 1995, 1996, 1997, 1998; Ţicleanu and Diaconiţa, 1997).

Magnetobiostratigraphic investigations were carried out during 1977–1985, aimed especially at the eastern Dacian Basin (Pospelova and Andreescu, 1977; Andreescu, 1981, 1983; Andreescu et al., 1981; Ghenea et al., 1982; Alexeeva et al., 1983), were subsequently extended (Andreescu et al., 1986; Rădan and Rădan, 1996, 1998; Rădan et al., 1993, 1996; Snel at al., 2006; Enciu, 2007) to the western sector (Olt-Danube). The detailed sampling of the Sarmatian-Romanian rocks for paleomagnetic analyses led to conspicuous paleontological and paleobotanical collections. In addition, numerous mineralogic, petrographic and fine sedimentologic features, related to the outcrops and/or the cores paleomagnetically investigated, were acquired.

4. Results and discussion

The Romanian-Pleistocene deposits of the Dacian Basin, developed in a wide range of sedimentary environments, provide a valuable record reflected in a variety of facies and faunal content. The main Upper Pliocene lithostratigraphic units in the Romanian territory are the following: Jiu-Motru (upper part) and Cândeşti formations, in the western area; Cândeşti and Izvoarele formations in the central area; Râmna (upper part), Cândeşti and Tuluceşti formations in the northeastern and eastern areas; and Trajkovo Fm in the southernmost area of the basin (Fig. 1).

Both the Jiu-Motru Fm (upper part) and the Râmna Fm represent Siensian-Pelendavian typical sequences of fluvial environments, developed in large progradational – aggradational alluvial plains. These formations are not shown in Fig. 1.

The Cândeşti, Trajkovo, and Tuluceşti formations are characterized by consistent, sometimes prevalent presence of rudito-arenitc sequences, reflecting typical, diagnostic alluvial environments. Consequently, those formations represent the proximal and proximal to median Carpathian alluvial fans (Cândeşti Fm) to the north, Balkan-Moesian, to the south (Trajkovo Fm), and those from the East-European and Scythian Platforms (Tuluceşti Fm.). The Izvoarele Fm, accumulated in prevalent fluvial environments, extended in the subsiding area between the Carpathian Foredeep and Moesian Platform (Figs. 1 and 2).

4.1. Romanian lithostratigraphic units

4.1.1. Cândeşti Formation

The Cândeşti Formation ("Cândeşti Beds", Mrazec and Teisseyre, 1901) is developed as a quasi-continuous alluvial train in the northern realm of the Dacian Basin (Fig. 1). Typical development of the Cândeşti Fm is to be found in the eastern basin domain between the Olt River, to the west, and the Siret River, to the east, where its thickness can exceed 2500 m in the Bend Zone of the Eastern Carpathians (Andreescu, 1969).

The type section of the Cândeşti Fm is localized in the Buzău valley near Cândeşti village (Fig. 1). The Cândeşti Fm is made up of thick polycyclic sequences of pebbles, locally indurated, sands, silts and clays. The main sedimentological feature of this unit is the prevalence of coarse clasts (gravel, pebbles) over sand and silt or clay.

No significant mollusc site exists in the type area of the Cândeşti Fm. Owing to its specific depositional environment, the extreme scarcity of the faunal record (molluscs) in the eastern area appears rather normal.

The single mammal site reported in the type area of the Cândeşti Fm is from Pralea 1 (Fig. 1), where Athanasiu and Preda (1928) mentioned *Mammuthus rumanus* (Ştefănescu) and *Stephanorhinus etruscus* (Falconer). Later, Motaş (1956) added "*Mastodon*" sp. and indeterminate Cervidae. To the west, in the Curtea de Argeş area (Fig. 1), a region located in the proximity of the Olt River, the

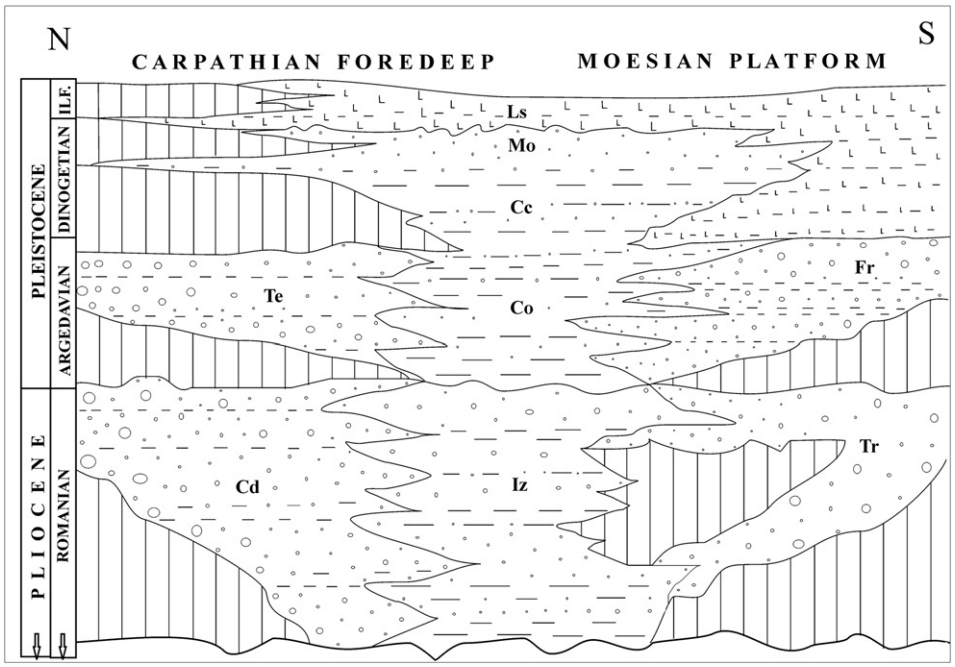

Fig. 2. Suggested relationships among the Romanian-Pleistocene deposits in the central area of the Dacian Basin (Olt-Arges sector) (Cc = Coconi Fm; Cd = Cândesti Fm; Co=Copăceni Beds; Fr = Frătesti Fm; Iz = Izvoarele Fm; Ls = Loess and Loessoid deposits; Mo = Mostistea Fm; Te = Tetoiu Fm; Tr = Trajkovo Fm; ILF = Ilfovian Stage).

Cândeşti Fm reaches a thickness up to 300 m, with significantly more large mammal taxa: *Anancus arvernensis* (Croizet and Jobert), *Zygolophodon borsoni* (Hays), *M. rumanus*, *S. etruscus*, *Hyppotigris stenonis* (Cocchi), *Leptobos* sp. (Mihăilă, 1971).

In the western Dacian Basin, west to the Olt River, the Cândeşti Fm, in spite of its somewhat atypical development (smaller thickness with prevailing sandy and/or small pebbly sequences), has frequently been shown to be rich in fossils, both molluscs and mammals. Consequently, the faunal record of the Cândeşti Fm from Oltenia allowed the elaboration of an accurate biochronologic scale (*NSM11c Subzone* and *NSM12 Zone*) valid for the Late Romanian from the entire Dacian Basin (Pană et al., 1981; Alexeeva et al., 1983; Andreescu, 1981, 1982, 1983, 2008; Andreescu et al., 1981, 1985; Lubenescu et al., 1987; Enciu and Andreescu, 1990; Munteanu, 2006; Enciu, 2007; Andreescu et al., 2010, in press) (Fig. 3).

On the other hand, among the most significant contributions on the various mammal taxa and the biochronologic scale refinement of the investigated mammal sites from Oltenia region, are Feru et al. (1978, 1979); Terzea and Boroneanţ (1979); Terzea (1981, 1997, 2004); Rădulescu, Samson (1986, 1990, 2001); Rădulescu et al. (1993, 1995, 1999), and Stiucă et al. (2003, 2004). According to these authors, both the large and small mammal remains yielded by the Cândeşti Fm in Oltenia, can accurately be referred to the *MN16a Subzone* (Fig. 4), of the Late Romanian, i.e. the Valahian. In addition, numerous Romanian sections have been bio-magnetostratigraphically investigated (Andreescu et al., 1981; Ghenea et al., 1982; Alexeeva et al., 1983; Rădan et al., 1993, 1996; Enciu et al., 1996; Snel et al., 2006; Enciu, 2007; Andreescu, 2008, 2009a, b).

Among the most significant bio-magnetostratigraphic results, those concerning the stratotype Romanian sections at Beceni and Pleşcoi (Fig. 1) are to be noted (Andreescu, 1982, 1983, 2008, 2009a; Ghenea et al., 1982; Alexeeva et al., 1983). In these type sections, the Pelendavian–Valahian biochronologic boundary, represented by the "Pleşcoi Fauna" (Andreescu, 1969, 2008) signifying, *inter alia*, the Akchagylian transgression, has been shown to be coincident with the subchron C2An2n (~3.2 Ma) of the C2An Chron (Gauss Epoch). Another event, of important basinal sedimentogenetic significance, was the Cândeşti Fm initiation, coincident with the C2An1r (=Kaena) – C2An1n boundary (~3.0 Ma in ATNTS-2004).

4.1.2. Trajkovo Formation (herein designated)

This lithostratigraphic unit, developed in the southernmost Dacian Basin, lying on the southern Moesian Platform, represents the counterpart of the Cândeşti Fm from the northern basin area (Figs. 1 and 2). The proposed reference section of this unit is the sand quarry "Chantaluka", 1 km east of the village of Bossilkovtsi (Fig. 1), northern Bulgaria (Markov and Spassov, 2003).

The deposits of this formation are made up of gravels and sandy gravels. They form elongated belts trending south–north, and are remains of the former alluvial fans originating in the Pre-Balkans Plateau. Their maximum thickness, reaching or even exceeding 50–60 m, is recorded in the Timok area. Lower values, between 8 and 12 m are to be found near the Danube.

The fossil record, as in the case of the "typical" Cândeşti Fm, is extremely scarce. The only mollusc site is located in the Tutrakan area (Fig. 1), where Manolescu (1915, *apud* Andreescu, in Pop et al., 1991; Andreescu and Pană, 1996) reported an assemblage originating from sands and silty sands overlying gravel to boulder sequences. This assemblage, with *P. pristinus* (Bielz), *Cyclopotomida munieri* (Sabba), *Psilunio craiovensis* (Tournouer), *Wenziella* sp., *Viviparus turgidus* (Bielz), *Melanopsis* div. sp. etc., is indicative of the Romanian, but is not diagnostic either for the Pelendavian or Valahian.

In various localities, situated both in the northern and southern Danube areas of Trajkovo Fm., there are reported numerous sites bearing large mammal fossils. Assemblages with *Mammut borsoni* and *A. arvernensis*, sometimes recorded together with *M. rumanus*, are found in the sites of Oprişoru-Vest, Cujmir, Calopăr, and Belcin (Bandrabur, 1971; Ghenea, 1977) from southwestern Oltenia, but also in Trajkovo and Bossilkovtsi (Evloghiev et al., 1995; Lister and van Essen, 2003; Markov and Spassov, 2003) from northern

Fig. 3. Revised Pliocene–Pleistocene Mollusc Zonation of the Dacian Basin. (After Andreescu et al., in press: the most significant revisions concerning the Late Pliocene–Pleistocene zonation are the following: 1-the former *NSM$_{11d}$ -Valahunio iconomianus Subzone*, became the second, *NSM$_{12b}$ Subzone*; 2 – the former *NSM$_{12c}$-Unio kujalnicensis* and NSM$_{12d}$-*Bogatschevia tamanensis* subzones, as a result of the Pliocene/Pleistocene boundary relocation, became *QM1* and *QM2* zones respectively; 3 – Pleistocene *QM5-QM9* have been outlined as new zones).

Bulgaria. Several of the mentioned sites, with the *M. rumanus-M. borsoni-A. arvernensis* association, are similar to the Curtea de Argeş (northern basin area) (Mihăilă, 1971), Cernăteşti (western Dacian Basin) (Feru et al., 1983) or Tulucești (eastern Dacian Basin) (Rădulescu and Samson, 1995, 2001) localities (Fig. 1).

4.1.3. Tulucești Formation

The Tulucești Formation (Munteanu, 2006) ("Tulucești Beds", Ghenea, 1968) is located in the easternmost area of the Dacian Basin. In Romania, only restricted outcrops are found in the southern Prut-Siret interfluve (Fig. 1). The sequences of the Tulucești Fm are represented mainly by fine gravels, sands, and sandy clays, 5–7 m thick at the type locality. Tulucești is among the most notable in Paratethys due to the Upper Pliocene mammal assemblage (Athanasiu, 1915; Ghenea and Rădulescu, 1964; Samson and Rădulescu, 1973; Samson, 1975; Rădulescu and Samson, 1995), in which the archaic mammoth "*Elephas antiquus rumanus*" was designated by Stefănescu (1924).

According to Rădulescu et al. (2003) the mammals from Tulucești are referable to the following taxa: *M. borsoni, A. arvernensis, M. rumanus*, *Paracamelus* cf. *kujalnensis* (Khomenko), *Cervus* cf. *perrieri* Croizet and Jobert, and *Allohippus euxinicus* (Ştefănescu). The above named authors and Stiucă et al. (2003) consider the fosiliferous level with *M. rumanus* as an equivalent to Cernăteşti in western Oltenia and to the Skortselskian Complex (Nikiforova et al., 1976) in Moldova Republic.

Paleomagnetically, the Podari mammal locality from Oltenia had been calibrated to the C2An2n and C2An-1r Subchrons of the C2An Chron (middle Gauss epoch) by Ghenea et al. (1982), Alexeeva et al. (1983) and Andreescu (1981, 1982, 1983, 2008, 2009a). By correlation, based on the fossil mammals, the Tulucești is considered an equivalent of Cernăteşti from the western Oltenia which, in turn, has the same geochronologic significance as Podari, corresponding to the ATNTS-2004 to 3.2–3.0 My (Fig. 4). The three mammal sites are placed in the Earliest Valahian.

4.1.4. Izvoarele Formation (Lubenescu et al., 1987, amended)

The sequences of this formation accumulated mainly in fluvial environments, as illustrated by the geophysical logs. In some restricted areas (Olteţ-Teleorman) these deposits could be considered as representing the products of medial-distal Carpathian alluvial channels, as well as Balkano-Moesian ones, at the junction between the Carpathian Foredeep and the Moesian Platform (Figs. 1 and 2). Izvoarele Fm was named by Lubenescu et al. (1987) based on borehole data, without specifying its lower and upper limits and lateral extent.

The mollusc fauna reported includes: *P. pristinus* (Bielz), *Pristinunio davilai* (Porumbaru), *Pelendunio bielzi* (Czekelius), *Psilunio*

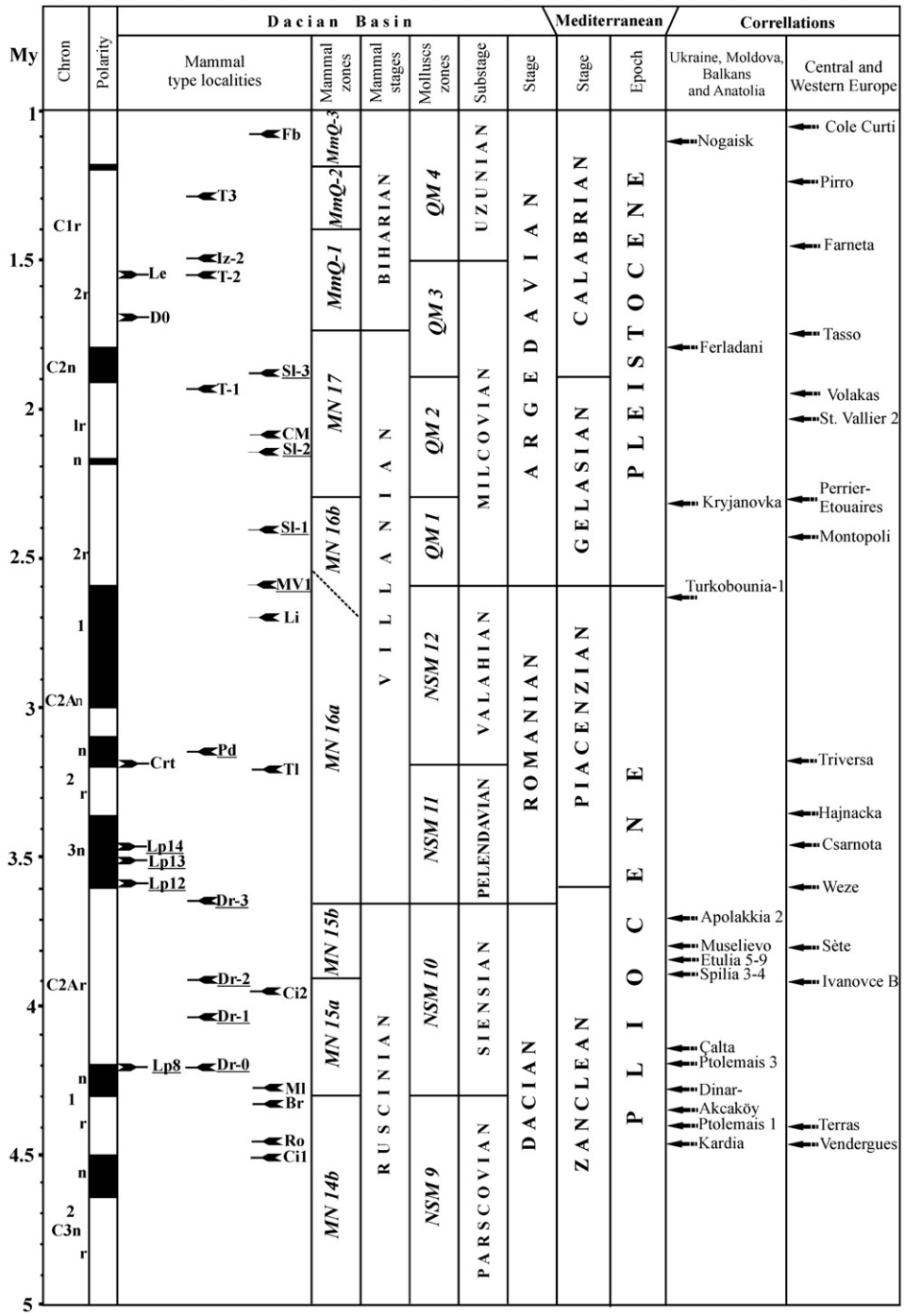

Fig. 4. Dacian Basin. Pliocene–Pleistocene Mammal Localities, Zonation, Age Assignment and Correlations with the Mollusc zones. (Br = Beresti, CM = Cherlestii Mosteni, Ci = Ciuperceni, Crt = Cernătesti, DO = Drăgănesti Olt, Dr = Drănic, Fb = Fierbinti, Iz = Izvoru, Le = Leu, Li = Lisa, Lp = Lupoaia, Ml = Mălusteni, MV = Milcovu din Vale, Pd = Podari, Ro = Rosiori, Sl = Slatina, T = Tetoiu; Underlined sites have been paleomagnetically investigated).

biplicatus (Bielz), *P. craiovensis* (Tournouer), *Rugunio condai* (Porumbaru), *Rugunio turbureensis* (Fontannes), *Rugunio* aff. *mojswari* (Penecke), *Cuneopsidea doljensis* (Sabba), *Pseudohyriopsis problematica* (Cobălcescu), *Anodonta* sp., *Dreissena polymorpha* Pallas, *V. bifarcinatus* (Bielz), *Viviparus stricturatus* (Neumayr), *Viviparus rudis* (Neumayr), *Viviparus strossmayerianus* (Brusina), *Viviparus turgidus* (Bielz), *Viviparus craiovensis* (Tournouer), *Melanopsis bergeroni* Sabba, *Melanopsis pterochilla* Brusina, *M. rumanus* Tournouer, *Melanopsis onusta* Sabba, *Melanopsis soubeirani* Porumbaru, *Melanopsis amaradicus* Fontannes, *Valvata piscinalis* Muller, *Valvata crusitensis* Fontannes, *Bulimus vukotinovici* (Brusina), *Bulimus melanthopsis* (Brusina), *Bulimus oncophorus* (Brusina), and *Planorbis* sp. The fauna does not allow a chronologic subdivision of these deposits, including "clays, sands with coal interbeddings, gravels and sands, apparently unconformably overlying the Parscovian Călineşti Fm" (Lubenescu et al., 1987, p.120). However, based on the above mentioned taxa, this formation could be assigned to either the Pelendavian or Valahian.

In the Radomireşti borehole, the geophysical log (Fig. 5) shows the Izvoarele Fm is a succession of fluvial, transitional cycles

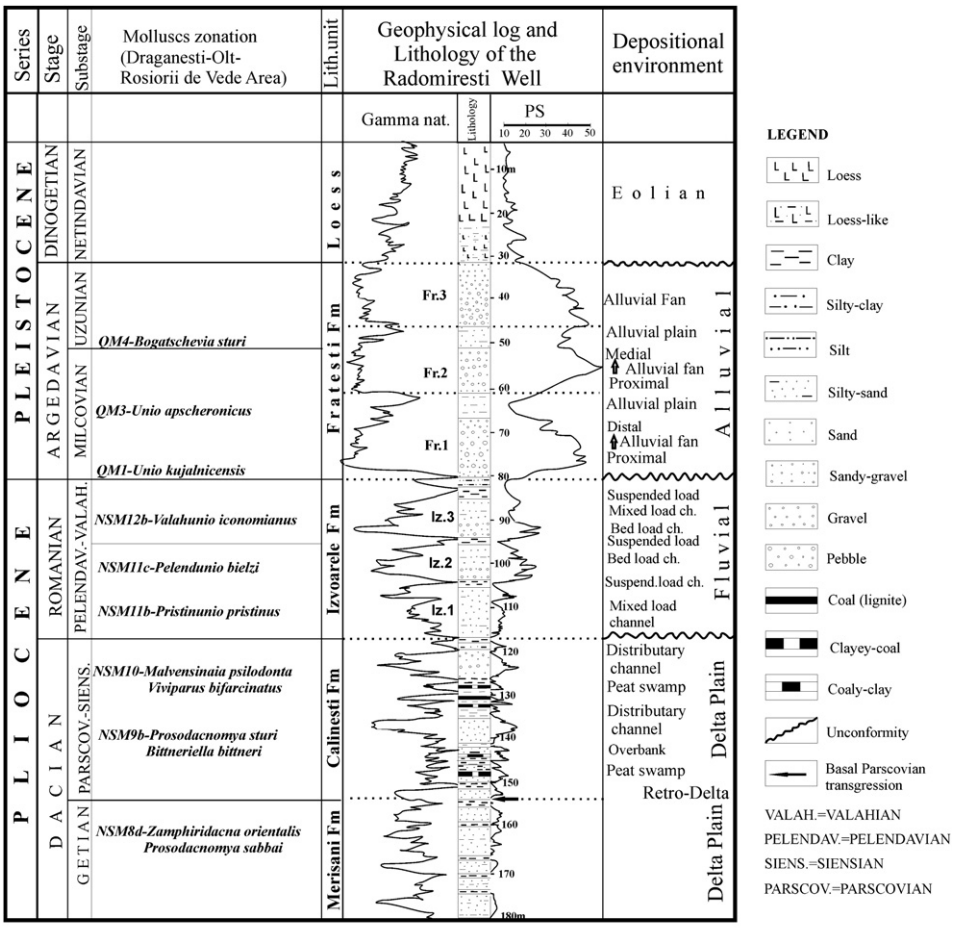

Fig. 5. The stratotype section (in Radomiresti Well), located in the Central Area (Olt-Arges Interfluve) of the Moesian Platform, of the redefined Izvoarele Fm (Iz1, Iz2, Iz3 can be considered as three successive members of the Izvoarele Formation, revealed by the three fluvial cycles; the black arrow is pointing to the basalmost Parscovian transgression).

overlying the Călineşti Fm, which represents sequences developed in the Dacian upper delta environments and the underlying Pleistocene alluvial Frăteşti Fm.

4.2. Pleistocene lithostratigraphic units

The main Pleistocene lithostratigraphic units from the Dacian Basin are the following: Frăteşti Fm; Vlădeni Fm; Tetoiu Fm (Andreescu et al., in press); Coconi Fm (Andreescu et al., in press); Vânători Fm (here defined); Călmăţui Fm (Andreescu et al., in press), Barboşi-Babele Fm; Mostiştea Fm (Andreescu et al., in press); Loess and loess-like deposits; and Alluvial deposits of the Middle–Upper Pleistocene fluvial terraces. The last two units, the Loess and Alluvial deposits, are not discussed in this contribution.

4.2.1. Frăteşti Formation

The Frăteşti Formation ("Frăteşti Beds", Liteanu, 1952) (Figs. 1, 2, 6, 7 and 9) is one of the best known, but also a controversial lithostratigraphic unit from the Dacian Basin. It extends over a large basin surface, spread over the Moesian Platform area.

The lithology and the fossil record come from both outcrops and data supplied by thousands of boreholes drilled in the Romanian Plain. Paradoxically, this advanced stage of knowledge resulted in controversies concerning the age of the "Frăteşti Beds": some authors related them to the Pleistocene (Liteanu, 1952, 1956, 1961; Liteanu and Ghenea, 1966; Liteanu et al., 1967; Bandrabur, 1971; Ghenea et al., 1982; Alexeeva et al., 1983), while others pleaded for Pliocene (Macarovici and Coteţ, 1962), or Late Pliocene and Early–Middle Pleistocene (Feru et al., 1979). However, considering that the mollusc and mammal taxa of the Frăteşti Fm staddle the former Pliocene-Pleistocene boundary (ca. 1.8 Ma), the endless controversies concerning the chronostratigraphic position of this unit become somewhat understandable.

Illustrative in this discussion is the manner in which Andreescu et al. (1981) presented the mollusc and mammal succession from Slatina – Milcovu din Vale-Izvoru, where the Frăteşti Fm. cropped out: two biochrons, then named *NSM12c-U. kujalnicensis* together with the Mammal Site Slatina-1 and *NSM12d-B. tamanensis-R. riphaei* and Slatina-2 Mammal Site, from the lower part of the sections were, according to the paleomagnetic investigations, included in the Pliocene, namely in the Latest Romanian. The Slatina-3 (*QM1-U. apscheronicus*) and Izvoru (*QM2-B. sturi*) sites, located in the upper segment of the Frăteşti Fm, had to be allotted to the Lowermost Pleistocene, in conformity with the paleomagnetic results.

Although the Frăteşti Fm is habitually devoid of fossils, or the shells are very rare and in a bad state of preservation, in places there are numerous well preserved ones: Milcovu din Vale, Clocociov, Slatina, Cherleştii-Moşteni, Izvoru, Uzunu, and Copăceni. Six Pleistocene mollusc zones (*QM1-QM6*) are based on the fossils collected in those sites.

The mammal remains are relatively abundant, especially in the southern and southwestern areas of the Dacian Basin.

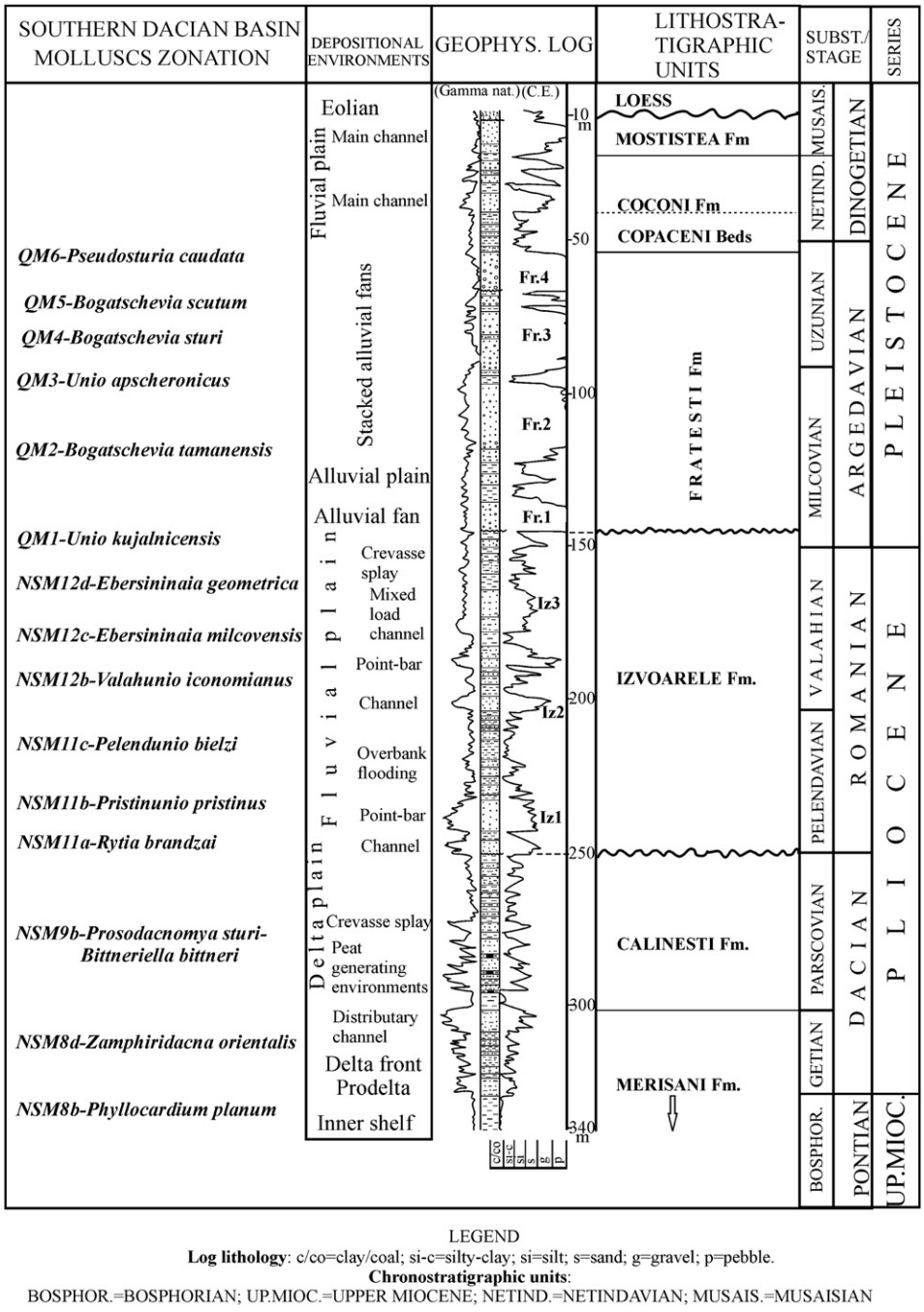

Fig. 6. The Pliocene–Pleistocene formations, their zonation and depositional environments in the borehole 68901/54-Berceni [the site has been established as the Stratotypical Section of the Frătesti Formation (= Frătesti Beds, Liteanu, 1952); Fr1 to Fr4 = Frătesti members; the underlying Izvoarele Fm is well developed in fluvial environments, while the Frătesti Fm represents a succession of stacked alluvial fans; several Romanian and Argedavian Molluscs zones have been imported either from neighbouring areas or Slatina-Milcov sites in the Olt valley region].

Besides the well-known sites, mentioned by various authors (Liteanu and Ghenea, 1966; Bandrabur, 1971; Feru et al., 1979) and those located in the Slatina area (Feru et al., 1978, 1979; Andreescu et al., 1981), an interesting rich large mammal site, Leu, with *Mammuthus meridionalis* (Nesti), *Plesippus athanasiui* Samson, *Stephanorhinus* ex gr. *etruscus*, *Alces gallicus* (Azzaroli), *Leptobos* cf. *furtivus* Duvernoy, *Pliotragus ardeus* (Deperet), *Castor plicidens* Major, *Ursus etruscus* Cuvier, *Cervus* sp. etc., has been reported (Popescu, 2004) south of Craiova (Figs. 1 and 4).

Other characteristic features of the Frăteşti Fm. refer to its major deposional style (stacked alluvial fans), thickness of lithological subdivisions, faunal content, subtle relations with the adjoining underlying and overlying formations and chronostratigraphic assignment, features which are depicted in Figs. 1, 2, 6, 7 and 9. In conclusion, the Frăteşti Fm can be seen as the most interesting Lower Pleistocene (Argedavian) lithostratigraphic unit in the Dacian Basin. Moreover, lying on the Moesian Platform, it could be viewed as a counterpart of the Tetoiu Fm. developed in the Carpathian Foredeep realm.

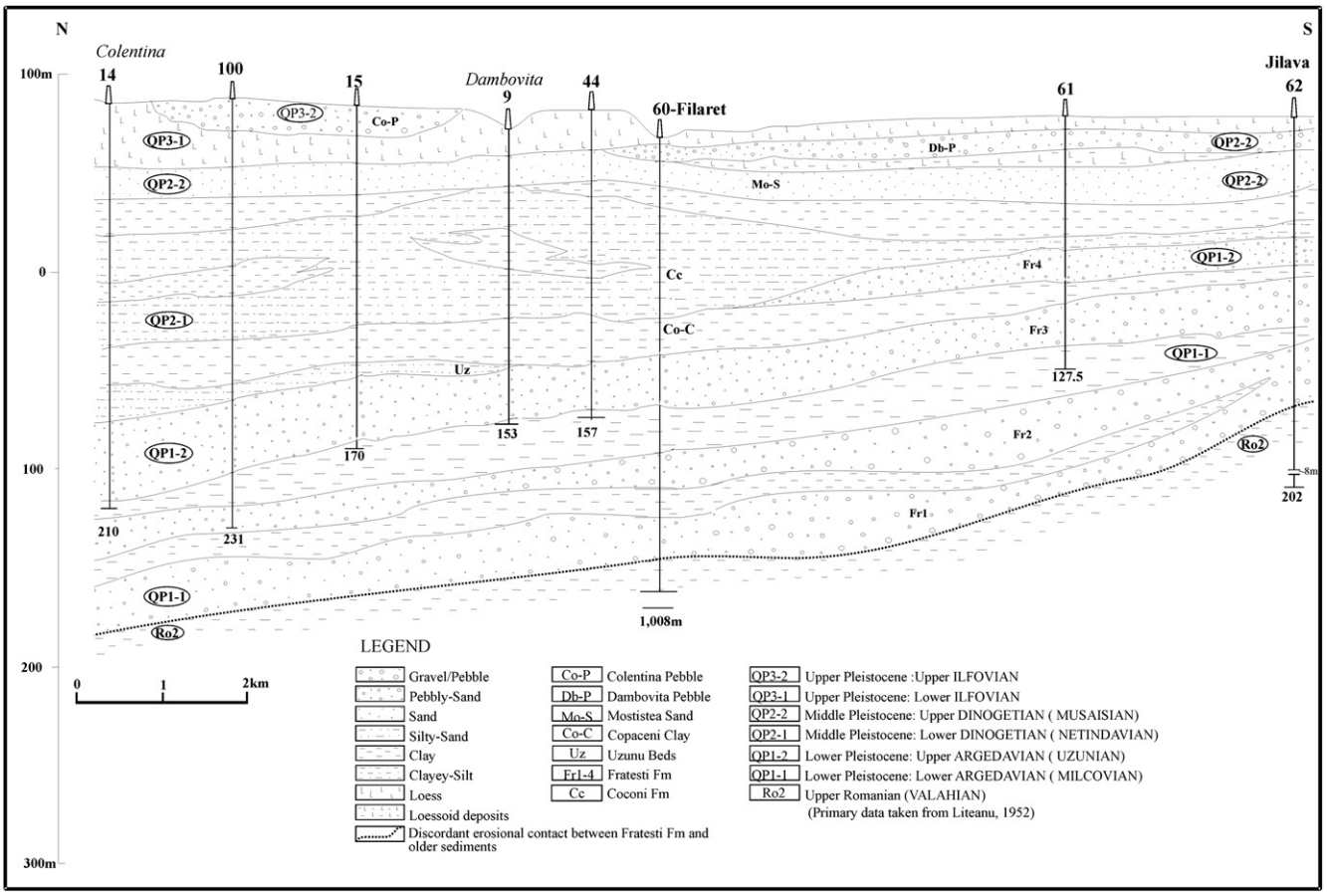

Fig. 7. Litho-facial cross-section showing detailed lithology and relationships among Pleistocene deposits in the Bucharest Area (according to Andreescu et al., in press).

4.2.2. Vlădeni Formation (herein designated)

The basinal extent of this unit can be only estimated, in the eastern area of the Moesian Platform, as it has nowhere been found in outcrop (Fig. 1). The deposits of this formation, represented mostly by pebbles, gravels and sands, grading vertically to sandy silts or silts and silty clays, drilled in the southeastern area of the Dacian Basin, represent alluvial fans, with source areas in South Dobrogea (Figs. 1 and 8). Their usual thickness, rather lower than 30–50 m, increases basinward, to the west and northeast. The type section is the borehole Feteşti-13, plotted in Fig. 8 as "Feteşti-North", where the thickness of the Vlădeni Fm reaches no more than 30 m.

These sequences, habitually devoid of fossils, unconformably overlie Romanian finer terrigenous deposits which in places are richly fossiliferous: *Wenziella subclivosa* (Teisseyre), *Cuneopsidea beyrichi* (Neumayr), *Rugunio mojsvari* (Penecke), *Moldavunio circula* (Andreescu), *Pelendunio* cf. *bielzi* (Czekelius), *Psilunio* ex gr. *acutus* (Neumayr), *Viviparus* div. sp., and *Melanopsis* div. sp., documenting the Pelendavian Substage (Papaianopol et al., 1987). As the Vlădeni Fm is unconformably underlain by sandy-silty-clayey Pelendavian sequences, and is unconformably overlain by the Dinogetian Reddish-Clay (Fig. 8), a Lower Argedavian (Milcovian) age of this unit could be inferred. Therefore, the Vlădeni Fm has to be roughly considered as a lateral equivalent of the Frăteşti Fm, developed in the southeasternmost Dacian Basin.

4.2.3. Tetoiu Formation

The Tetoiu Formation has been described elsewhere (Andreescu et al., in press). It is an equivalent, in the southern-central area of

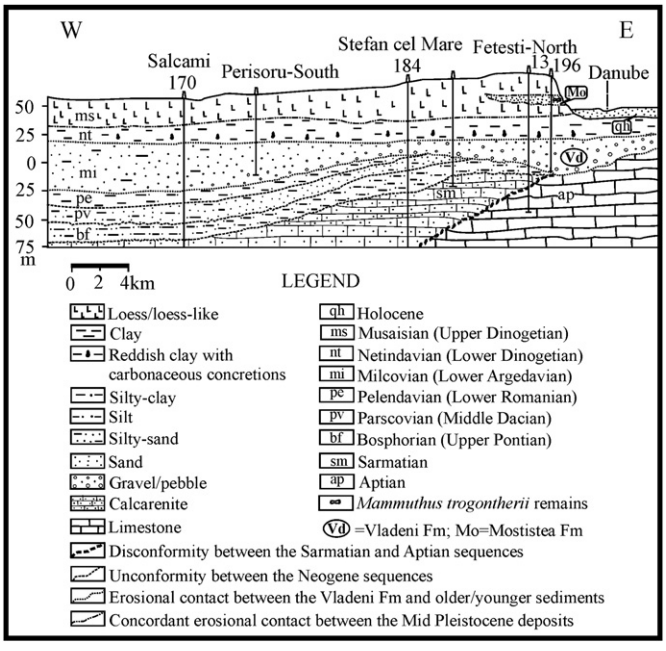

Fig. 8. Litho-facial cross-section showing the relationships among the Neogene-Quaternary deposits in the southeastern Dacian Basin (after Andreescu et al., in press, based on primary data from Papaianopol et al., 1987; Papaianopol, 1993; Enciu, 2007).

the Carpathian Foredeep, of the Frăteşti Fm (Figs. 1 and 2). The sediments, predominantly developed in sandy-pebbly facies, are locally rich in fossil remains, both molluscs (Andreescu et al., 1985; Lubenescu et al., 1986, 1987) and large mammals (Samson and Rădulescu, 1973; Rădulescu and Samson, 1990).

4.2.4. Copăceni Beds (Figs. 2 and 7)

This unit, provisionally here designated as the "Copăceni Beds", may eventually be considered either as a "distinct" formation, or as the lower member of the Coconi Fm. (Figs. 2, 3 and 7). To the north this unit is dominated by fine siliciclasts (clay, silt), and the sandy sequences become rather subordinated. Towards the south the Copăceni Beds interfinger with the sandy-pebbly members of the Frăteşti Fm.

The micromammals found in Copăceni (Fig. 1) are still under study. However, the mollusc taxa, especially the unionids *Pseudosturia caudata* Tschepalyga, *Bogatschevia* cf. *scutum* (Bogaciov), *B. sturi* (Hoernes), *B.* cf. *tamanica* (Jatzko), *Wenziella* ex gr. *wilhelmi* (Penecke), *Potomida ovata* Tschepalyga, *Margaritifera* cf. *arca* Tschepalyga, *Crassiana* cf. *pseudodavilai* Rudiuk, *Unio* cf. *chasaricus* Bogaciov, *U. kujalnicensis* Jatzko, and an extremely abundant microgastropod assemblage (taxa are not yet identified), suggest correlation of this site with the 8th terraces of the Nistru and Prut rivers.

4.2.5. Coconi Formation

The Coconi Formation (Andreescu et al., in press) is equivalent to the "Marly Complex" (Liteanu, 1952) and "Coconi Beds" (Alexeeva et al., 1983). If the Copăceni Beds are to be considered as a formation, *per se*, then the "Marly Complex" has to be seen as the continuously upward development, during the Middle Pleistocene, of the prevailingly clayey-silty sequences in the same area dominated by fluvial plain environments, located in the transition zone between the Carpathian Foredeep, to the north, and the Moesian Platform, to the south (Fig. 2).

The thickness, ranging between 50 and 100 m, is relatively uniform on the whole eastern Romanian Plain. This illustrates an acutely diminishing rate of subsidence during the Middle Pleistocene (Early Dinogetian = Netindavian), in the southeastern area of the Moesian Platform.

4.2.6. Vânători Formation (herein defined) (= Tuluceşti Formation, upper part)

Munteanu (2006), following Macarovici (1960), considered the Tuluceşti Fm as constituted by two members. In the lower one, various types of sands and small pebbles prevail, yielding a relatively rich mollusc fauna: *Psilunio sandbergeri* (Neumayr), *Sibinunio sibinenesis* (Penecke), *Bittneriella stoliczkai* (Neumayr), *Plicatibaphia flabellatiformis* (Gr.-Beresovski), *Viviparus* cf. *turgidus* (Bielz), *V. bifarcinatus* (Bielz), and *Melanopsis* div. sp. etc.

This assemblage underlies the true Tuluceşti Fm, bearing the well-known mammalian remains, whereas in the upper "member", 8–10 m of sands and clays, a completely different mollusc assemblage is present: *U. apscheronicus* (Ali-Zade), *Unio pictorum* Linnaeus, *Unio tumidus* Philipsson, *Didacna crassa* (Eichwald), *Didacna pseudocrassa* Pavlov, *Monodacna pontica* (Eichwald), *D. polymorpha* Pallas, *Corbicula fluminalis* (Muller), *Viviparus sadleri* (Neumayr), *Viviparus altus* (Pavlov), *Viviparus diluvianus* (Kunth), *Viviparus aethiops* (Parrey), *Viviparus istriensis* (Pavlov), *Viviparus romaloi* (Cobălcescu), *Viviparus geticus* (Pavlov), *Fagotia acicularis* (Ferrussac), *Fagotia esperi* (Ferrussac), *Theodoxus danubialis* Pfeiffer, and *Gibbula deversa* Milaschewitsch etc. The above mentioned taxa outline the *QM7-D. crassa-M. pontica* Zone.

The lower 'mollusc association', undoubtedly the *NSM10 Zone* (most probably, *NSM10b Subzone*), points to the Siensian (Late Dacian). Those deposits have been generated in the alluvial plains of fluvial environments. On the other hand, the "Upper Tuluceşti Member" is genetically completely different, its sequences being accumulated in prevailingly freshwater, estuarine environments, with weak brackish influences.

The hiatus between the two "members" of the Tuluceşti Fm spans at least 2.4–2.5 Ma. Having in view the above observations, it is considered more logical to split the Tuluceşti Fm., and designate its former upper member as a new formation, the Vânători Fm. Vânători is a village in the proximity of the Tuluceşti classical site (Fig. 1). The type section of the Vânători Fm is located in an outcrop 400 m south of the Tuluceşti railway station, from where Munteanu (2006, pg. 28) described 9–10 m of sands and clays yielding the above mentioned mollusc fauna. The age of the Vânători Fm, based on the *QM7 Zone*, is Lowermost Middle Pleistocene (Lower Dinogetian = Netindavian Substage) (Fig. 3).

4.2.7. Călmăţui Formation

Călmăţui Formation (Andreescu et al., in press) refers to a succession (50–70 m) of coarse clastic sediments, the "psamo-psephitic complex" of Feru et al. (1977). These deposits, representing typical facies of some alluvial fans originating in the northern and central Dobrogea (Fig. 1), merge westward into the Coconi Fm.

Based on the mammal remains found in two boreholes, in the basal, prevalent sandy member, Feru at al. (1977) assigned the "psamo-psephitic complex" to the Middle Pleistocene, considering it as an equivalent of the Tiraspolian mammal complex (Nikiforova et al., 1976). To the north, according to the borehole data mentioned by Munteanu (2006), the Călmăţui Fm is gradually interfingering with the Vânători Fm, also Lower Dinogetian in age, as shown by the presence of the *QM7-D. crassa-M. pontica Zone*.

4.2.8. Barboşi-Babele Formation

The Barboşi-Babele Formation ("Barboşi-Babele Beds", Macarovici, 1960; "Babele-Barboşi Formation", Enciu, 2007) is a succession of sandy-clayey deposits, reaching a thickness up to 80–90 m, developed in the easternmost area of the Dacian Basin, underlain by the sandy-gravelly sequences of the Tuluceşti Fm. The faunal content is represented, as in the Vânători Fm, by a mixed freshwater and lacustrine fauna: *U. pictorum, U. tumidus, Dreissena polymorha*, *Sphaerium* div. sp., *Corbicula* div. sp., *Pisidium* div. sp., *Viviparus* div. sp., *Melanopsis* div. sp., *Lithoglyphus* div. sp., *Valvata* div. sp., *Theodoxus* div. sp. and brackish estuarine molluscs: *Didacna pontocaspia* Pavlov, *D. pseudocrassa* Pavlov, and *Adacna plicata* (Eichwald) (Macarovici and Coteţ, 1962; Macarovici and Costeţchi, 1973). This fauna, outlining the *QM8-D. pontocaspia-A. plicata Zone* (Fig. 3), correlates with the mollusc fauna yielded by the "Babele Beds" (Macarovici and Costeţchi, 1973), mentioned in the alluvial deposits of the terraces: T5-Kolkotova (Nistru), T5-Pietricica (Prut) and T5-Nagornoe (Danube), Middle Pleistocene in age (~0.5 Ma), representing the Lowermost Musaisian Substage in the Dacian Basin.

4.2.9. Mostiştea Formation

The Mostiştea Formation (Andreescu et al., in press) (Mostiştea Sands, Liteanu, 1952; Mostiştea Beds, Alexeeva et al., 1983) until recently was considered to be generally devoid of any significant molluscan fauna. However, Macarovici and Coteţ (1962) and Munteanu (2006) mentioned *U. pictorum*, *U.* aff. *pictorum, Anodonta* sp., *C. fluminalis*, *Sphaerium corneum* Linnaeus, *Sphaerium subnobilis* Cobălcescu, *Musculum lacustre* Muller, *Viviparus* div. sp., *Lithoglyphus naticoides* Pfeiffer, *T. danubialis*, *Radix ovata* Draparnaud, and *Planorbis corneus* Linnaeus etc., similar to the molluscan fauna from the "Upper Babele Beds", equivalent to T4-T3 terraces of the

Prut and Danube rivers. The finding of *Mammuthus trogontherii* (Pohlig) remains (Apostol, 1971, 1974) located in the eastern Romanian Plain, has definitely indicated assignment to the Upper Dinogetian (Musaisian).

5. Romanian and Pleistocene biochronologic and chronostratigraphic units

The first biozonation in the Dacian Basin, based on the mollusc faunas, referred to the Sarmatian-Pliocene and earliest Pleistocene. Tewlve Middle-Late Miocene-Pliocene mollusc zones (*NSM1 – NSM12)*, and two in the Early Pleistocene (*QM1 – QM2*) have been proposed (Andreescu, 1981). New data (Andreescu et al., 1985; Lubenescu et al., 1987; Papaianopol et al., 1987; Enciu and Andreescu, 1990; Enciu, 2007) by detailed mapping and processing information coming from coal or hydrogeological boreholes, drilled in various areas of the Dacian Basin, allowed fossil record enrichment and, finally, detailed sequential analyses of the Pliocene–Pleistocene deposits. One of the most outstanding scientific gain of those investigations consisted in refining the biochronology (molluscs) of the Dacian-Pleistocene time span.

Several zones/subzones, as for example those referring to the Dacian (*NSM8c, NSM9* and *NSM10*), have been revised and, consequently, their meaning has gradually been improved. As an result of the mentioned revisions, both the Dacian and Romanian stages had to be redefined, so that the Siensian Substage, formerly considered as the Lowermost Romanian (Andreescu, 1981, 1982), became the Uppermost Dacian, biochronologically marked by the *NSM10-M. psilodonta – Vieja bifarciantus Zone* (Andreescu and Pană, 1996). In this meaning, the Romanian Stage, represented by the Pelendavian and Valahian substages, extends over the time span ~3.7–1.8 Ma (Fig. 10).

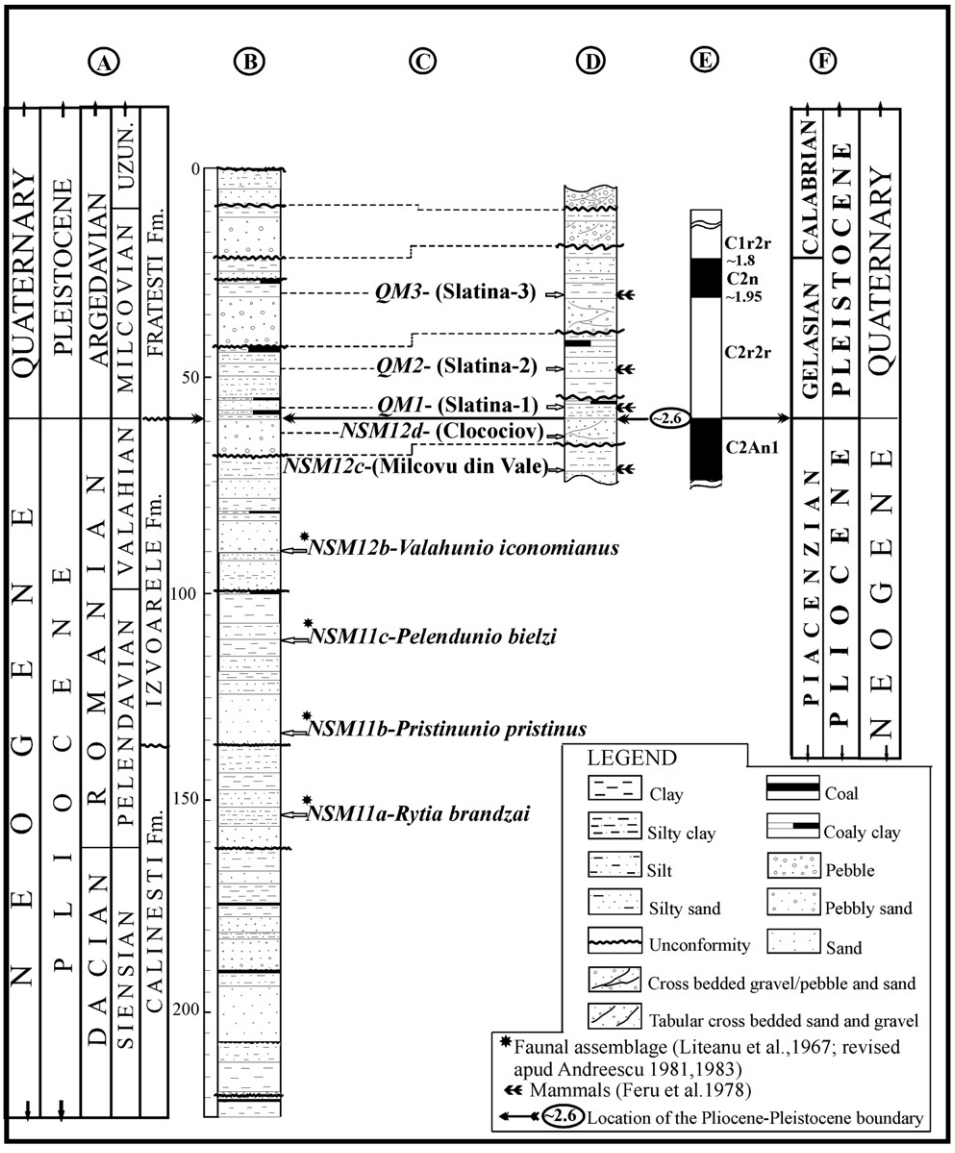

Fig. 9. Reassessed Pliocene/Pleistocene boundary in the Dacian Basin (Stratotypical Slatina Area, Olt District; after Andreescu et al., 2010). A = Upper Pliocene–Pleistocene lithostratigraphic and chronostratigraphic units in the Central Dacian Basin, applied to the Slatina Area; B = Lithology of the upper part of the H4-Slatina Drill-Site, in which the Upper Călinesti Fm. (= Siensian), Izvoarele Fm and Frătesti Fm (lower and middle parts) are represented; C = Molluscs zonation: *NSM11a* to *NSM12b*, inferred, taking into account the faunal assemblages described by Liteanu et al., 1967; *NSM12c* to *QM3* are coming from the former Milcovu din Vale and Slatina outcrops (Andreescu et al., 1981); D = Former Pliocene-Pleistocene stratotypical sections of Slatina and Milcovu din Vale (Andreescu et al., 1981); E = Slatina-Milcovu din Vale magnetostratigrafic column (Andreescu et al., 1981); F = Upper Pliocene/Lower Pleistocene (Neogene/Quaternary) boundary in the Mediterranean realm.

In the stratotype area of the Romanian Stage, a new subzone, *NSM12a-Euxinicardium ebersini-Euxinicardium motasi Subzone* had to be outlined, heralding the huge Caspian Akchagylian transgression (= Pleşcoi Beds auct.) in the northeastern Dacian Basin. The former *NSM11d-Valahunio iconomianus,* then included in the Latest Pelendavian, become the second Valahian, *NSM12b Subzone* (Fig. 3).

The ICS decision (June, 2009) to accept the proposal of the Subcommission on Quaternary Stratigraphy (SQS) (August, 2008), concerning the lower boundary of the Quaternary System/Period to be coincident with the base of Gelasian Stage (2.588 Ma), and the base of Pleistocene Series, changed the status of the Pliocene-Pleistocene in the Paratethys realm. In the Dacian Basin, the *NSM12c-U. kujalnicensis* and *12d-B. tamanensis* subzones, defining the Late Valahian, as a result of the Pliocene-Pleistocene boundary relocation, became *QM1* and *QM2* zones respectively. The Romanian-Pleistocene mollusc zonation can be seen in Fig. 3 (Andreescu et al., 2010). Inspection of Figs. 3 and 10 reveals the differences between the previous (column A) and the present (column B) zonation chart and, naturally, their age assignment.

Several of the new Pleistocene zones, as for example *QM1-QM6*, already separated in the Euxino-Caspian domain (Tchepalyga, 1972; Tchepalyga, in Nikiforova et al., 1976, 1986), could be safely outlined in the Dacian Basin. The last three Pleistocene mollusc zones (*QM7-QM9*) in the easternmost area of the Dacian Basin, characterize the Dinogetian Stage (Mid-Pleistocene deposits). *QM1-U. kujalnicensis; QM2-B. tamanensis; QM3-U. apscheronicus* and *QM4-B. sturi* zones have been outlined (Andreescu et al., 1981) in the Milcov-Slatina area, and their taxa content did not change. The *QM5-Bogatschevia scutum* assemblage comes from Uzunu Beds, described by Macarovici and Coteţ (1962); the *QM6-P. caudata* assemblage has been mentioned in chapter 4.2.4. Copăceni Beds; the *QM7-D. crassa-M. pontica* assemblage characterizes the Vânători Fm (see chapter 3.2.6); the *QM8-D. pontocaspia-A. plicata* assemblage comes from Barboşi-Babele Beds (Macarovici, 1960) (chapter 4.2.8) and the *QM9-U. pictorum-U. tumidus Zone* is mainly conceived from the freshwater fluvio-lacustrine mollusc assemblages reported by Macarovici and Coteţ (1962), Macarovici and Costeţchi (1973) and Munteanu (2006) in the southern and southeasternmost areas of the Dacian Basin.

Based on detailed biochronologic separations, expressed in the Romanian–Pleistocene zonal revisions, and in outlining of a series of new mollusc zones (Fig. 3), on the one hand, and on the magnetobiostratigraphic investigations, on the other hand, the Romanian Stage and its substages, namely the Pelendavian and Valahian were redefined, with a series of a new Pleistocene chronostratigraphic units: the Argedavian Stage (Lower Pleistocene) with Milcovian and Uzunian substages; the Dinogetian Stage (Middle Pleistocene) with Netindavian and Musaisian substages and the Ilfovian Stage (Upper Pleistocene) (Figs. 3 and 10). All the necessary data to outline the above mentiond chronostratigraphic units, except for the Ilfovian outlined elsewhere (Andreescu et al., in press), are to be found here. Taking into account the former classical area of Slatina-Milcovul din Vale, where the former Pliocene/Pleistocene boundary (~1.8 Ma) has been recognized by Andreescu et al. (1981), and the borehole data from the southern Dacian Basin, the revised Pliocene/Pleistocene boundary is coincident with the lowermost sequences of the Frăteşti Fm (Figs. 3, 4, 6–10).

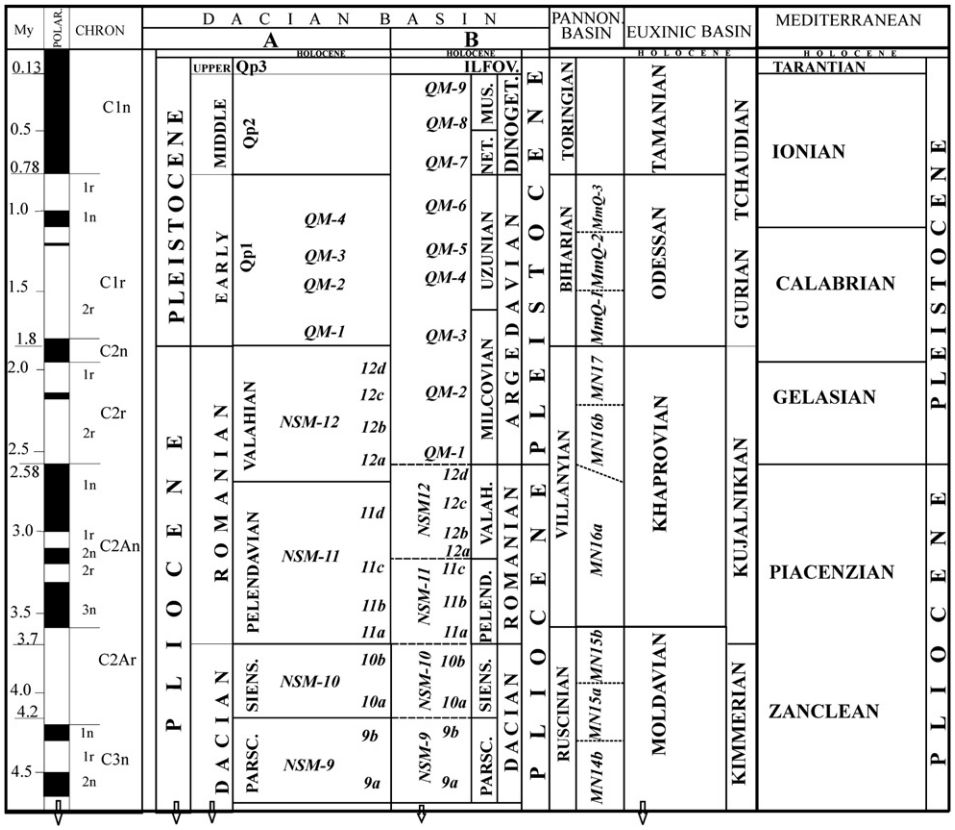

Fig. 10. Former (column A) and current (column B) state of the Pliocene–Pleistocene biochronologic (Molluscs, Mammals) and chronostratigraphic units in the Dacian Basin and correlations with the Pannonian, Euxinic and Mediterranean realms. (*NSM-9 – QM-9* = Mollusc zones; *MN14b-MnQ3* = Mammal zones; PARSC. = Parscovian; SIENS. = Siensian; PELEND. = Pelendavian; VALAH. = Valahian; DINOGET. = Dinogetian NET. = Netindavian; MUS. = Musaisian; ILFOV. = Ilfovian).

6. Conclusions

This contribution was intended to define or redefine some of the main Upper Pliocene-Pleistocene lithostratigrafic, biochronologic and chronostratigraphic units in the Dacian Basin. The first step consisted in the outlining the new (Trajkjovo Fm, Vlădeni Fm), or redefining the already proposed (Izvoarele Fm, Frăteşti Fm) Romanian and Pleistocene formations, with the faunal record (molluscs, mammals).

The next step consisted in defining the Romanian-Pleistocene biochronological units based on molluscs and/or mammals. Accordingly, the Romanian zones *NSM11-Moldavunio lenticularis,* characterizing the Early Romanian (Pelendavian), and *NSM12-E. milcovensis-B. pretamanensis* in the Late Romanian (Valahian) have been redefined (Figs. 3 and 10). A distinct significance, in the base of the *NSM12 Zone*, has *12a-Euxinicardium ebersini-Euxinicardium motasi Subzone* which could be seen as a "paleobiological echo" of the huge Akchagylian transgression in the Caspian Basin. Zones *QM1- QM9* were redefined or outlined (Fig. 3).

The mammal faunas, previously recorded in various sites (Milcovu din Vale, Slatina, Tetoiu etc.) have been revised, and new assemblages, especially of micromammals have been revealed (Lupoaia, Drănic, Podari etc.) so that for many sites with upper Pliocene and/or Pleistocene mammal associations (Figs. 1 and 4) new taxa have been added to faunal lists, with implications in an accurate establishing of host deposit ages.

The Upper Pliocene (Romanian)-Pleistocene chronostratigraphic units have been outlined. The Romanian Stage had to be redefined, since its former upper boundary, according to the new Pliocene-Pleistocene boundary at ~2.6 Ma, is now situated in the Early Pleistocene (Fig. 10), along with the two substages, Pelendavian and Valahian, of the Romanian Stage.

Finally, one of the major achievements of this contribution consists in the establishment of 3 Pleistocene stages: Argedavian, Dinogetian, Ilfovian; and 4 substages: Milcovian (Early Argedavian), Uzunian (Late Argedavian), Netindavian (Early Dinogetian), and Musaisian (Late Dinogetian). The new named stages and substages come from: Argedava (Fortress and Capital of the ancient Daco-Getian tribes); Dinogetia (Daco-Getian, then a Roman Fortress); Milcovu din Vale Site; Uzunu Site; Netindava (Daco-Getian Fortress); Dinogetia (Geto-Dacian, then a Roman Fortress); and Musaisos (Ancient, Daco-Getian name of the Buzău River) (Fig. 1).

Acknowledgements

The authors express their gratitude to A. Tesakov and V. Titov for their help and understanding. Special thanks are to be addressed to the editors and reviewers of QI for their critical revision leading to considerable improvement of the manuscript.

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