NEW FOSSIL MAMMAL ASSOCIATIONS OF THE JIU VALLEY A CONTRIBUTION TO THE EARLY AND EARLY LATE PLIOCENE BIOSTRATIGRAPHY OF THE DACIC BASIN, ROMANIA

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A brief account is given of current investigations upon Early and Early Late Pliocene fossiliferous deposits outcropping in the valley of the Jiu River. The Early Pliocene sequence of beds investigated at Drănic supplied three fossiliferous levels in superposition containing molluscan faunas associated with small mammal remains. The two first levels designated Drănic-1 and Drănic-2 contain rich accumulations of smooth unionids and viviparids indicating the Early Romanian. The small mammals, including a large-sized *Mimomys* species (*M.* cf. *rhodonensis* group), are assigned to the MN—15a subzone. The Drănic-3 level, which yielded the earliest sculptured unionids and a more evolved *Mimomys* form, may be correlated with the Early/Middle Romanian boundary and the top of the MN-15b subzone. The Early Late Pliocene fossiliferous level at Podari (Sand Quarry) yielded an abundant molluscan fauna in association with the richest small mammal assemblage of the Dacic Basin. This fossil level may be correlated with the Middle Romanian (NSM-11c subzone) and the MN-16a subzone. Several micromammalian species are recorded for the first time in the Dacic Basin. A review of the most significant small mammal associations of the Dacic Basin are presented and evidence for climatic changes is assessed.

Key words: small mammals, mollusca, Early Pliocene (Early Romanian, MN-15 zone), Early Late Pliocene (Middle Romanian, MN-16a subzone), Dacic Basin (Paratethys, Romania), biostratigraphy, paleoclimatology.

1. INTRODUCTION

During the summer of 1992, excavations were carried out in two fossil localities in the valley of the Jiu River. One of them, the Podari-Sand Quarry, is already well known for its paleontological content including an abundant molluscan fauna (Pană, Enache & Andreescu 1981) associated with sparse remains of small mammals (Feru, Radulescu & Samson 1979). The other fossil sequence is located near the comumne of Drănic and yielded, in superposed sediments, a succession of three small mammal associations which are new for the Dacic Basin. The fossils were recovered by washing and sieving large quantities of deposits : 500 kg at Podari and 1 ton at Drănic.

The aim of the present report is to establish a correlation between the molluscan faunas — used to define the biostratigraphic subdivisions of the Paratethys area (including the Dacic Basin) — and the micromammalian associations, the latter having the role to precise the relationship of the stratigraphic divisions of the Dacic Basin and the classical geological stages of the Mediterranean area.

On the other hand, it appears to be important for correlation to outline the small mammal assemblages of the Dacic Basin and to compare them with the contemporary similar associations from other parts of the

continent in view of a better understanding of the evolutionary history of certain phyla and the dynamics of migration of some taxa considered as biostratigraphic markers.

In order to precise the affinities of the newly discovered small mammal assemblages and to establish their place within the biostratigraphic scheme of the Dacic Basin, a review on the most significant micromammalian faunas Early Pliocene in age is presented. Correlations with the biostratigraphic subdivisions based on molluscan faunas (Andreescu 1981, 1983) and with the MN zones (Mein 1975) are proposed. Paleomagnetic determinations are also mentioned.

2. SUCCESSION OF THE SMALL MAMMAL ASSOCIATIONS

2.1. THE EARLY PLIOCENE

2.1.1. Bereşti (code **Br.**)

This fossil locality, situated in the northeastern extremity of the Dacic Basin, southern Moldavia, yielded the oldest Pliocene micromammalian assemblage (Simionescu 1932). A revision of the mammalian species was undertaken by Radulescu & Samson (1967 a, b; 1989 a, b), Radulescu, Samson & Stiucă (1992), Samson & Radulescu (1973).

The faunal assemblage (Tables 1 and 2) is distinguished by the absence of arvicolids, the high frequency of lagomorphs, especially the ochotonids, the appearance of a small-sized cricetid considered as a distinct subgenus (*Moldavimus* Samson & Radulescu) within the vast group of the genus *Cricetulus*, the presence of a primitive desman *(Desmana amutriensis)* regarded as a characteristic Early Pliocene species of the Dacic Basin. The primitive leporid species *Trischizolagus dumitrescuae*, which is abundantly represented at Bereşti, is a good stratigraphic marker recorded in various faunal assemblages from Spain (Lopez Martinez 1977) in the west to Afghanistan (Sen 1983) in the east; the species is present in the Republic of Moldova (identified as *Pratilepus kutschurganicus)* (David & Shushpanov 1986) and the Ukraine (named *Pratilepus kutschurganicus* and *P. ukrainicus)* (Topachevsky 1980).

The dominance of lagomorphs and the occurrence of small cricetids indicate a relatively dry environment with open vegetation, reflecting deteriorating climatic conditions, even though the three species of castorids and the desman are water (and forest) indicators.

The Bereşti fauna may be reasonably situated within the MN-14 zone; at the same time, this fauna appears to be coincident with the last part of the Dacian stage of the Dacic Basin (Radulescu & Samson 1989 a).

An equivalent of the Bereşti fauna might be represented by the Sagaidak faunal complex of the Republic of Moldova (Gabunia, Vekua & Alexeeva 1986) and partially by the Kuchurgan faunal complex from the Ukraine (Nikiforova & al. 1986).

2.1.2. Măluşteni (code Ml)

The next biostratigraphic level is represented by the mammalian fauna from Măluşteni (Simionescu 1930), a fossil locality situated near Bereşti.

A revision of the small mammals showed that Măluşteni is later than Bereşti (Radulescu & Samson 1989 a). At Măluşteni, the small mammal composition is distinguished by the first appearance of the primitive vole *Mimomys moldavicus* (Kormos 1930, Radulescu & Samson 1989 a) in the Dacic Basin. It is worth noting that the area of distribution of this species includes the Republic of Moldova (Alexandrova 1986) and Greece (described as *M. davakosi*) (Van de Weerd 1979) as well as Asia Minor (identified as *M. gracilis*) (Sen 1977). The presence of a flying squirrel (*Pliopetaurista* sp.) and a desman (*D. amutriensis*) is association with two species of castorids is another characteristic feature of the faunal assemblage (Tables 1 and 2).

Although the lagomorphs are relatively numerous, the fauna as a whole suggests more humid conditions corresponding to a dominant savannah landscape with patches of woodland including high trees as shown by the occurrence of *Pliopetaurista*.

Table 1

Distribution of the small mammal species at the Early Pliocene and Early Late Pliocene sites of the Dacic Basin, Romania
Insectivora and Lagomorpha

	Br	Ml	Lp—8	Dr—1	Dr—2	Dr—3	Pd
INSECTIVORA							
Erinaceus sp.	—	+	—	—	—	—	—
Desmana amutriensis Radulescu, Samson & Stiuca	+	+	+	—	—	—	—
Desmana nehringi Kormos	—	—	—	+	+	—	—
Desmaninae indet. (very large)	—	—	—	—	—	—	+
Galemys sulimskii Rümke	—	—	—	—	+	—	—
Galemys kormosi (Schreuder)	—	—	—	—	—	—	+
Dibolia sp.	—	—	—	—	+	—	—
Desmanella sp.	—	—	—	—	—	—	+
Deinsdorfia cf. *kordosi* Reumer	—	—	—	—	+	+	—
Sorex cf. *minutus* group	—	—	—	—	—	—	+
Petenyiella gracilis Kretzoi	—	—	—	—	—	—	+
Beremendia fissidens Kormos	—	—	—	—	—	—	+
Blarinoides mariae Sulimski	—	—	—	—	—	+	+
Talpa neagui Radulescu & Samson	+	+	—	—	—	—	—
Talpa sp.	—	—	—	—	—	—	+
LAGOMORPHA							
Trischizolagus dumitrescuae Radulescu & Samson	+	+	—	—	—	—	—
Ochotona ursui Simionescu	+	+	—	—	—	—	—
Pliolagomys sp.	+	+	—	—	—	—	—
Ochotonoides sp.	—	—	—	—	—	—	+

The presence of a primitive species of the genus *Mimomys* indicates that Măluşteni may be placed within the MN-15 a subzone. In the local biostratigraphic scheme, the Măluşteni fauna may be situated at the very beginning of the Romanian. On the basis of the occurrence of *M. moldavicus*, Măluşteni appears to be equivalent to the bottom of the Chumeshti horizon (containing the same *Mimomys* species) of the Republic of Moldova (Alexandrova 1986, Nikiforova & al. 1986).

The fossiliferous deposits at Bereşti and Măluşteni did not contain any molluscan fauna.

2.1.3. Lupoaia Quarry (code **Lp-8**)

The micromammalian association (Tables 1 and 2) coming from the clayey deposit at the base of the coal layer VIII in the Lupoaia Quarry (Radulescu, Samson & Stiucă 1989) represents a subsequent phase in the development of small mammal fauna of the Dacic Basin.

The Lupoaia fauna is distinguished by the occurrence of a large-sized species of *Mimomys (M. rhabonensis)*. Compared with *M. moldavicus*, the *Mimomys* from Lupoaia appears to be more evolved, although its dentine tracts are very low. *M. rhabonensis* presents some similarities with the primitive form of *M. occitanus* Thaler described from Villalba Alta and Arquillo-3 (Spain) (Chaline, Mein & Adrover 1981, Radulescu & Samson 1989 a).

The desman is the relatively large-sized species *D. amutriensis* (related to *D. verestchagini)* (Rümke 1985) found also at Bereşti and Măluşteni. The occurrence of *Apodemus dominans* marks the earliest record of this species in the Dacic Basin.

Table 2

Distribution of the small mammal species at the Early Pliocene and Early Late Pliocene sites of the Dacic Basin, Romania
Rodentia

	Br	Ml	Lp—8	Dr—1	Dr—2	Dr—3	Pd
Pliopetaurista sp.	—	+	—	—	—	—	—
Castor praefiber Depéret	+	+	—	—	—	+	—
Zamolxifiber covurluiensis (Simionescu)	+	+	?	—	+	+	—
Romanocastor filipescui Radulescu & Samson	+	—	—	—	—	—	—
Trogontherium cf. *minus* Newton	—	—	—	—	—	—	+
Dryomimus eliomyoides Kretzoi	—	—	—	—	—	—	+
Prospalax rumanus Simionescu	?	+	—	—	—	—	—
Pliospalax macovei (Simionescu)	+	+	—	—	—	—	—
Apodemus dominans Kretzoi	—	—	+	—	+	+	+
Micromys prdeminutus Kretzoi	—	—	—	—	+	—	+
Cricetulus (Moldavimus) simionescui Schaub	+	—	—	—	—	—	—
Trilophomys sp.	—	—	—	—	+	—	—
Dolomys nehringi Kretzoi	—	—	—	—	—	—	+
Propliomys cf. *hungaricus* (Kormos)	—	—	—	—	—	—	+
Pliomys sp.	—	—	—	—	—	—	+
Mimomys moldavicus Kormos	—	+	—	—	—	—	—
Mimomys rhabonensis Radulescu, Samson & Stiuca	—	—	+	—	—	—	—
Mimomys cf. *rhabonensis* group	—	—	—	+	+	+	—
Mimomys sp. (small)	—	—	—	—	+	—	—

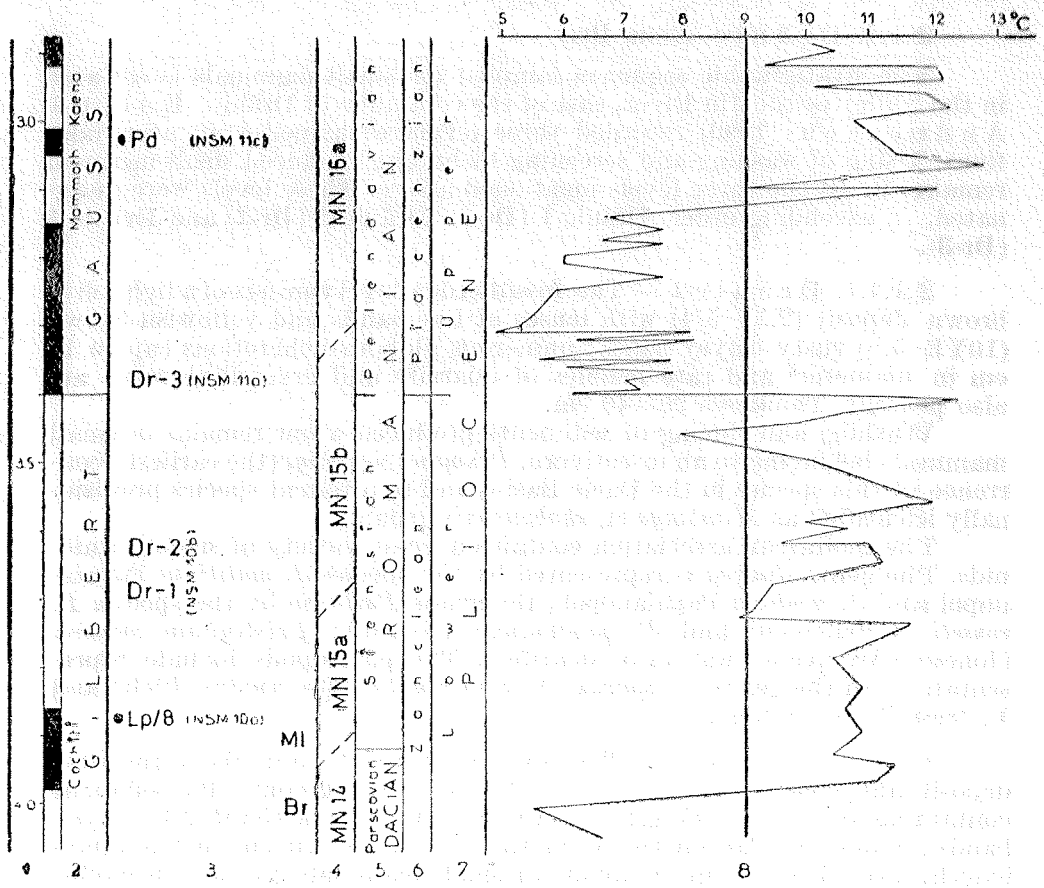

Fig. 1. — Correlation chart for marine/continental Pliocene chronology of the Dacic Basin. 1. Geochronometric scale in my. 2. Magnetic polarity time scale. 3. Succession of fossil localities. 4. Mammal Neogene faunal zones (M e i n 1975). 5. Stages of Central Paratethys (A n d r e e s c u 1981). 6. Stages of the Mediterranean area. 7. Marine chronostratigraphy (series). 8. Estimated winter sea-surface temperature (SST) in the North Atlantic Ocean during the Pliocene; vertical line indicates modern winter SST (P o o r e 1990)

Paleomagnetic determinations (Andreescu, Rădan & Rădan 1986) showed that the mammal-bearing level at Lupoaia Quarry is situated within the Cochiti event of the Gilbert epoch at approximately 3.86—3.9 my, corresponding to the bottom of the Early Romanian, NSM 10a subzone. An equivalence with MN-15a subzone was also suggested (Radulescu, Samson & Stiucă 1989).

The small mammals from Lupoaia are indicative of a local humid environment developed under temperate climatic conditions.

2.1.4. Drănic (code **Dr.**)

The stratigraphic sequence sampled for small mammals is situated in the valley of the Jiu River, east of the commune of Drănic. Enciu & Andreescu (1990) recorded three levels with molluscan accumulations. Using of washing and screening technique produced small mammal remains in all the three levels mentioned above. These levels were designated, in ascending order, Drănic-1 (**Dr-1**), Drănic-2 (**Dr-2**) and Drănic-3 (**Dr-3**).

2.1.4.1. Drănic-1 — The fossiliferous level consists of a light olive brown deposit (2.5Y 5/4) with lenses of fine sands and yellowish brown (10YR 5/8) rusty clayey zones; numerous globous concretions (up to 10 cm in diameter) and rare pebbles of quarzite and crystalline rocks are also present. Thickness 20—40 cm.

Washing and sieving of sediments produced a few remains of small mammals belonging to an insectivore, *Desmana nehringi* (the earliest occurrence of this species in the Dacic Basin) and to a rodent species provisionally identified as *Mimomys* cf. *rhabonensis* group.

The molluscan association contains a great variety of smooth unionids. The genus *Jazkoa* is represented by the species *J. malitiosa* Papaianopol and *J. modesta* Papaianopol; the genus *Psilunio* by the species *P. rosseti* (Cobălcescu) and *P. pannonicus* (Neum.); *Pristinunio mrazeci* (Ionescu-Argetoaia) was also identified. The gastropods include representatives of the genus *Viviparus* (*V. bifarcinatus bifarcinatus* (Bielz) and *V. transitorius* Sabba).

2.1.4.2. Drănic-2 — This level is located 4—5 m above the **Dr-1** deposit and consists of a brown (7.5YR 4/4) ferruginous silty sediment containing frequent dark gray (10YR 4/1) and black (5YR 2/1) clayey bands; numerous carbonised wood fragments, 15—20 cm in maximum length, are also present. Remains of small mammals and a rich molluscan fauna were recovered. This fossiliferous deposit is overlain by a succession, 1.5 m thick, of silty and sandy layers with clayey intercalations varying in colour from graysh brown (2.5Y 5/2) to very dark gray (5Y 3/1). This succession yielded only sparse remains of small mammals.

As a whole, the micromammalian association is represented at least by four insectivores and six rodent species. The faunal list is indicated in Tables 1 and 2. The molluses are represented by smooth unionids and an abundance of viviparids with *V. bifarcinatus bifarcinatus* as dominant species.

Compared with older faunas (Măluşteni, Lupoaia Quarry), the **Dr-2** small mammal assemblage is distinguished by several characteristic fea-

tures: the Desmaninae are represented by *D. nehringi* (identified also at **Dr-1**), a taxon believed to be a northern immigrant whose earliest appearance in Europe is recorded at Podlesice, Poland (beginning of the MN-14 zone) (Rzebik-Kowalska 1971, Mein 1990); presence of some taxa known from older mammalian associations (*Zamolxifiber*, *Apodemus dominans*); occurrence of a *Mimomys* form which appears to be a descendant of the large-sized *M. rhabonensis* lineage; a higher frequency of the murid species.

The molluscan fauna is indicative of the Early Romanian (Enciu & Andreescu 1990).

The small mammal assemblage may be situated at the beginning of the MN-15b subzone. Judging from the evolutionary stage of the large-sized *Mimomys* form, a broad equivalence with Sète, France, might be accepted.

2.1.4.3. Drăgănic-3 — The fossiliferous level representing this locality is 12—13 m above **Dr-2**. It consists of a grayish brown (2.5Y 5/2) silty and sandy deposit, 25 cm thick, with numerous white concretions and dark brown (7.5YR 4/4) to yellowish red (5YR 5/8) stains indicating a process of soil formation.

The molluscan fauna contains the earliest sculptured unionids represented by various species of the genus *Wenziella* (*W. clivosa* (Brusina), *W. subclivosa* (Teiss.), *W. acuta* (Ion.-Arget.), *W. ponderosa* (Wenz), *W. gorjensis* (Teiss.)) associated with *Psilunio* cf. *slanicensis* Papaianopol, *P. orolesi* Papaianopol and other forms. The viviparids belong to the taxa *V. craiovensis* (Tourn.), *V. stricturatus* (Neum.) and *V. bifarcinatus bifarcinatus*.

The small mammal association consists of at least six species including two insectivores and four rodents (Tables 1 and 2). *Blarinoides mariae* is recorded here for the first time in the Dacic Basin. A small castorid assigned to *Z. covurluiensis* represents a holdover from earlier times; this small species is unknown later than **Dr-3**. The large-sized *Mimomys* form possessing some dolomyian features is more advanced as compared with **Dr-2** specimens.

The molluscan fauna (appearance of sculptured species of unionids) indicates that **Dr-3** may be placed at the boundary Early/Middle Romanian. The small mammal composition suggests an equivalence with the end of the MN-15b subzone. The Kishlitsa horizon (distinguished by the first appearance of sculptured unionids) in the Republic of Moldova (Nikiforova & al. 1986) might represent a partial equivalent of **Dr-3**.

Taking into consideration the increase of murids and the presence of the Desmaninae (*Desmana*, *Galemys*) and Castoridae, the habitat at depositional sites (**Dr-1**, -2 and -3) was rather represented by a humid wooded landscape with temperate trees.

2.2. THE EARLY LATE PLIOCENE

2.2.1. Podari (code **Pd**)

Excavations undertaken at Podari (Sand Quarry), south of Craiova, supplied the richest Pliocene mammalian assemblage of the Dacic Basin. The stratigraphic sequence consists of sands, 12—13 m thick, overlain by yellowish brown (10YR 5/6) silty and sandy deposits with light brownish

gray (2.5Y 6/2) and strong brown (7.5YR 5/6) spots; laterally, the deposits consists predominantly of sands containing polyhedric pebbles (diameter up to 9 cm). This upper part of the sequence contains very important molluscan accumulations associated with small mammal remains.

The extremely rich association of unionids and gastropods was studied by Pană & al. (1981) and reviewed by Enciu & Andreescu (1990). It is worth mentioning the presence of many characteristic species as *Pristinunio pristinus* (Bielz), *P. davillai* (Porumbaru), the same *Wenziella* as at **Dr-3**, *Rugunio mojsvari* (Penecke), *R. moldavensis* (Hoern.), *R. tubureensis* (Font.), *R. pilari* (Brusina), *Rythia slavonica* (Hoern.), *R. norskaensis* (Penecke), *Cuneopsidea beyrichi* (Neum.), *C. sculpta* (Brusina), *C. magna* Andreescu, *Sulcopotomida herjeui* (Porumbaru) and *S. cymatoïdes* (Brusina). The viviparids include, besides Early Romanian species, some new forms as *V. pilari* (Brusina), *V. turgidus* (Bielz), *V. mammatus* (Sabba) and *V. rudis* (Neum.).

The first small mammal remains from Podari, belonging to four species, were recorded by Feru, Radulescu & Samson (1979). The new investigations yielded a faunal assemblage containing 17 species: 8 insectivores, 8 rodents and an ochotonid lagomorph. With the exception of *Blarinoides mariae*, present at **Dr-3**, the Podari fauna is completely renewed. It is worth noting that the representatives of the genus *Mimomys* are absent. They are replaced by a *Dolomys* form *(D. nehringi)* associated with species of *Propliomys* and *Pliomys*. It is difficult to explain the lack of *Mimomys* at Podari, the members of the genus being widely spread in equivalent faunal assemblages of Europe.

The molluscan fauna is Middle Romanian in age (NSM 11c subzone according to Andreescu (1983)).

The micromammalian assemblage may be placed within the MN-16a subzone. The presence of some species *(Dolomys nehringi, Propliomys hungaricus, Micromys*, and other forms) suggests a relationship with the Csarnota-2 fauna of Hungary (Janossy 1986, Kretzoi 1962).

Paleomagnetic determinations indicated a normal polarity for the sandy deposits at Podari (Andreescu 1983). The fossiliferous levels including molluscs and small mammals might be placed within the middle Gauss subchron at approximately 3.01—3.05 my (Feru, Radulescu & Samson 1983).

As a whole, the faunas indicate a warm temperate climate.

3. EVIDENCE FOR CLIMATIC CHANGES

The Berești fauna is indicative of an increase of continentality (abundance of lagomorphs, especially the Ochotonidae, presence of *Cricetulus)* at about 4 my. This relatively dry time interval was followed by a more humid and, probably, warmer period as shown by both faunal assemblages at Măluşteni and Lupoaia (3.8—3.9 my), the latter one being characterized by the occurrence of *Apodemus dominans*.

The subsequent small mammal assemblages from Drănic (**Dr-1**, **-2** and **-3**) point to climatic conditions of wet and temperate aspect *(Apodemus dominans* in association with desmans and castorids). The faunal

succession **Dr-1** to **Dr-3** seems to cover a time interval of about 0.3 my (3.65—3.35 my). As already mentioned, **Dr-3** appears to be situated at the boundary Early/Late Pliocene coincident with the Gilbert/Gauss paleomagnetic boundary (Zanclean/Piacenzian in the Mediterranean area, Kimmerian/Akchagylian of the eastern Paratethys, Early/Middle Romanian of the Dacic Basin) (Fig. 1).

After an important biostratigraphic gap, the Podari small mammal assemblage is indicative of a warmer period (presence of numerous insectivores including *Desmanella*, a genus recorded for the first time in Romania, high frequency of murid species, absence of *Mimomys* forms which are replaced by species belonging to the genera *Dolomys*, *Propliomys* and *Pliomys*).

The faunal turnover registered at Podari is regarded as being situated at approximately 3 my (middle Gauss subchron of normal polarity).

The general climatic aspects inferred from faunal data of the Dacic Basin are in agreement with the paleoenvironmental interpretations on relative abundances of the Arvicolidae and Muridae in the Greek faunas (Van der Meulen & van Kolfschoten 1988) and with the oscillations of the sea surface temperature between 4.5—3 my registered on the basis of distribution of ostracode assemblages in modern and Pliocene age marine sediments along the continental margin of the Eastern United States (Poore 1990). The cooling registered at approximately 3.2 my (Shackleton & Opdyke 1977) appears to precede the Podari fauna and to postdate the **Dr-3** fossil site.

Acknowledgements. Thanks are first due to Prof. dr. *Constantin Enache*, engineer *Ion Cumpănașu*, the Mayor of the commune of Drănic, doctor *Marin Rădulescu*, director of the Clinical Hospital No. 3, Craiova, Mrs. *Doina Vardol* and *Stefania Cismaru* for work facilities they kindly provided and for permission to live at Villa "Relly", Padea; without their comprehensive help, it would be impossible to our field party to succeed in executing excavations and finding fossil remains. Thanks are also due to *Horia Ilinca* and *Dumitru Pegulescu*, research assistants, who helped in the collecting and sorting of the microfossils.

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Received 7 January 1993