

The Turolian proboscideans (Mammalia) of Europe: preliminary observations

Georgi N. MARKOV

MARKOV G. N. 2008. The Turolian proboscideans (Mammalia) of Europe: preliminary observations. – *Historia naturalis bulgarica*, **19**: 153-178.

Abstract. The paper deals with six proboscidean species from the Turolian of Europe. Problems of their taxonomy, phylogeny, assumed geographic range and time span are discussed; an attempt is made to outline the most important localities and material for each of the six taxa. With the exception of *Anancus*, a later immigrant, the other five proboscideans seem to be part of the large-scale mammal migrations from West Asia into Europe around the Vallesian/Turolian transition.

Key words: Proboscidea, Late Miocene, Europe, taxonomy, dispersals

Introduction

The Turolian proboscideans of Europe are something of a paradox. On one hand, they are represented by abundant material from numerous localities (Fig. 1); on the other, virtually each of the species discussed in this paper has been, or still is, involved in controversies of taxonomy, phylogeny, geography and chronology. These problems are interrelated, since choice of taxonomy obviously influences assumed ranges in space and time; mixing the Turolian taxa with closely related but not identical species creates a false impression of Vallesian proboscidean relicts in the Turolian, or, in two cases, of early appearances of taxa typical for the Pliocene.

In this paper, some preliminary results from an ongoing research on the Turolian proboscideans of Europe and Southwest Asia are presented, with taxonomical notes and a brief outline of the most important localities and finds for each species.

Institutional abbreviations:

HGI: Hungarian Geological Institute, Budapest.

HNHM: Hungarian Natural History Museum, Budapest.

MMNH: Macedonian Museum of Natural History, Skopje.

MNHN: Muséum National d'Histoire Naturelle, Paris.

NHM: Natural History Museum, London.

NHMW: Naturhistorisches Museum Wien, Vienna.

NMNH: National Museum of Natural History – BAS, Sofia.

NMNHAs: Palaeontology Museum (Branch of NMNH – BAS), Assenovgrad.

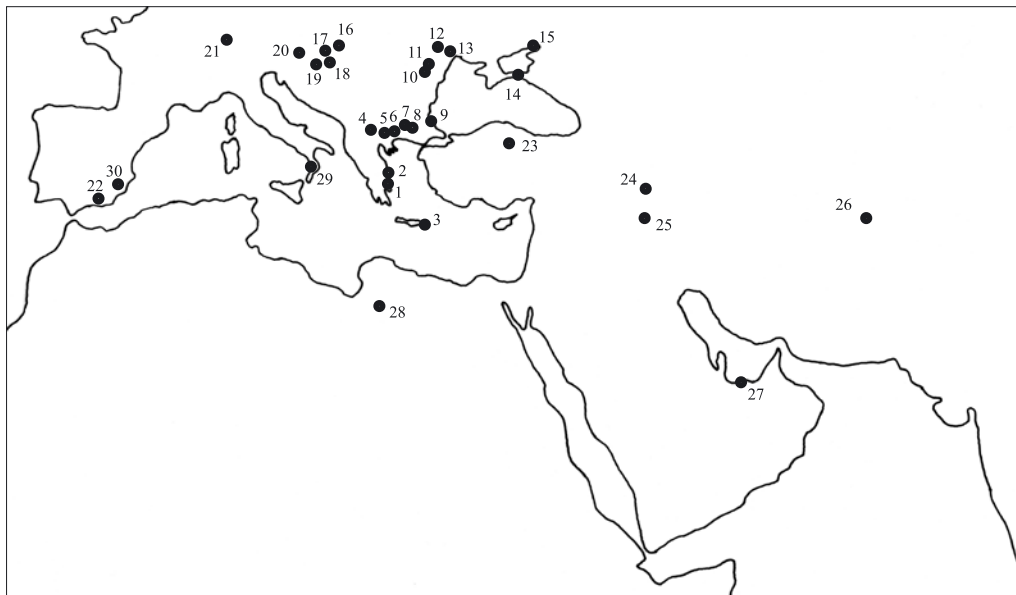


Fig. 1. Selected Turolian localities with proboscidean fauna in Europe and adjacent areas. 1: Pikermi; 2: Halmypotamos; 3: Maronia/Siteia; 4: Dolni Disan; 5: Kalimantsi; 6: Hadzhidimovo; 7: Ahmatovo; 8: Ezerovo; 9: Burgas; 10: Cimişlia; 11: Taraklia; 12: Grebenniki; 13: Belka; 14: Kertch; 15: Morskaya 2; 16: Pestszentlőrincz; 17: Csákvár; 18: Polgárdi; 19: Baltavár; 20: Kohfidisch; 21: Dorn-Dürkheim 1; 22: Alfacar; 23: Kayadibi; 24: Maragheh; 25: Injana; 26: Molayan; 27: Jebel Barakah; 28: Sahabi; 29: Cessaniti; 30: Crevillente 2.

RHMR: Regional History Museum, Russe.

SU: Palaeontology Museum of the Sofia University, Sofia.

Systematics and range:

Deinotherium gigantissimum Stefanescu, 1892 (= *D. proavum* Eichwald, 1835)

Taxonomical remarks:

Two problems concerning the Turolian deinotheres are whether or not they represent a species different from *D. giganteum* Kaup, and, if yes (the approach adopted here), what is the correct name to be used for that species. Following most of the authors who have discussed its status, I use the name *D. gigantissimum* Stefanescu, 1892. It was argued by CODREA (1994) that *D. proavum* Eichwald, 1835 has priority, and subsequently the name has been employed in recent literature (e.g. GASPARIK, 2001). The problem, however, is somewhat more complicated than a simple priority issue, and as suggested by M. Pickford (e-mail dated 19.07.2002), the case probably needs a ruling by the ICZN.

A century of debate on the status of the largest European deinotheres could be summarized thus: numerous authors have argued against separate specific status, pointing out that size alone is a weak criterion (several important finds from Eastern Europe showing morphological

differences, however, were unknown to them: see below); others (e.g. GRÄF, 1957; TOBIEN, 1988) were inclined to accept *D. gigantissimum* as a valid species – or at least the possibility that future finds might confirm its validity. A crucial point was made by TARABUKIN (1974), who noted the strongly developed mandibular angle present in all mandibles referable to *D. gigantissimum* but not in *D. giganteum*, and included this character in his revised diagnosis of the species. Tarabukin’s observation was based on limited material (two mandibles from the Moldovan localities Pripiceni and Goleshty / Găleşti) but it is confirmed by the shape of the mandible in the skeleton from Ezerovo¹, Bulgaria, and the Turolian deinotheres from Alfacar (see BERGOUNOIX & CROUZEL, 1959, Pl. 3). In all those specimens, the angle of the mandible is strongly developed, with its lowest point far below the ventral border of the horizontal ramus, unlike the state observed in *D. giganteum* (Fig. 2). This character, along with some aspects of cranial morphology², supports the separate status of *D. gigantissimum*, a species larger and later than *D. giganteum*.

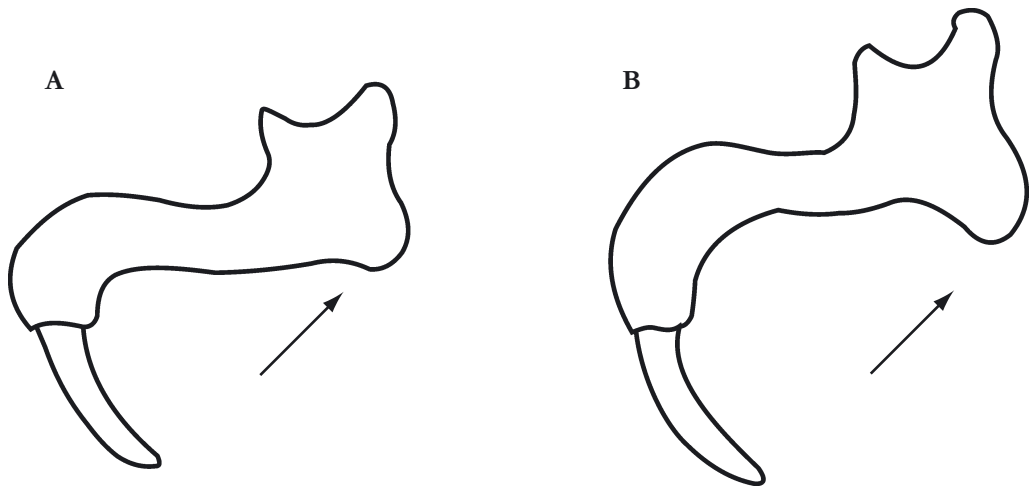


Fig. 2. Mandibular shape in *Deinotherium giganteum* (A) and *D. gigantissimum* (B), lateral view. Arrow marks angle of the mandible. Not to scale.

¹ The Ezerovo skeleton, stored at SU, remained unpublished for decades following the death of I. Nikolov in 1982 (photo and some metrical data were provided by TOBIEN, 1986, 1988; the specimen was briefly discussed by MARKOV et al., 2002, who referred it to *D. gigantissimum*). Aspects of its postcranial morphology were discussed by HUTTUNEN & GÖHLICH, 2002, and HUTTUNEN, 2004). The name “*D. thraciensis*” (in varying spellings) referring to the Ezerovo skeleton has been used in passim by I. Nikolov on several occasions, including posthumous publications, none of which, however, included a formal description of this “species”. Quite recently, a description of the skeleton (as “*Deinotherium thraceiensis* sp. nov.”) partially based on I. Nikolov’s notes was published (KOVACHEV & NIKOLOV, 2008: although the paper is dated 2006 it actually appeared in 2008). The Ezerovo skeleton, however, is conspecific with the rest of the material referred to *D. gigantissimum* and certainly represents no new species. Proboscidean taxa from Ezerovo, *contra* KOVACHEV & NIKOLOV (2008), include *Deinotherium gigantissimum*, “*Mammul?* *obliquelophus*”, *Choerolophodon pentelici*, *Tetralophodon atticus*, and *Anancus* sp. (MARKOV, 2004b).

² Briefly discussed by MARKOV et al. (2002); note, however, that premaxillaries in the Ezerovo skull are partially reconstructed and its marked shortness might be an artefact. Besides, although strongly developed, the angle of the mandible seems to be additionally “strengthened” with plaster.

Important localities and material³:

Material from the type locality of *D. gigantissimum*, Găiceana in Romania, is scarce (as is the material from the type locality of *D. proavum*, Rakhny Lesovye, or Rakhny Lisovi, now in Ukraine; spelt “Rachnow ljasowj” by EICHWALD, 1835). The most important finds referable to that species include a skeleton with partially preserved mandible from Mânzați (Romania), an almost complete skeleton with a fully preserved mandible from Pripiceni (Moldova), a skeleton with preserved mandible and skull from Ezerovo (Bulgaria), all belonging to adult individuals. Juvenile *D. gigantissimum* remains are known too: a maxillary fragment and two mandibles with deciduous dentition from Nessebar (Bulgaria), misidentified as *P. bavaricum* by previous authors (see MARKOV, 2004a, 2004b, 2008), deciduous dentition from Cimișlia in Moldova (misidentified as *D. giganteum* by SIMIONESCU & BARBU, 1939; permanent molars from the same locality were referred to *D. gigantissimum* by these authors), the nearby Moldovan locality Taraklia (or Taraclia) (KHOMENKO, 1914, Pl. 1, Fig. 16). From Pikermi in Greece, apart from postcranial adult remains (GAUDRY, 1860; pers. obs. MNHN, 2002), there is a palate with D2-D4 described by WAGNER (1857, Pl. 7, Fig. 15), and an unpublished D2 (NHM M10103, pers. obs. NHM, 2006), which, with its dimensions of 49.4 x 43.7 mm, is one of the largest deinotheres D2's known so far. Deciduous premolars from Kayadibi, Turkey, published by GAZIRY (1976), most probably belong in *D. gigantissimum* too (I am grateful to M. Pickford for drawing my attention to the Kayadibi specimens). Deciduous premolars described by SANDERS (2003) from the middle member of the Sinap Formation in Turkey are, according to this author, of similar size to the Kayadibi sample⁴; with ages of late MN10 for the Sinap material and early MN11 for Kayadibi (SANDERS, 2003), the two might indeed be conspecific (in that case, Turkish material would mark one of the earliest occurrences of *D. gigantissimum*). In Western Europe, *D. gigantissimum* (published as *D. giganteum*) appears at several Spanish Turolian localities, e.g. Alfacar (BERGOUNIOUX & CROUZEL, 1959, 1962); Crevillente 2 and Crevillente 16 (MAZO & MONTOYA, 2003), and others, spanning from MN11 to MN12. Deinotheres from the German Turolian locality Dorn-Dürkheim 1 (“*Deinotherium* n. sp.” of FRANZEN & STORCH, 1999) belong in this species too, as well as finds from the Austrian localities Kohfidisch (referred to *D. giganteum* by BACHMAYER & ZAPFE, 1969, 1972, who nevertheless noted that dimensions of Kohfidisch deinotheres surpassed known range for that species; formerly assumed to be Vallesian, the age of Kohfidisch is actually Turolian as demonstrated by VISLOBOKOVA & DAXNER-HÖCK, 2004), and, possibly, Prottes, Wilfersdorf, and others (pers. obs., NHMW, 2006; see also HUTTUNEN, 2002, for the large dimensions of some teeth attributed to *D. giganteum* by that author). Abundant material is known from numerous localities in Hungary (GASPARIK, 1993, 2001) and Bulgaria (MARKOV, 2004a, 2004b). The species is represented in Greece not only by finds from Pikermi but also Samos, Halmyropotamos, Kerassiá and Crete (see e.g. ATHANASSIOU, 2004 and references therein, as well as THEODOROU et al., 2003; Turolian material referred to *D. giganteum*), in Macedonia (LASKAREV, 1948; GAREVSKI, 1976a; and

³ This is a brief outline of important localities and finds, not an exhaustive list, for *D. gigantissimum* as well as for the rest of the taxa discussed further.

⁴ Actually, they are even larger (see SANDERS, 2003, Fig. 10.2). D2 is practically of the same size as NHM M10103, and size of D3 is close to the teeth in MMNH 2740, an unpublished palate with D2-D4 from the area of Veles, Macedonia (pers. obs. MMNH 2003), SU 301, unpublished D3 from Rogozen, Bulgaria, and the material from Cimișlia, Moldova, discussed above.

pers. obs., MMNH, 2003), Romania (apart from Găiceana and Mânzați, also at Vernești and others: see ATHANASIU, 1907), Moldova (Pripiceni, Gălești, Cimișlia, Taraklia, and others: see quoted works by KHOMENKO, 1914; SIMIONESCU & BARBU, 1939; TARABUKIN, 1974, as well as PAVLOW, 1907), Ukraine (Novaya Emetovka, Belka and others: see e.g. KOROTKEVICH, 1988), and South Russia: Novocherkassk (BAJGUSHEVA & TISHKOV, 1998), Obuhovka sand pit near Rostov (BAJGUSHEVA & TITOV, 2006), Kossyakino and Armavir (see VISLOBOKOVA & SOTNIKOVA, 2001). For the last two localities, the age was given as Ruscinian by VISLOBOKOVA & SOTNIKOVA (2001) but this is not convincing: fauna is apparently of mixed age, including Turolian as well as Villafranchian elements; on problems concerning the correlation of these two localities (including with each other) see ALEXEEVA (1959). There is not a single locality yielding *Deinotherium gigantissimum* that can be positively dated to the Pliocene (frequent reports of “Pliocene” deinotheres in Europe in older literature refer to Pliocene in an older sense, i.e. the Late Miocene of present-day concepts).

The easternmost occurrences of *D. gigantissimum* seem to be marked at (Upper) Maragheh (Iran: “*Deinotherium* sp.”, ERDBRINK et al., 1976; BERNOR, 1986)⁵, Injana (Iraq: “*Deinotherium* sp. / *Prodeinotherium* sp.”, THOMAS et al., 1980 – a crenulated loph, probably from a deciduous tooth, hence the uncertain determination), and Molayan (Afghanistan: “*Deinotherium* sp. of very large size”, BRUNET et al., 1984).

In summary, *D. gigantissimum* is represented in Turolian localities ranging from Spain through Central and Eastern Europe to Turkey, Iran, Iraq and Afghanistan. Material includes several skeletons (one preserving the skull and mandible), several mandibles of adult individuals, deciduous dentition, mandibles and maxillary fragments of juvenile individuals, and numerous isolated dental and postcranial finds. Known time span is MN11 – MN12, with possible occurrences in MN13 and probable first appearance in the latest Vallesian. Reported Ruscinian age for deinotheres remains from two localities in Russia is most probably erroneous (the fauna in these localities seems to be a heterogeneous assemblage of different age).

“*Mammut*” *obliquelophus* (Mucha, 1980)

Taxonomical remarks:

Quite a number of finds demonstrate the occurrence in the Turolian of a mammutid close to “*Mammut*” *borsoni* but differing from it in the longer mandibular symphysis. This species has been confused both with *Zygodon turicensis*⁶ and with the Pliocene mammutid “*M.*” *borsoni*, some finds have been incorrectly referred to “*Mammut praetypicum*” (a name that should not be used for the Turolian mammutids: see below). To further complicate the situation, both “*M.*” *borsoni* and the Turolian species most probably belong to a separate, yet unnamed genus, differing from *Zygodon* as well as *Mammut* (MARKOV, 2004a, 2004b).

Decades ago, it was noted by ALEXEEVA (1965) that most probably two different mammutids are mixed under the name “*M.*” *borsoni*: the brevirostrine “*M.*” *borsoni* s. str. from

⁵ Notably, DE BONIS et al. (1994) listed *D. giganteum* from Upper Maragheh – thus accepting, the employed taxonomy notwithstanding, the conspicuity of deinotheres at U. Maragheh, Pikermi, Samos and Halmypotamos.

⁶ TASSY (1985) demonstrated both the similarity of the Turolian form to “*M.*” *borsoni* (and not to *Z. turicensis*, a species not known from the Turolian), and its distinctiveness, using the designation *Zygodon* cf. *borsoni*.

the Pliocene, and a closely related late Miocene form with a longer symphysis. This, I believe, remains a correct opinion, supported by numerous finds. Ironically, the situation around the Turolian species has been obscured by some unfortunate taxonomic decisions, and the uncertain stratigraphy for several important finds. Central to the taxonomical problem is a publication by KUBIAK (1972), describing a mandible and skull fragment of unknown exact locality but probably from the so-called Balta Sands in Podolia, nowadays in the Ukraine. KUBIAK (1972) referred the material to “*Mammot praetypicum* (Schlesinger, 1919)”, elevating Schlesinger’s “*Mastodon (Mammot) americanus* forma *praetypica*” to a specific rank and basing his determination on dental similarities between Schlesinger’s material and the find from Podolia. This, however, is unwarranted. The material described by Kubiak certainly differs from “*M.* *borsoni*”, but this is not the case with Schlesinger’s taxon. “Types” of “*M. praetypicum*” cited by KUBIAK (1972) were in fact chosen as lectotypes by OSBORN (1936) – an unfortunate decision, since it is evident from the work by SCHLESINGER (1922) that he regarded as type specimen a hemimandible from Ajnácskö (now Hajnáčka in Slovakia). The paper by SCHLESINGER (1919) appeared earlier, but was written later, than his 1922 work, being a summary of his two monographs on the elephantoids stored at the museums in Vienna (SCHLESINGER, 1917) and Budapest (SCHLESINGER, 1922). Apparently, it was not supposed to be published before the 1922 volume – the 1919 paper treats “forma *praetypica*” as a name already published, and so does not name a type or use the designation “nova forma” (which appears in the 1922 monograph). Osborn’s lectotypes (probably of Pliocene age), are not informative: as said, dental morphology in “*M.* *borsoni*” and the Turolian species is practically identical, and the only reliable character permitting to distinguish between the two is the symphyseal length. Thus, if Osborn’s “types” are considered, “*M. praetypicum*” is a *nomen vanum*. If the species is treated as based on the hemimandible from Hajnáčka – as apparently was Schlesinger’s intention – then it falls into synonymy with “*M.* *borsoni*”: the hemimandible is clearly brevirostrine (SCHLESINGER, 1919, 1922), and the locality is of early Villafranchian (MN16a) age. In both cases, “*M. praetypicum*” is not a name to be used for the Turolian longirostrine species. KUBIAK (1972) speculated that symphyseal length might vary in “*Mammot praetypicum*” (since the symphysis is long in the mandible from Podolia but obviously short in Hajnáčka); in my opinion, this is not the case. Rather, the Hajnáčka hemimandible and the Podolia elephantoid belong to two different species – the first to “*M.* *borsoni*” and the second to a species which, by the time of Kubiak’s publication, was nameless⁷. Thus, KUBIAK (1972) was perfectly correct in his opinion that the Podolia material is earlier and more primitive than “*M.* *borsoni*” – but not in his choice of taxonomy.

The only taxon based on a mandible with unequivocally long symphysis (though unfortunately the age is speculative), is *Mastodon obliquelophus*, described by MUCHA (1980), from Romanovka, Ukraine, and although a taxon based on a well dated specimen would be preferable, the longirostrine⁸ Turolian mammutids should be referred to Mucha’s species. As noted, dental morphology in “*M.* *obliquelophus*” and “*M.* *borsoni*” is practically identical, and the only reliable character that helps distinguishing between the two is the symphyseal length (Fig. 3): symphysis longer than the tooth row and bearing well developed tusks in

⁷ *Mastodon pavlovi* Osborn, 1936, based on upper M1-M3 from Pestchana, Podolia, is – similarly to “*M. praetypicum*” – either *nomen vanum* or, more probably, a junior synonym of “*M.* *borsoni*”: according to PAVLOW (1894), these molars were found together with a mandible with short symphysis.

⁸ That is, longirostrine in comparison with “*M.* *borsoni*”; compared to the more primitive genus *Zygolophodon*, the symphysis in “*M.* *obliquelophus*” is reduced.

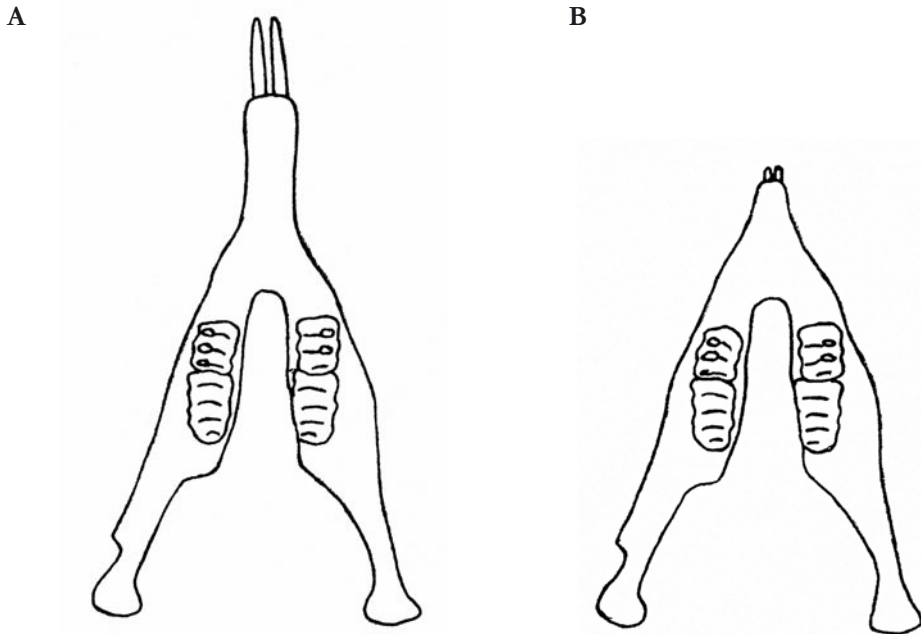


Fig. 3. Symphyseal length and shape in “*Mammut*” *obliquephus* (A) and “*M.*” *borsoni* (B), occlusal view. Not to scale.

“*M.*” *obliquephus*, significantly reduced (shorter than the tooth row) and with small vestigial tusks in “*M.*” *borsoni*. Note that in both species, the symphysis is deflected, *contra* TOBIEN (1976). Various published mandibles of “*M.*” *borsoni* – e.g. BAKALOV & NIKOLOV (1962, Pl. 53), seem to lack the easily breakable tip of the symphysis; the actual symphyseal shape in “*M.*” *borsoni* can be observed in the specimens from Bossilkovtsi in Bulgaria (CHALWADŽIEV, 1986, Pl. 1)⁹, and Milia (Grevena, Greece) published by TSOUKALA (2000, Fig. 7).

Worth mentioning is a left hemimandible of a juvenile mammutid from Shanxi (or Shansi), China, originally published by HOPWOOD (1935, Pl. 6, Fig. 5) as *Mastodon americanus* and referred by TOBIEN et al. (1988) to *Mammut borsoni*. The specimen, a cast of which is stored at NHM (coll. number M14825), has a longer symphysis than the two juvenile mandibles from Pikermi (see below), judging both from the preserved part of the symphysis and the shape of the horizontal ramus which is narrower and higher than the Pikermi specimens (pers. obs. NHM, 2006). In this aspect, the Shanxi specimen is more primitive than the Pikermi material and conspecificity with “*M.*” *obliquephus* is far from granted (not to mention “*M.*” *borsoni*). From Shanxi, the species *Zygodophodon shansiensis* was described by CHOW & CHANG (1961) (synonymized with *Mammut borsoni* by TOBIEN et al., 1988). The holotype of *Z. shansiensis* is an isolated m3 (CHOW & CHANG, 1961, Pl. 1, Figs. 2, 2a), so, first, there is no information on the symphyseal length in this taxon and, second, in the absence of comparable material it

⁹ The tip of the symphysis of the Bossilkovtsi specimen, stored at RHMR, has later been slightly damaged. Currently it is restored in plaster, obscuring its original deflected shape (pers. obs.).

is impossible to prove or reject conspecificity between the type of *Z. shansiensis* and the juvenile hemimandible described by HOPWOOD (1935). Thus, the problem of the synonymy between *Z. shansiensis* and “*M.*” *borsoni* remains unclear, as well as the taxonomic position of the juvenile specimen from Shanxi – which could represent yet another (unnamed) species of the unnamed genus including “*M.*” *borsoni* and “*M.*” *obliquephus*.

Important localities and material:

In addition to Romanovka and the unknown precise locality of the Balta Sands already mentioned, mandibles with a long symphysis and *borsoni*-like teeth are known from Ferladany in Moldova (PAVLOW, 1894, Pl. 3, Fig. 5, 5a, as *Mastodon borsoni*), and Ahmatovo in Bulgaria (NIKOLOV & KOVAČEV, 1966, Pl. 2, Fig. 1, as *Zygodon borsoni*). Juvenile remains are known from Pikermi in Greece (mandible and palate stored at MNHN: GAUDRY, 1862; see also TASSY, 1985; unpublished skull with mandible at NHM: TASSY, 1985; pers. obs. NHM, 2006), “RZO-24” in Greece (unpublished skull: KOUFOS, 1980, as *Mammot tapiroides*), Belka in Ukraine (skull with mandible: KOROTKEVICH, 1988, Pl. 25b, as *Turicius turicensis*; only a photo is provided). Deciduous dentition from Halmyropotamos (Greece) published by MELENTIS (1967) as *Mastodon (Zygodon) tapiroides* is another example, as well as unpublished remains from Hadzhidimovo at NMNHAs, and the area of Veles at MNMH (pers. obs., MNMH, 2003). A d4 from the Turolian locality Csákvár (Hungary), referred by GASPARIK (2001) to *Z. turicensis* has a morphology close to “*M.*” *borsoni* (pers. obs., HNHM, 2005) and thus most probably belongs to “*M.*” *obliquephus* too, as well as the mammutids from other Turolian localities in Hungary (see GASPARIK, 2001). Similarly, the M1 from the Turolian locality Las Pedrizas (Teruel, Spain), referred by MAZO (1996) to *Z. turicensis* should rather be attributed to “*M.*” *obliquephus*, as well as the material from “RZO 5” in Greece (DE BONIS et al., 1992a) and the Turolian (MN12) locality Morskaya 2 in South Russia (Sea of Azov region), attributed by TITOV et al. (2006) to *Mammot borsoni*. Another possible locality of “*M.*” *obliquephus* in Eastern Europe is Curtea de Argeș in Romania with material described by ATHANASIU (1907)¹⁰. Also, the Italian locality Gravittelli, MN13 (ROOK, 1992: “*Z. borsoni* and *Z. turicensis*”) might mark the occurrence of “*M.*” *obliquephus* in the country.

Worth mentioning is a skull from Topolčani in Slovakia, published by SCHMIDT (1963) as “*Tetralophodon grandincisivus*” but, as noted by TOBIEN (1978), actually belonging to a mammutid. Without direct observations of the material I wouldn’t venture a more precise determination but the specimen is important in any case, being only the third adult mammutid skull from the Old World known so far. (The Topolčani skull was referred to *Mammot borsoni* by ČERNÁNSKÝ, 2006, who seemed to be unaware of Tobien’s comment).

In summary, “*Mammot*” *obliquephus* is present in Spain, several localities in Hungary, Bulgaria, Macedonia, Greece, ? Romania, Moldova, Ukraine and southern Russia (e.g. mainly in Central and Eastern Europe). Material includes mandible and skull fragment of an adult individual, several adult mandibles, three skulls with mandibles of juvenile individuals (all of them unpublished), a juvenile mandible and palate, deciduous dentition, and numerous isolated teeth that can only tentatively be attributed to the species basing on their Turolian age. Known time span: MN11 – MN12, with possible later occurrences.

¹⁰ Thus, while Schlesinger’s choice of taxonomy and concepts on mammutid evolution might be outdated, his suggestion (SCHLESINGER, 1922, p. 136) that mammutids from Curtea de Argeș, Ferladany, Pikermi and other “Pontian” localities belong to the same form seems to remain perfectly valid.

Choerolophodon pentelici* (Gaudry et Lartet, 1856)*Taxonomical remarks:**

Far less problematic compared to the rest of the taxa discussed here, the most important issue concerning *Choerolophodon pentelici* is the status of the Vallesian choerolophodons from Turkey which in turn influences the species' assumed time span. I regard *Ch. pentelici* as a Turolian species, characterized by a straight mandibular symphysis and strongly redressed perinasal area of the skull (see TASSY, 1985). I follow the suggestion made by TASSY (1985, p. 633, 646) that Vallesian material, and especially the skull from Akın in Turkey, described by GAZIRY (1976, Pl. 6, Fig. 1-5), represents a different, and more primitive, species. Thus, I agree with SANDERS (2003) that the Vallesian species, referred to as *Choerolophodon anatolicus* (Ozansoy, 1965) by that author¹¹, includes “*Choerolophodon pentelici lydiensis*” described by TASSY et al. (1989); unlike SANDERS (2003), however, I am not convinced that MN11 material from the lower levels of Kemiklitepe (KTD66), referred to *Choerolophodon pentelici* ssp. indet. by TASSY (1994), should be excluded from *Ch. pentelici*. Rather, judging from the straight ventral border of the symphysis in KTD66 (see TASSY, 1994, Pl. 1), this specimen seems indeed to represent early *Ch. pentelici*. In addition, accepting the separate specific status of Vallesian choerolophodonts does not necessarily mean that any Vallesian find should be automatically excluded from *Ch. pentelici*: it is possible that the replacement of the earlier and more primitive species by *Ch. pentelici* took place as early as the latest Vallesian.

Important localities and material:

Pikermi, the type locality, has yielded mandibles and skulls of juvenile individuals. Craniomandibular finds of adults are rare – several mandibles and hemimandibles from the area of Burgas in Bulgaria (see BAKALOW, 1911; BAKALOV & NIKOLOV, 1962 – misidentified as “*Trilophodon*” *angustidens*: TASSY, 1983; APOSTOLOV & NIKOLOV, 1985, as *Choerolophodon* (*Synconolophus*) *serridentinoides*; unpublished material at NMNH), an unpublished mandible with both third molars from Ezerovo and an unpublished skull with damaged teeth from Ahmatovo (both at NMNHAs) are among the few specimens known so far. The species is known from Macedonia (the area of Veles: ĆIRIĆ, 1957; pers. obs., MNHN, 2003) which seems to mark the limit of its distribution in the west, from Bulgaria, Greece (Pikermi, Samos, Halmyropotamos etc.: DE BONIS et al., 1994), Turkey (GAZIRY, 1976; TASSY, 1994, 2005), Moldova (localities listed by LUNGU & OBADA, 2001 but also Lozovo: PIDOPLICHKO, 1956, Pl. 15, Fig. 3, misidentified as *A. arvernensis*), Ukraine (localities listed by KOROTKEVICH, 1988 and KRAHMALNAYA, 1996 but also Grebenniki: BURCHAK-ABRAMOVICH, 1940, Fig. 2, misidentified as *T. longirostris*: P. Tassy, pers. comm. 2002), possibly Romania (ȘTIUCA, 2003)¹², Iran (Maragheh: SCHLESINGER, 1917; DE MECQUENEM, 1924, etc.), and Iraq (Injana: see THOMAS et al., 1980).

In summary, *Choerolophodon pentelici* seems to be confined to the area from present-day Macedonia and Greece in the west, through Bulgaria, Romania, Moldova, Ukraine and Turkey to Iran and Iraq in the east. Material includes skulls and mandibles of juvenile as well as adult

¹¹ It is possible that *Choerolophodon serridentinoides* (Viret et Yalçınlar, 1952) is a senior synonym for *Ch. anatolicus*.

¹² The hemimandible (of unclear precise age) from Bacău in Romania, referred by RĂDULESCU & ȘOVA (1987, Pl. 1, Fig. 1) to *Ch. pentelici*, seems to have a deflected symphysis, judging from the photo, and more probably belongs in the Vallesian species of *Choerolophodon*.

individuals, isolated dental and postcranial remains. Assumed time span depends on adopted taxonomy (i.e. status of Vallesian and MN11 choerolophodonts) and is most probably MN11 – MN12, with reported presence in MN13 needing further evidence.

“*Mastodon*” *grandincisivus* Schlesinger, 1917

Taxonomical remarks:

Attributed by previous authors to *Tetralophodon* and *Stegotrabelodon*, “*Mastodon*” *grandincisivus* is actually an amebelodontid, as demonstrated by TASSY (1985) and belongs to a yet undescribed genus, diagnosis of which was practically provided by TASSY (1985, 1999). In this paper, Tassy’s provisional designation as “*Mastodon*” (in quotation marks) is followed (another provisional solution, attributing the species to *Amebelodon* was employed by GERAADS et al., 2005; in my opinion, tetralophodont intermediary teeth and tubular dentine of the lower tusks are too important differences, preventing attribution to *Amebelodon*).

Important localities and material:

The uncertain taxonomic position of “*M.*” *grandincisivus* is mostly due to the scarcity of known material (or, more precisely, of published material). The holotype from Maragheh, Iran, is a lower tusk (SCHLESINGER, 1917). Mandibles of adult individuals lacking symphyses are known from Pestszentlőrincz in Hungary (SCHLESINGER, 1922, Pl. 2- 3) and Oryahovo in Bulgaria (BAKALOV & NIKOLOV, 1962, Pl. 66). It is important to note that photo of the Oryahovo mandible in BAKALOV & NIKOLOV (1962) is extremely misleading since it is taken after a “reconstruction” of the specimen: the whole symphysis is rebuilt (pers. obs., SU), obviously following the reconstruction in SCHLESINGER (1922, Pl. 1); parts of the mandibular branches are reconstructed too. The real shape of the symphysis in “*M.*” *grandincisivus* is observable in a unique juvenile mandible from Hadzhidimovo, Bulgaria (unpublished), stored at NMNHAs (coll. no. HD38029). At Pestszentlőrincz, as well as Oryahovo, mandibles are associated with lower tusks matching the type specimen from Maragheh (thus permitting their attribution to “*M.*” *grandincisivus*), upper tusks and third molars, and, in the Hungarian locality, with postcranial remains. The only known skull of the species is from the mine Maritza – Iztok in Bulgaria and was recently published by KOVACHEV (2006) (as *Stegotrabelodon grandincisivus*; note that despite being dated 2004 this work appeared in 2006).

Apart from these, isolated finds attributable to “*M.*” *grandincisivus* are known from Kertch in the Ukraine, Amasya in Turkey (GAZIRY, 1976), the area of Burgas in Bulgaria (MARKOV, 2004b) and several localities in Hungary (GASPARIK, 2001; pers. obs. HNHM, 2005). The species (or a closely related form) seems to be present at Cherevichnoe and Novoukrainka in the Ukraine (KOROTKEVICH, 1979), Sahabi in Libya¹³ and Jebel Barakah, UAE (TASSY, 1999), and possibly in the Indo-Pakistan region as well (TASSY, 1983, 1985). For Pakistan, another find deserves a brief comment: U.Z. 69/636, left and right m3 from Lehri (Punjab), published by SARWAR (1977, Figs. 48 and 49) as “*Anancus osborni*”. It was suggested by TASSY (1983) that U.Z. 69/636 might belong to *Paratetralophodon hasnotensis*. Lophid number and structure, however,

¹³The hypodigm of “*Amebelodon cyrenaicus*”, described by GAZIRY (1987) from Sahabi seems to be heterogeneous: judging from the collection numbers, referred specimens are from several different localities and none of them is in any way associated with the type. The type might belong to “*M.*” *grandincisivus* as suggested by TASSY (1999), as well as part of the material referred to *Stegotrabelodon lybicus* (e.g. GAZIRY, 1987, Fig. 11).

speak against this (H. Saegusa, pers. comm. 2007)¹⁴. U.Z. 69/636, while certainly no *Anancus*, apparently represents a new elephantoid taxon that could be related to “*M.*” *grandincisivus* (H. Saegusa, G. N. Markov, unpublished data). Further east, an incomplete third upper molar from Shanxi, China, holotype of *Gomphotherium changzhiensis* Zhai, 1963, resembles “*M.*” *grandincisivus* in the significant amounts of cement and the morphology of the loph (“L-shaped”, after the original description by ZHAI, 1963, and mesio-distally compressed). The specimen was referred to *Choerolophodon* sp. by TOBIEN et al. (1986, p. 144) but the morphology of the preserved lophs is not typically choerodont, and the enamel is smooth. The presence of *Choerolophodon* in China is far from certain (TASSY, 1994), and the Shanxi molar is worth having in mind as a possible indication for the occurrence of a *grandincisivus*-like elephantoid in East Asia.

Another European locality yielding “*M.*” *grandincisivus* seems to be Pikermi: unpublished juvenile lower tusks stored at MNHN – Paris and NHM – London probably belong to that species (pers. obs. MNHN, 2004, NHM, 2006), and a maxillary fragment with D2-D4 figured by MARINOS & SYMEONIDIS (1974, Pl. 7) and misidentified as *Cb. pentelici* by these authors is either *Tetralophodon atticus* or “*Mastodon*” *grandincisivus* (since geographic and chronological distribution of these two taxa overlap, determination cannot be certain). Note that while BERNOR et al. (1996) listed “*Stegotetralodon grandincisivus*” from Pikermi, the taxon they had in mind is *Tetralophodon atticus*: TASSY (2005).

In addition, material from the Vallesian locality Yulaflı in Turkey was referred to *Amebelodon grandincisivus* by GERAADS et al. (2005), who hinted that Vallesian “*grandincisivus*” might differ at the specific level from Turolian “*M.*” *grandincisivus* proper. Bearing in mind that this is precisely the case with Vallesian vs. Turolian *Deinotherium*, *Choerolophodon* and *Tetralophodon*, this is a very plausible suggestion. Moreover, according to GERAADS et al. (2005), Oryahovo material has the closest morphology to Yulaflı, and since the Oryahovo find is isolated it might actually represent this Vallesian form and not “real” “*M.*” *grandincisivus*. This might also be the case with material from Austria: two second upper molars from Belvedere described by SCHLESINGER (1917, p. 100) and referred by that author to *T. longirostris*, are very similar to the M2 from Yulaflı figured by GERAADS et al. (2005, Fig. 4E), their complex morphology – double trefoil pattern with additional heavy posttrite ornamentation (pers. obs., NHMW, 2006; on loph(id) structure of *Tetralophodon* see SAEGUSA et al., 2005) fitting better with an identification as “*M.*” *grandincisivus* or a closely related form. Other Austrian material possibly belonging in that taxon (Mannersdorf bei Angern, Haag and Fischamend) was discussed by TOBIEN (1978) who suggested a Turolian age for it. Considering Turkish Vallesian material, however, this need not necessarily be the case.

In summary, albeit rare, the known finds of “*Mastodon*” *grandincisivus* seem to give a fairly correct idea of its distribution area: from Central Europe (Hungary and possibly Austria) through the Balkans (Bulgaria, ?Greece) and Ukraine to Iran. The species seems to have occurred in Libya and the United Arab Emirates too; Vallesian finds from Turkey, as well as late Miocene material from Indo-Pakistan might represent close but not necessarily identical taxa. Material includes a skull, two fragmented mandibles of adult individuals, one mandible of a juvenile individual, postcranials and isolated teeth. The few Turolian localities of known precise age are all MN12; the species must have appeared in Europe in MN11 or even earlier, if the Turkish

¹⁴ Incidentally, NHM M18670, an unpublished right m3 from the Middle Siwaliks, has the morphology that could be expected for lower third molars in *P. hasnotensis* (pers. obs. NHM, 2006).

MN10 material is conspecific with the rest. Similarly, if the Sahabi material belongs to “*M.*” *grandincisivus*, it might mark one of the last appearances of the species, in MN13.

***Tetralophodon atticus* (Wagner, 1857)**

Taxonomical remarks:

Apart from treatment by OSBORN (1936) of *Mastodon atticus* as a mammutid, there seems to be no particular controversy about the name and phylogeny of this species. TASSY (1996) suggested that *T. atticus* might be a primitive *Stegotetralodon*. To some extent, this is a matter of terminology (considering the likely descent of elephants from a derived African *Tetralophodon*, the distinction between “derived *Tetralophodon*” and “primitive *Stegotetralodon*” is becoming increasingly technical). Still, if a line must be drawn between derived tetralophodont gomphotheres and primitive elephants, a useful criterion would be the occlusal motion as discussed by SAEGUSA (1996). If propalinal motion is taken to be a trait defining elephantids (and stegodontids) but not tetralophodont gomphotheres, *T. atticus* – judging from the few known permanent molars – should rather be assigned to tetralophodont gomphotheres, i.e. to *Tetralophodon*.

Important localities and material:

Very few remains have been referred to *T. atticus* in the literature, either originally or by subsequent revisions: two palatal fragments and a hemimandible of juvenile individuals from Pikermi, Greece, upper third molar from the same locality, and juvenile remains from Taraklia, Moldova, originally published by KHOMENKO (1914) which might be *T. atticus* but also “*M.*” *grandincisivus* (see TASSY, 1985 for details), as well as new material from Akkaşdağı, Turkey (TASSY, 2005)¹⁵. The material, however, seems to be a lot richer than that, including specimens referred to other taxa (mostly *T. longirostris*, but also *Ch. pentelici* and others) as well as unpublished finds. Among the most important are a skull with M1-M2 and M3 erupting, from Dolni Disan in Macedonia, published by GAREVSKI (1976b) (as *Bunolophodon longirostris*; this is the only adult skull of *T. atticus* known so far), juvenile mandible with skull fragment from Cimişlia in Moldova (SIMIONESCU & BARBU, 1939), unpublished juvenile mandible from Hadzhidimovo in Bulgaria, and an unpublished juvenile skull from Kalimantsi (also in Bulgaria; the skull might alternatively belong to “*M.*” *grandincisivus*) (MARKOV, 2004a, 2004b). Similarly, the maxillary fragment from Pikermi figured by MARINOS & SYMEONIDIS (1974) is either *Tetralophodon atticus* or “*Mastodon*” *grandincisivus* as said above.

In Western Europe, *T. atticus* seems to be present at the Turolian locality Dorn-Dürkheim 1 in Germany with material figured by GAZIRY (1997, Pl. 1, Fig. 1; Pl. 4, Fig. 1-3; and Pl. 5) and

¹⁵ A right M3 from Belvedere (Vienna, Austria) referred by SCHLESINGER (1917, Pl. 17, Fig. 3) to “forma *attica*” (i.e. *T. atticus*) is indeed similar to the Pikermi M3 published by VACEK (1877, Pl. 7, Fig. 1) in its number of lochs (six); this number, however, is known to occur in *T. longirostris* too (see TASSY, 1985, Fig. 292 C: morphe complexe). The complex morphology of the Belvedere third molars (a left M3, apparently from the same individual as the figured M3d, is stored at NHMW: pers. obs., 2006) differs from the Turolian material from SE Europe but also from “*M.*” *grandincisivus* (which might be present at Belvedere: see above). Tetralophodons from the late Miocene of Austria are problematic in general: derived characters displayed by specimens from e.g. Mannersdorf bei Angern, Stettenhof, Belvedere (SCHLESINGER, 1917) and Hohenwarth (ZAPFE, 1957) show evolutionary tendencies in a rather different direction than those in *T. atticus*. Equivocal information on the precise age of some of the Austrian localities further obscures the mechanism of replacement of *T. longirostris* by *T. atticus* around the Vallesian / Turolian transition. A brief co-existence of different species of *Tetralophodon* in the latest Vallesian / earliest Turolian cannot be ruled out entirely.

attributed by this author to several different taxa; in my opinion, the only other elephantoid at Dorn-Dürkheim 1, co-occurring with *T. atticus*, is *Anancus* (see below). A posterior third molar fragment from the surroundings of Teschen in Silesia (now Cieszyn and Český Těšín in Poland and the Czech Republic) figured by SCHLESINGER (1917, Pl. 17, Fig. 2, as “*M. (B.) longirostre* forma *sublatidens* nova forma”) is very similar in its morphology (lophs compressed mesio-distally, reduced accessory conules, cementodonty) to Turolian material referred by MARKOV (2004b) to *T. atticus* and might belong to that species. Finds from the Turolian of Hungary (Gubacs, Baltavár, Polgárdi, Csákvár: SCHLESINGER, 1922; GASPARIK, 2001) belong, I believe, to *T. atticus*, as well as material from Taraklia in Moldova described by RIABININ (1929), the Ukrainian localities Grebenniki (BURCHAK-ABRAMOVICH, 1940), and Novaya Emetovka – Kostev Ovrág (KOROTKEVICH, 1988, Pl. 25; only a photo is provided). Tetralophodons reported from the Turolian of Greece (e.g. Kerassía: “*Tetralophodon* cf. *longirostris*”, THEODOROU et al., 2003) more probably belong in *T. atticus* and not *T. longirostris*. The juvenile skull fragment from Maragheh, Iran, attributed by SCHLESINGER (1917, Pl. 11) to *T. longirostris* might belong to “*M.*” *grandincisivus* as noted by TASSY (1986), but three deciduous premolars from Maragheh stored at MNHN and erroneously referred to *Ch. pentelici* by DE MECQUENEM (1924, Pl. XIX, Figs. 6, 9) match closely the type of *T. atticus* from Pikermi (pers. obs., MNHN 2005) and, in my opinion, demonstrate that *T. atticus* and “*M.*” *grandincisivus* co-occur at Maragheh¹⁶. Finally, the “tetralophodont gomphotheriid indet.” reported by BRUNET et al. (1984) from Molayan in Afghanistan, should, if tetralophodont indeed, belong either to *T. atticus* or to “*M.*” *grandincisivus*.

Worth noting is the material from Crevillente 2 (Spain, MN11), described by MAZO & MONTOYA (2003) as “*Tetralophodon* cf. *longirostris* ‘grandincisivoform’”. The *Tetralophodon* from Crevillente 2 has a similar development of the mandibular symphysis as that observed in *T. atticus* (see TASSY, 1985 on that character) but is significantly more derived in its dental morphology and probably represents a new species (H. Saegusa, G. N. Markov, unpublished data). The presence in the early Turolian (MN11) of Spain of a *Tetralophodon* species more derived than *T. atticus* (the type locality of which is MN12), together with the evolutionary tendencies observed in the Austrian specimens mentioned above, aptly demonstrates the complex history of European tetralophodons and, in my opinion, supports the idea that Turolian tetralophodons were new immigrants to Europe rather than descendants of the Vallesian species.

In summary, *Tetralophodon atticus* is known from Turolian localities ranging from Germany in the west through Central Europe, the Balkans (Greece, Macedonia, Bulgaria), Turkey, Moldova and Ukraine, to Iran in the east. Material includes an adult skull, several juvenile mandibles and maxillary fragments, deciduous and permanent teeth, and probably a skull of a juvenile individual (which, alternatively, could belong to “*M.*” *grandincisivus*). Known time span is MN11 – MN12, with possible occurrences in MN13.

***Anancus* sp.**

Taxonomical remarks:

While there seems to be a consensus on the occurrence of anancines in the Turolian of Europe, differing from *Anancus arvernensis*, numerous problems remain unresolved, including the name to

¹⁶ Co-occurrence of *Tetralophodon* and “*M.*” *grandincisivus* or a related species seems to have been anything but exceptional, with Yulafli being one of the earliest examples, as well as probably Belvedere and Mannersdorf bei Angern. The genus represented by “*M.*” *grandincisivus* apparently coexisted with members of the TGSE clade throughout its entire distribution area, from North Africa to Pakistan and (possibly) China.

be used. TASSY (1986) employed the name cf. *Anancus* sp. (suggesting that this species, together with Indian *A. perimensis* and Chinese *A. cuneatus* / *paisuyensis*, belongs to the stem-group of *Anancus*), and two decades later *Anancus* sp. remains the least controversial designation. A key issue is the material from Dorn-Dürkheim 1, attributed by GAZIRY (1997) to four different taxa – *Tetralophodon longirostris*, *Anancus arvernensis turoliensis*, *Stegotetabelodon lehmanni* and *Stegolophodon caementifer* (the latter three being newly erected by GAZIRY, 1997). METZ-MULLER (2000) revised the material and acknowledged the presence of two elephantoid taxa – *Tetralophodon longirostris* and an unnamed *Anancus* species, (appearing as “*Anancus* sp. 2 de Dorn-Dürkheim” on e.g. Fig. 91; her “*Anancus* sp. 1 de Hohenwart” is based on material that belongs in *Tetralophodon*: H. Saegusa, pers. comm.). At first glance, Metz-Muller’s decision not to name what she apparently recognized as a new species is justified, since the quoted source (METZ-MULLER, 2000) is an unpublished PhD thesis, and any new name provided would technically be a *nomen nudum*. However, the material referred to *Anancus* sp. by METZ-MULLER (2000) includes the holotype of *Stegotetabelodon lehmanni* Gaziry, 1997, so Metz-Muller’s conclusion that the species *Stegotetabelodon lehmanni* is not valid is erroneous: following her arguments, the name *Anancus lehmanni* (Gaziry) should be adopted for the Turolian anancine present at Dorn-Dürkheim 1. This would seem to solve the name problem but several more points must be considered: Agreeing with METZ-MULLER (2000) that the genera *Tetralophodon* and *Anancus* co-occur at Dorn-Dürkheim 1, I think that the first is represented not by *T. longirostris* but by *T. atticus*, the Turolian species of the genus (including holotype as well as figured referred specimens of “*Stegolophodon caementifer*” – a taxon not discussed at all by METZ-MULLER, 2000, and part of the hypodigm of “*Stegotetabelodon lehmanni*”). The holotype of *Anancus arvernensis turoliensis*, referred by METZ-MULLER (2000) to *T. longirostris*, does not, in my opinion, belong either to that species or to *T. atticus* but to *Anancus*. If I am correct, the binomen *Anancus turoliensis* Gaziry, 1997 needs discussion as a possible alternative to *Anancus lehmanni* (Gaziry, 1997). According to Article 24.1 of the International Code of Zoological Nomenclature (providing synonymy between *A. turoliensis* and *A. lehmanni* is accepted), the name *A. lehmanni* should take precedence, being initially proposed at higher rank (see also Article 61.2.1 of The Code). The problem, however, is if the two types are indeed conspecific, and if DD 3151 (M3d, type of “*St.*” *lehmanni*) adequately demonstrates morphological differences between the Turolian species and *A. arvernensis*.

Adequacy of type specimens is a problem affecting two potential senior synonyms too (although these names are obscure, rarely used, and generally considered to be synonymous with *A. arvernensis*, none of them is technically *nomen oblitum* and thus a short discussion is necessary): *Mastodon intermedius* Eichwald from the area of Kremenetz in Volhynia, then Russian Empire (now Kremenets, western Ukraine) is based on a hemimandible with worn m2-m3 and thus is *nomen dubium* at best, displaying general anancine morphology. Eichwald changed more than once his opinion whether the specimen represents an upper or a lower jaw fragment; while it is evident from his works – e.g. EICHWALD (1835, 1853) – that both designations refer to the same specimen, OSBORN (1936) apparently did not notice that and considered the “type” (a maxilla that never existed) lost, designating the hemimandible as paralectotype). The find comes from an area that has yielded mainly Turolian taxa and thus could theoretically belong to the Turolian anancine species but usage of the name is certainly not to be recommended¹⁷.

¹⁷ To further complicate things, *Mastodon intermedius* Teilhard et Trassaert, 1937, type species of *Sinomastodon* Tobien, Cheng et Li, 1986, is a junior primary homonym of *Mastodon intermedius* Eichwald, 1831. Obviously, suppressing the name *Sinomastodon intermedius* (Teilhard et Trassaert), would be a particularly bad decision.

Mastodon arvernensis var. *progressor* Khomenko, 1912, is based on a mandible from Gavanoşy, Bessarabia (now Gavanoasa, Moldova) which displays no clear morphological differences compared to *A. arvernensis*, apart from a slightly longer mandibular symphysis. Anyway, lower molars with anancine affinities from Dorn-Dürkheim 1 differ little from *A. arvernensis*, and it seems that any taxon based on lower teeth would be of doubtful position.

Thus, although it seems that – for the time being at least – the appropriate name for the Turolian *Anancus* of Europe is *Anancus lehmanni* (Gaziry), I adopt a more cautious approach and use the name *Anancus* sp., considering that relations to (and possible synonymy with) other primitive anancines from Asia, such as *A. cuneatus* / *paisuyensis* remain unresolved. In addition, some of the Turolian finds from Europe do not differ drastically from the type specimen of *Anancus osiris*, described by ARAMBOURG (1946, Pl. 9, Fig. 1) from the area of Giza in Egypt (the precise age of the locality is unknown). While not necessarily conspecific with the Turolian anancines of Europe, *A. osiris* might be their descendant, evolving in Africa in parallel with *A. arvernensis* (*A. osiris* and *A. arvernensis* were considered sister taxa by TASSY, 1986). Finally, lumping all Turolian *Anancus* finds from Europe into one species might be over-simplistic but available material is insufficient, in my opinion, for any less vague conclusions.

Important localities and material:

Material consists of isolated dental remains (and several mandibles or mandibular fragments), making the Turolian anancines the most problematic of all taxa discussed here. Apart from Dorn-Dürkheim 1, type locality of *Anancus lehmanni*, Turolian anancines occur at localities in Spain (e.g. Alfacar: BERGOUNOIX & CROUZEL, 1958; TASSY, 1986), Hungary (GASPARIK, 2001; pers. obs. HNHM and HGI, 2005), Bulgaria (e.g. Ezerovo, Ahmatovo: MARKOV, 2004a, 2004b).

In summary, Turolian anancines are known from localities in Spain, Germany, Hungary and Bulgaria, and might be present at other Central and Eastern European localities too. The available material is scarce, consisting almost entirely of isolated molars. Compared to *A. arvernensis*, differences in the morphology of lower molars are subtle, so the determination even of a preserved mandible can only be tentative, and influenced by assumed Turolian age: a result that is far from satisfactory. The material permits no definite conclusions even on the number of anancine species (one or more) in the Turolian of Europe, leaving problems of taxonomy, range and time span open. The first appearance of *Anancus* seems to have been not earlier than MN12 (although Dorn-Dürkheim 1 is supposed to be of MN11 age, it seems to contain reworked fossils, and both GAZIRY, 1997, and METZ-MULLER, 2000, assumed a MN12 age for the proboscideans). *Anancus* is notably absent from early MN12 localities such as Pikermi or Hadzhidimovo, and while having in mind possible gaps in the fossil record, it seems plausible that the first occurrences of the genus in Europe were indeed in late MN12.

Discussion, summary and conclusions

The picture emerging from this overview could be summarized thus: at the beginning of the Turolian, an association of five proboscidean species (each representing a different clade) appears in Europe, apparently migrating from the east. The idea of faunal migrations from

West Asia to Europe around the Vallesian / Turolian transition is certainly not new, and neither is the observation on taxa shared by e.g. Balkan and Iranian Turolian localities (see for example DE BONIS et al., 1992a, 1992b, 1994, and sources therein) but analyses often either omit proboscideans, or employ inaccurate taxonomy. Choice of taxonomy can obviously influence – and influence heavily – conclusions on migrations, faunal composition and diversity, regionality, etc. Some examples: BERNOR et al. (1996) listed, as said above, “*Stegotetabelodon grandincisivus*” from Pikermi actually meaning *Tetralophodon atticus*. At the generic level, this results in a taxon shared by Sahabi (type locality of *Stegotetabelodon syrticus*) and Pikermi for entirely wrong reasons (ironically, Sahabi and Pikermi seem to share a taxon indeed: “*M.*” *grandincisivus*, which however has nothing to do with *Stegotetabelodon*). If, on the other hand, *T. atticus* is regarded as a primitive *Stegotetabelodon* as suggested by TASSY (1996), Sahabi and Pikermi appear to share another taxon. If the mammutid occurring at the Turolian Hungarian locality Hatvan is attributed to *Zygalophodon*, this results in the apparent presence of a primitive relict taxon (see discussion in BERNOR et al., 2003); referring it to “*Mammul*” *borsoni* (GASPARIK, 2001) implies an early appearance of a Pliocene species; a determination as “*M.*” *obliquephus*, on the other hand, adds another “typical Pikerminian element” (in the expression of BERNOR et al., 2003) to the Hatvan fauna. Thus, choice of taxonomy could (and does) create the impression of Vallesian relicts in the Turolian (if *D. giganteum* and *D. gigantissimum*, or *T. longirostris* and *T. atticus* are lumped together, or “*M.*” *obliquephus* confused with *Z. turicensis*), or of early appearances of Pliocene taxa such as “*Mammul*” *borsoni* and *Anancus arvernensis*, if their late Miocene congeners are not recognized as separate species.

In my opinion, the five proboscideans that appear in the early Turolian of Europe (being part of the “Pikerminian biome”, a convenient label would be the “Pikerminian proboscidean fauna”, or PPF) are all immigrants, part of the large-scale late Miocene faunal migrations, and not Vallesian relicts, nor species evolving gradually in Europe from Vallesian ancestors. Three of the five PPF species (“*Mammul*” *obliquephus*, *Choerolophodon pentelici*, and “*Mastodon*” *grandincisivus*) have no closely related forms in the Vallesian of Europe and their origins are most probably Asiatic. “*Mammul*” *obliquephus* seems to be a descendant of Asiatic zygalophodons (see TASSY, 1985, and SAUNDERS & TASSY, 1989 on the origins of “*M.*” *borsoni*). Choerolophodons are generally an Afro-Asiatic group, and “*Mastodon*” *grandincisivus*, although of obscure origins, has no similarities to earlier European taxa. There is no evidence of direct relation between *Tetralophodon atticus* and *T. longirostris* (rather, judging from opposite tendencies in the mandibular morphology of these two taxa, they are not closely related). As for *Deinotherium gigantissimum*, a gradual evolution from *D. giganteum* in Europe is unlikely (as is generally the isolated gradual evolution of “lineages” within the small area of Europe). More probably, as with the other PPF species, *D. gigantissimum* is an immigrant displacing the earlier local species. (A useful parallel is the pattern of mammoth evolution in Eurasia as presented by LISTER & SHER, 2001; LISTER et al., 2005). Such a major proboscidean migration into Europe is not unprecedented: a similar event seems to have taken place in the middle Miocene, with the Astaracian arrival of *Choerolophodon* and *Platybelodon* (confined to the Eastern Mediterranean), and *Deinotherium* and *Tetralophodon* reaching Western Europe (see MARKOV, 2008). As with the Astaracian proboscideans, ranges reached by different PPF taxa vary: *Deinotherium gigantissimum*, “*Mammul*” *obliquephus* and *Tetralophodon atticus* spread across Western Europe but “*Mastodon*” *grandincisivus* was apparently confined to Central Europe and *Choerolophodon pentelici* is not known west of Greece and Macedonia.

On a larger scale, the PPF model seems to be generally operational, but perhaps oversimplistic, omitting several important details. One, distribution areas for each of the five PPF species do not overlap entirely (“*M.*” *grandincisivus* and *Ch. pentelici* confined to Central and Eastern Europe respectively; mammutids are so far absent from the Turolian localities of Turkey, Iran and Iraq). In fact, the only localities so far that have yielded all five PPF species (see Table 1) are Hadzhidimovo, Pikermi and Taraklia (presence of “*M.*” *grandincisivus* at the latter two is not entirely certain). Two, at least one of the PPF taxa, “*M.*” *grandincisivus*, might have been spread in territories beyond the PPF area – Sahabi in Libya, Jebel Barakah (UAE) and possibly Indo-Pakistan as well. It is very probable, however, that – as with the Vallesian and Turolian “grandincisivoids” – we are actually mixing different species due to scarcity of material, and it is the unnamed genus represented by “*M.*” *grandincisivus*, rather than the species itself, that occurs at the African and SW Asian localities. Last but not least, apparently more than the five PPF species (and, with *Anancus* sp., the six species) discussed here were present in the Turolian of Europe: as said, the *Tetralophodon* from Crevillente 2 probably represents a new species and not *T. atticus*; in addition, FERRETTI et al. (2003) reported *Stegotrabelodon syrticus* from Cessaniti in Calabria, Italy. Although these are isolated occurrences so far, finds from Crevillente 2 and Cessaniti demonstrate that proboscidean diversity in the Turolian was even higher – and further emphasize how different, and novel, the Turolian proboscidean fauna of Europe has been compared to the Vallesian.

As noted in the Introduction, these are preliminary results from an ongoing research. A thorough revision of the rich material stored at various collections in Moldova, Ukraine and Russia would doubtlessly add to the general picture outlined here, and – hopefully – permit providing revised diagnoses for the taxa discussed above (which, I believe, would be premature at present). Our knowledge on the five PPF species is gradually increasing, with new or revised finds providing additional information on various aspects of their morphology, status, and span. Turolian anancines, on the other hand, remain poorly known, and apart from a name (*A. lehmanni*) that might or might not be appropriate for them, little can be added to the discussion by TASSY (1986). Two more taxa, so far represented by isolated finds (*Tetralophodon* sp. at Crevillente 2 and *Stegotrabelodon* at Cessaniti), provide a good example for the complex pattern of proboscidean evolution and dispersals in the late Miocene.

Acknowledgements

Prof. P. Tassy and Dr. C. Sagne (MNHN); Drs. J. Hooker and A. Carrant (NHM); Prof. J. Szabó and Dr. M. Gasparik (HNHM); Prof. L. Kordos (HGI); Drs. G. Daxner-Höck and U. Göhlich (NHMW); Drs. G. Mladenovski and S. Petkovski (MMNH); Dr. N. Nenov and V. Petkov (RHMR); Drs. M. Ivanov, V. Stoyanova and S. Darakchieva (SU) for access to collections; Prof. R. Garevski (Skopje) for access to unpublished material and data; Pascal Tassy, Haruo Saegusa, Martin Pickford, Mihaly Gasparik, Denis Geraads, Ursula Göhlich, Marco Ferretti, William Sanders, Roman Croitor, Vadim Titov, Nikolai Spassov, Serdar Mayda and Csaba Toth for numerous valuable and inspiring discussions, shared information and help with sometimes arcane literature. The author gratefully acknowledges HNHM, NHMW, NHM and the financial support of the European Union for visits to Budapest (SYNTHEsys HU-TAF-1144), Vienna

(SYNTHESES AT-TAF-1640) and London (SYNTHESES GB-TAF-1641), and support from the exchange program between the Bulgarian Academy of Sciences and CNRS, Direction des Relations Internationales, for visits to MNHN – Paris.

References

- ALEXEEVA L. I. 1959. Significance of the mammals of the Armavir formation for the stratigraphy of the continental deposits on North Caucasus. – Trudy GIN AN SSR, **32**: 185-191. (In Russian).
- ALEXEEVA L. I. 1965. Stratigraphical review of the proboscideans of Eopleistocene (according to the materials of the European South of the USSR). – In: Quaternary Period and its History. Nauka, Moscow, 69-90. (In Russian).
- APOSTOLOV A., NIKOLOV I. 1985. Neue Funde von Tertiären und Quartären Säugetieren im Bezirk von Burgas (VR Bulgarien). – Geologica Macedonica, **2** (1): 121-145.
- ARAMBOURG C. 1946. *Anancus Osiris*, un Mastodonte nouveau du Pliocène inférieur d'Égypte. – Bulletin de la Société géologique de France (5), **15**: 479-495.
- ATHANASIU S. 1907. Contribuțiuni la studiul faunei terțiare de mamifere din România [Beiträge zur Kenntnis der Tertiären Säugetierfauna Rumäniens]. – Anuarul Institutului Geologic al României, **1** (1): 9-214.
- ATHANASSIOU A. 2004. On a *Deinotherium* (Proboscidea) finding in the Neogene of Crete. – Carnets de Géologie / Notebooks on Geology, Brest, Letter 2004/05 (CG2004_L05): 1-7.
- BACHMAYER F., ZAPFE H. 1969. Die Fauna der altpliozänen Höhlen- und Spaltenfüllungen bei Kohfidisch, Burgenland (Österreich). – Annalen des Naturhistorischen Museums in Wien, **73**: 123-139.
- BACHMAYER F., ZAPFE H. 1972. Die Fauna der altpliozänen Höhlen- und Spaltenfüllungen bei Kohfidisch, Burgenland (Österreich). Proboscidea. – Annalen des Naturhistorischen Museums in Wien, **76**: 19-27.
- BAJGUSHEVA V. S., TISHKOV M. Y. 1998. About the find of *Deinotherium giganteum* KAUP skeleton near Novochechensk town of Rostov Region. – In: Kiyashko V. Y. (ed.). Historical and archeological researches in Azov and on the Lower Don in 1995-1997, 15, Azov, 305-311. (In Russian).
- BAJGUSHEVA V. S., TITOV V. V. 2006. About teeth of *Deinotherium giganteum* Kaup from eastern Paratethys. – Hellenic Journal of Geosciences, **41**: 177-182.
- BAKALOV P. 1911. Beiträge zur Paläontologie Bulgariens. I. Mastodonreste aus Bulgarien. – Annuaire de l'Université de Sofia, **6**: 1-41. (In Bulgarian with German summary).
- BAKALOV P., NIKOLOV I. 1962. Les Fossiles de Bulgarie. X. Mammifères Tertiaires. BAS, Sofia, 162 p. (In Bulgarian with French summary).
- BERGOUNIOUX F.-M., CROUZEL F. 1958. Les Mastodontes d'Espagne. – Estudios Geológicos, **14**: 223-365.
- BERGOUNIOUX F.-M., CROUZEL F. 1959. *Dinotherium giganteum* à Alfacar (Granada). – Estudios Geológicos, **15**: 55-62.
- BERGOUNIOUX F.-M., CROUZEL F. 1962. Les Déinothéridés d'Espagne. – Bulletin de la Société géologique de France, **7**: 394-404.

- BERNOR R. L. 1986. Mammalian biostratigraphy, geochronology, and zoogeographic relationships of the late Miocene Maragheh fauna, Iran. – *Journal of Vertebrate Paleontology*, **6** (1): 76-95.
- BERNOR R. L., FEIBEL C., VIRANTA S. 2003. The Vertebrate Locality of Hatvan, Late Miocene (Middle Turolian, MN12), Hungary. – In: Petculescu A., Ştiucă E. (eds.). *Advances in Vertebrate Paleontology “Hen to Panta”*, Bucharest, 105-112.
- BERNOR R. L., SOLOUNIAS N., SWISHER C. C. III, VAN COUVERING J. A. 1996. The correlation of three classical “Pikermian” mammal faunas – Maragheh, Samos, and Pikermi – with the European MN unit system. – In: Bernor R. L., Fahlbusch V., Mittmann H.-W. (eds.). *The Evolution of Western Eurasian Neogene Mammal Faunas*. Columbia University Press, New York, 137-154.
- BRUNET M., HEINTZ E., BATTAIL B. 1984. Molayan (Afghanistan) and the Khaur Siwaliks of Pakistan: an example of biogeographic isolation of Late Miocene mammalian faunas. – *Geologie en Mijnbouw*, **63**: 31-38.
- BURCHAK-ABRAMOVICH N. 1940. Contribution to the Study of the Hipparionfauna of South Ukraine. I. Proboscidea from the Meotic Deposits of the Village Grebenniki, Tiraspol District (Moldavian SSR). – *AN URSR Geologichnii Zhurnal*, **7** (1-2): 27-52. (In Ukrainian with English summary).
- ČERNÁNSKÝ A. 2006. Revision of a mastodon find from the Neogene at Kuzmice near Topolčany (Slovakia). – *Slovak Geological Magazine*, **12** (1): 57-62.
- CHALWADDŽIEV M. 1986. Über einen Fund von *Zygolophodon borsoni* (Hays) bei dem Dorf Bossilkowzi, Bezirk Russe. – *Jahrbuch der Museen in Nordbulgarien*, **12**: 261-271. (In Bulgarian with German summary).
- CHOW M., CHANG Y. 1961. New Mastodonts from North China. – *Vertebrata PalAsiatica*, **5** (3): 245-262. (In Chinese with English summary).
- ĆIRIĆ A. 1957. Pikermiska fauna iz okoline Titovog Velesa. – *Glasnik Prirodniackog Muzeja Srpske Zemlje* (Bull. Mus. Hist. Nat. du Pays Serbe), Série A, **8**: 1-82.
- CODREA V. 1994. A priority issue: *Deinotherium proavum* Eichwald or *Deinotherium gigantissimum* Ştefănescu? – In: *The Miocene from the Transylvanian Basin – Romania, Cluj-Napoca*, 105-110.
- DE BONIS L., BOUVRAIN G., GERAADS D., KOUFOS G. 1992a. Diversity and paleoecology of Greek late Miocene mammalian faunas. – *Palaeogeography, Palaeoclimatology, Palaeoecology*, **91**: 99-121.
- DE BONIS L., BRUNET M., HEINTZ E., SEN S. 1992b. La province greco-irano-afghane et la répartition des faunes mammaliennes au Miocène supérieur. – *Paleontologia i Evolucio*, **24-25**: 103-112.
- DE BONIS L., BOUVRAIN G., GERAADS D., KOUFOS G. D., SEN S., TASSY P. 1994. Les gisements de mammifères de Miocène supérieur de Kemiklitepe, Turquie: 11. Biochronologie, paléocologie et relations paléobiogéographiques. – *Bulletin du Museum d’Histoire Naturelle, Paris, série 4, section C*, **16** (1): 225-240.
- DE MECQUENEM R. 1924. Contribution à l’étude des fossiles de Maragha. – *Annales de Paléontologie*, **13**: 135-60.
- EICHWALD E. 1835. De pecorum et pachydermorum reliquiis fossilibus in Lithuania, Volhynia et Podolia repertis. – *Nova acta Academiae Caesareae Leopoldino-Carolinae Germanicae Naturae Curiosorum*, **17**: 677-780.
- EICHWALD E. 1853. *Lethaea Rossica ou Paléontologie de la Russie*. Troisième volume. Schweizerbart, Stuttgart, 533 p.

- ERDRBRINK D. P., PIEM H. N. A., HEBEDA E. H., CUP C., DANKERS P., CLOETINGH S. A. P. L. 1976. The bone bearing beds near Maragheh in N. W. Iran. – Proceedings Koninklijke Nederlandse Akademie van Wetenschappen, Amsterdam, Series B, **79**: 97-113.
- FERRETTI M.P., ROOK L., TORRE D. 2003. *Stegotrabelodon* (Proboscidea, Elephantidae) from the Late Miocene of Southern Italy. – Journal of Vertebrate Paleontology, **23** (3): 659-666.
- FRANZEN J. L., STORCH G. 1999. Late Miocene mammals from Central Europe. – In: Agusti J., Rook L., Andrews P. (eds.). Hominoid Evolution and Climatic Change in Europe. Volume 1, The Evolution of Neogene Terrestrial Ecosystems in Europe, Cambridge University Press, Cambridge, 165-190.
- GAREVSKI R. 1976a. Ein weiterer Beitrag zur Kenntnis der Pikermifauna Mazedoniens. Die Dinotherienreste von der Umgebung T. Veles. – Fragmenta Balcanica Musei Macedonici Scientiarum Naturalium, **10** (3): 21-25.
- GAREVSKI R. 1976b. Weiterer Beitrag zur Kenntnis der Pikermifauna Mazedoniens. Der Mastodonschädel von der Umgebung des Dorfes Dolni Disan (Negotino). – Posebno Izdanje Musei Macedonici Scientiarum Naturalium, **7**: 21-26.
- GASPARIK M. 1993. Deinotheres (Proboscidea, Mammalia) of Hungary. – Annales historico-naturales Musei nationalis hungarici, **85**: 3-17.
- GASPARIK M. 2001. Neogene proboscidean remains from Hungary; an overview. – Fragmenta Palaeontologica Hungarica, **19**: 61-77.
- GAUDRY A. 1860. Résultats des fouilles exécutées en Grèce sous les auspices de l'Académie. – Comptes rendus hebdomadaires des séances de l'Académie des sciences, **51**: 802-804.
- GAUDRY A. 1862. Animaux fossiles et Géologie de l'Attique. Savy, Paris, 476 p.
- GAZIRY A. W. 1976. Jungtertiäre Mastodonten aus Anatolien (Türkei). – Geologisches Jahrbuch, **22**: 3-143.
- GAZIRY A. W. 1987. Remains of Proboscidea From the Early Pliocene of Sahabi, Libya. – In: Boaz N. T., El- Arnauti A., Gaziry A. W., de Heinzelin J., Boaz D. D. (eds.). Neogene Paleontology and Geology of Sahabi, Alan Liss Inc., New York, 183-203.
- GAZIRY A. W. 1997. Die Mastodonten (Proboscidea, Mammalia) aus Dorn-Dürkheim 1 (Rheinhessen). – In: Franzen J. L. (ed.). Die Säugetiere aus dem Turolium von Dorn-Dürkheim 1 (Rheinhessen, Deutschland). Courier Forschungsinstitut Senckenberg, **197**: 73-115.
- GERAADS D., KAYA T., MAYDA S. 2005. Late Miocene large mammals from Yulafli, Thrace region, Turkey, and their biogeographic implications. – Acta Palaeontologica Polonica, **50** (3): 523-544.
- GRÄF I. 1957. Die Prinzipien der Artbestimmung bei *Dinotherium*. – Palaeontographica, Abt. A, **108**: 131-185.
- HOPWOOD A. T. 1935. Fossil Proboscidea from China. – Palaeontologica Sinica, Series C, **9** (3): 1-108.
- HUTTUNEN K. 2002. Deinotheriidae (Proboscidea, Mammalia) dental remains from the Miocene of Lower Austria and Burgenland. – Annalen des Naturhistorischen Museums in Wien, **103 A**: 251-285.
- HUTTUNEN K. 2004. On a *Prodeinotherium bavaricum* (Proboscidea, Mammalia) skeleton from Franzensbad, Czech Republic. – Annalen des Naturhistorischen Museums in Wien, **105 A**: 333-361.
- HUTTUNEN K., GÖHLICH U. 2002. A partial skeleton of *Prodeinotherium bavaricum* (Proboscidea, Mammalia) from the Middle Miocene of Unterzolling (Upper Freshwater Molasse, Germany). – Geobios, **35**: 489-514.

- KHOMENKO J. 1914. La faune méotique du village Taraklia du district de Bendery. – Trudy Bessarabskago Obshestva Estestvoispytatelei i liubitelei estestvoznania (Trav. Soc. Nat. Bessarabie), **5**: 1-55. (In Russian with French summary).
- KOROTKEVICH E. L. 1979. Grandincisivoïd mastodonts of the northern Black Sea region in the Ukr. SSR. – Vestnik Zoologii, **4**: 34-40. (In Russian with English summary).
- KOROTKEVICH E. L. 1988. History of the formation of the Hipparion fauna of Eastern Europe. – Naukova Dumka, Kiev, 162 p. (In Russian).
- KOUFOS G. D. 1980. Paleontological and stratigraphical study on the continental Neogene deposits of Axios Basin. – Scientific Annals of the Faculty of Physics and Mathematics, University of Thessaloniki, **19**: 1-322. (In Greek).
- KOVACHEV D. 2006. [Dated 2004]. Cranium of *Stegotetrabelodon* (Proboscideo [sic], Mammalia) from the Neogene in the East Maritsa basin. – Review of the Bulgarian Geological Society, **65** (1-3): 167-173. (In Bulgarian with English summary).
- KOVACHEV D., NIKOLOV I. 2008. [Dated 2006]. *Deinotherium thraceiense* sp. nov. from the Miocene near Ezerovo, Plovdiv District. – Geologica Balcanica, **35** (3-4): 5-40.
- KRAHMALNAYA T. V. 1996. Hipparion fauna of the Old Meotian of the Northern Black Sea region. – Naukova Dumka, Kiev, 225 p. (In Russian with English summary).
- KUBIAK H. 1972. The Skull of *Mammot praetypicum* (Proboscidea, Mammalia) from the Collection of the Jagiellonian University in Cracow, Poland. – Acta Zoologica Cracoviensia, **17** (13): 305-324.
- LASKAREV V. 1948. Sur les restes fossiles de *Deinotherium* en Serbie. – Glasnik Prirodniackog Muzeja Srpske Zemlje (Bull. Mus. Hist. Nat. du Pays Serbe), Série A, **1**: 1-20. (In Serbian with French summary).
- LISTER A. M., SHER A. V. 2001. The Origin and Evolution of the Woolly Mammoth. – Science, **294**: 1094-1097.
- LISTER A. M., SHER A. V., VAN ESSEN H., WEI G. 2005. The pattern and process of mammoth evolution in Eurasia. – Quaternary International, **126-128**: 49-64.
- LUNGU A., OBADA T. 2001. Contributions to study of the Neogene representatives of Ordo Proboscidea (Mammalia) from Eastern Europe. – In: Cavaretta G., P. Gioia, M. Mussi, M.R. Palombo (eds). The World of Elephants. Proceedings of the 1st International Congress, Consiglio Nazionale delle Ricerche - Roma, 119-121.
- MARINOS G., SYMEONIDIS N. 1974. Neue Funde aus Pikermi (Attika, Griechenland) und eine allgemeine geologische Übersicht dieses paläontologischen Raumes. – Annales Géologiques des Pays Helléniques, **26**: 1-27.
- MARKOV G. N. 2004a. The fossil proboscideans of Bulgaria and the importance of some Bulgarian finds – a brief review. – Historia naturalis bulgarica, **16**: 139-150.
- MARKOV G. N. 2004b. The Fossil Proboscideans of Bulgaria. – Unpublished PhD Thesis, Sofia, 225 + 81 p. (In Bulgarian with English summary).
- MARKOV G. N. 2008. Fossil proboscideans (Mammalia) from the vicinities of Varna: a rare indication of middle Miocene vertebrate fauna in Bulgaria. – Historia naturalis bulgarica, **19**: 137-152.
- MAZO A. V. 1996. Gomphotheres and mammutids from the Iberian Peninsula. – In: Shoshani J., Tassy P. (eds). The Proboscidea. Evolution and Palaeoecology of Elephants and their Relatives, Oxford University Press, Oxford, New York, Tokyo, 136-142.
- MAZO A. V., MONTROYA P. 2003. Proboscidea (Mammalia) from the Upper Miocene of Crevillente (Alicante, Spain). – Scripta Geologica, **126**: 79-109.

- MELENTIS J. K. 1967. Studien über fossile Vertebraten Griechenlands. 19. Die Pikermi-Fauna von Halmyropotamos (Euboä, Griechenland), 1. Teil: Odontologie und Kraniologie. – *Annales Géologiques des Pays Helléniques*, **19**: 283-411.
- METZ-MULLER F. 2000. La population d'*Anancus arvernensis* (Proboscidea, Mammalia) du Pliocène de Dorkovo (Bulgarie); étude des modalités évolutives d'*Anancus arvernensis* et phylogénie du genre *Anancus*. – Unpublished doctoral thesis, Muséum National d'Histoire Naturelle, Paris.
- MUCHA B. B. 1980. A new species of yoke-toothed mastodont from the Pliocene of Southwest USSR. – In: Quaternary and Neogene faunas and floras of Moldavskaya SSR, Shtiintsa, Kishinev, 19-26. (In Russian).
- NIKOLOV I, KOVAČEV D. 1966. Pliozäne Säugetierfauna aus Assenovgrad. – Travaux sur la géologie de Bulgarie – série paléontologie, **8**: 131-142. (In Bulgarian with German summary).
- OSBORN H. F. 1936. Proboscidea. Vol. I. – American Museum Press, New York, xi + 802 p.
- PAVLOW M. 1894. Les mastodontes de la Russie et leurs rapports avec les mastodontes des autres pays. – Mémoires de l'Académie Impériale des sciences de St.-Petersbourg, **1** (3): 1-43.
- PAVLOW M. 1907. *Dinotherium giganteum* Kaup des environs de Tiraspol. – Annuaire géologique et minéralogique de la Russie, **9** (1-2): 1-7.
- PIDOPLICHKO I. G. 1956. Materials on the study of past faunas of the Ukr. SSR, Second Edition. – Academy of Sciences of the Ukr. SSR, Kiev, 236 p. (In Ukrainian).
- RĂDULESCU C., ȘOVA C. 1987. A preliminary note on a Late Miocene mammalian fauna from Moldavia (Romania). – Travaux de l'Institut de Spéologie "Émile Racovitza", **28**: 67-71.
- RIABININ A. N. 1929. Faune de mammifères de Taraklia. I. Carnivora vera, Rodentia, Subungulata. – Travaux de Musée Géologique près l'Académie des Sciences de l'URSS, **5**: 75-134. (In Russian with French summary).
- ROOK L. 1992. Italian Messinian localities with vertebrate faunas. – *Paleontologia i Evolució*, **24-25**: 141-147.
- SAEGUSA H. 1996. Sister group relationships within Elephantoidea as suggested by the occlusal direction of their teeth. – In: Ratanasthien B., Rieb S. L. (eds.). Proceedings International Symposium on Geology and Environment 31 January – 2 February 1996, 133-145.
- SAEGUSA H., THASOD Y., RATANASTHIEN B. 2005. Notes on Asian stegodontids. – *Quaternary International*, **126-128**: 31-48.
- SANDERS W. J. 2003. Proboscidea. – In: Fortelius M., Kappelman J., Sen S., Bernor R. L. (eds.). *Geology and Paleontology of the Miocene Sinap Formation, Turkey*, Columbia University Press, New York, 202-219.
- SARWAR M. 1977. Taxonomy and distribution of the Siwalik Proboscidea. – Bulletin of the Department of Zoology, University of the Punjab (New Series), Article **10**: 1-172.
- SAUNDERS J. J., TASSY P. 1989. Le mastodonte américain. – *La Recherche*, **209**: 452-461.
- SCHLESINGER G. 1917. Die Mastodonten des K. K. Naturhistorischen Hofmuseums. – Denkschriften des K. K. Naturhistorischen Hofmuseums, Geologisch-Paläontologische Reihe, **1**: 1-230.
- SCHLESINGER G. 1919. Die stratigraphische Bedeutung der europäischen Mastodonten. – Mitteilungen der Geologischen Gesellschaft in Wien, **11** (1918): 129-166.
- SCHLESINGER G. 1922. Die Mastodonten der Budapester Sammlungen. – *Geologica Hungarica*, **2** (2), 284 p.
- SCHMIDT Z. 1963. *Tetralophodon grandincisivus* Schlesinger, 1917 z pliocénu (pontu) v Kuzmiciach pri Topolčanoch. – *Geologické práce, Zprávy* **27**: 169-174.

- SIMIONESCU I., BARBU V. 1939. Mamiferele pliocene dela Cimişlia (România). III. Proboscidieni. – Academia Română Publicaţiunile Fondului V. Adamachi, **9** (52): 1-20.
- ŞTIUCA E. 2003. Note préliminaire sur les mammifères du Miocène de Reghiu (Dept. Vrancea, Roumanie). – In: Petculescu A., Ştiucă E. (eds.). *Advances in Vertebrate Paleontology “Hen to Panta”*, Bucharest, 113-116.
- TARABUKIN B. A. 1974. New data on the systematics, phylogeny and ecology of Suborder Deinotherioidea Osborn (1921). – In: *Mammals of the late Cenozoic from Southwestern USSR, Kishinev*, 77-90. (In Russian).
- TASSY P. 1983. Les Elephantoides miocènes du plateau du Potwar, groupe de Siwalik, Pakistan. – *Annales de Paléontologie (Vert.- Invert.)*, **69** (2): 99-136; (3): 235-297; (4): 317-354.
- TASSY P. 1985. La place des mastodontes miocènes de l’ancien monde dans la phylogénie des Proboscidea (Mammalia): hypothèses et conjectures. – Unpublished Thèse Doctorat ès Sciences, UPMC, Paris, 85-34, Volumes I-III.
- TASSY P. 1986. Nouveaux Elephantoides (Mammalia) dans le miocène du Kenya: essai de réévaluation systématique. – *Cahiers de Paléontologie. Éditions du Centre National de la Recherche Scientifique (CNRS), Paris*, 135 p.
- TASSY P. 1994. Les gisements de mammifères de Miocène supérieur de Kemiklitepe, Turquie: 7. Proboscidea (Mammalia). – *Bulletin du Muséum d’Histoire Naturelle, Paris, série 4, section C*, **16** (1): 143-157.
- TASSY P. 1996. Who is who among the Proboscidea? – In: Shoshani J., Tassy P. (eds.). *The Proboscidea. Evolution and Palaeoecology of Elephants and their Relatives*, Oxford University Press, Oxford, New York, Tokyo, 39-48.
- TASSY P. 1999. Miocene Elephantids (Mammalia) from the Emirate of Abu Dhabi, United Arab Emirates: Palaeobiogeographic Implications. – In: Whybrow P. J., Hill A. (eds.). *Fossil Vertebrates of Arabia*. Yale University Press, New Haven, 209-233.
- TASSY P. 2005. Proboscideans (Mammalia) from the late Miocene of Akkaşdağı, Turkey. – In: Sen S. (ed.). *Geology, mammals and environments at Akkaşdağı, late Miocene of Central Anatolia*. *Geodiversitas*, **27** (4): 707-714.
- TASSY P., SEN S., JAEGER J.-J., MAZIN J.-M., DALFES N. 1989. Une sous-espèce nouvelle de *Choerolophodon pentelici* (Proboscidea, Mammalia) à Esmé Akçaköy, Miocène supérieur d’Anatolie occidentale. – *Comptes rendus de l’Académie des sciences, Paris, Série II*, **309**: 2143-2146.
- THEODOROU G., ATHANASSIOU A., ROUSSIAKIS S., ILIOPOULOS G. 2003. Preliminary remarks on the Late Miocene herbivores of Kerassía (Northern Euboea, Greece). – In: Reumer, J. W. F., Wessels, W. (eds.). *Distribution and Migration of Tertiary Mammals in Eurasia. A volume in Honour of Hans de Bruijn*. *Deinsea*, **10**: 519-530.
- THOMAS H., SEN S., LIGABUE G. 1980. La faune Miocène de la Formation Agha Jari du Jebel Hamrin (Irak). – *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen, Series B*, **83** (3): 269-287.
- TITOV V. V., TESAKOV A. S., DANILOV I. G., DANUKALOVA G. A., MASHCHENKO E. N., PANTELEEV A. V., SOTNIKOVA M. V., SYCHEVSKAYA E. K. 2006. The First Representative Vertebrate Fauna from the Late Miocene of Southern European Russia. – *Doklady Biological Sciences*, **411**: 508-509. [Original Russian text published in *Doklady Akademii Nauk*, 2006, **411** (5): 715-717].
- TOBIEN H. 1976. Zur paläontologischen Geschichte der Mastodonten (Proboscidea, Mammalia). – *Mainzer geowissenschaftliche Mitteilungen*, **5**: 143-225.

- TOBIEN H. 1978. On the Evolution of Mastodonts (Proboscidea, Mammalia). Part 2: The bunodont tetralophodont Groups. – *Geologisches Jahrbuch Hessen*, **106**: 159-208.
- TOBIEN H. 1986. Die paläontologische Geschichte der Proboscider (Mammalia) im Mainzer Becken (BRD). – *Mainzer Naturwissenschaftliches Archiv*, **24**: 155-261.
- TOBIEN H. 1988. Contributions à l'étude du gisement miocène supérieur de Montredon (Hérault). Les grands mammifères. 7 – les proboscidiens Deinotheriidae. – *Palaeovertebrata*, Montpellier, Mémoire extraordinaire 1988: 135-175.
- TOBIEN H., CHEN G., LI Y. 1986. Mastodonts (Proboscidea, Mammalia) from the Late Neogene and Early Pleistocene of the People's Republic of China. Part 1: Historical Account; the Genera *Gomphotherium*, *Choerolophodon*, *Synconolophus*, *Amebelodon*, *Platybelodon*, *Sinomastodon*. – *Mainzer geowissenschaftliche Mitteilungen*, **15**: 119-181.
- TOBIEN H., CHEN G., LI Y. 1988. Mastodonts (Proboscidea, Mammalia) from the Late Neogene and Early Pleistocene of the People's Republic of China. Part 2: The Genera *Tetralophodon*, *Anancus*, *Stegotetrabelodon*, *Zygodolophodon*, *Mammut*, *Stegolophodon*. Some generalities on the Chinese Mastodonts. – *Mainzer geowissenschaftliche Mitteilungen*, **17**: 95-220.
- TSOUKALA E. 2000. Remains of a Pliocene *Mammut borsoni* (Hays, 1834) (Proboscidea, Mammalia), from Milia (Grevena, W. Macedonia, Greece). – *Annales de Paléontologie*, **86** (3): 165-191.
- VACEK M. 1877. Über Österreichische Mastodonten und ihre Beziehungen zu den Mastodonarten Europas. *Abhandlungen der k. k. Geologischen Reichsanstalt*, **7** (4): 1-45.
- VISLOBOKOVA I., DAXNER-HÖCK G. 2004. The importance of Late Miocene faunal exchanges between Eastern Mediterranean Areas and Central Europe. – In: Chatzipetros A. A., Pavlides S. B. (eds.). *Proceedings of the 5th International Symposium on Eastern Mediterranean Geology*, vol. 1, 363-364.
- VISLOBOKOVA I. A., SOTNIKOVA M. V. 2001. Pliocene faunas with Proboscideans of the Former Soviet Union. – In: Cavaretta G., P. Gioia, M. Mussi, M.R. Palombo (eds.). *The World of Elephants. Proceedings of the 1st International Congress, Consiglio Nazionale delle Ricerche - Roma*, 157-160.
- WAGNER A. 1857. Neue Beiträge zur Kenntniss der fossilen Säugthier-Ueberreste von Pikermi. – *Abhandlungen der königlichen bayerischen Akademie der Wissenschaften, München, II. Cl.*, **8** (1): 109-158.
- ZAPFE H. 1957. Ein bedeutender Mastodon-Fund aus dem Unterpliozän von Niederösterreich. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen*, **104** (3): 382-406.
- ZHAI R. 1963. A New Species of *Gomphotherium* from Changzhi, SE. Shansi. – *Vertebrata Palasiatica*, **7** (1): 59-61. (In Chinese with English summary).

Received on 28.03.2008

Author's address:

Georgi N. Markov, National Museum of Natural History – BAS, Tsar Osvoboditel Blvd. 1, 1000 Sofia, Bulgaria, e-mail: markov@nmnh.bas.bg

Туроолските хоботни (*Mammalia*) на Европа: предварителни бележки

Георги Н. МАРКОВ

(Резюме)

Статията разглежда шест вида хоботни от турола на Европа. Дискутирани са проблеми на тяхната таксономия, филогения, географско разпространение и хронология; накратко са очертани най-важните находища и материал за всеки от шестте таксона. С изключение на *Anapcus*, по-късен имигрант, останалите пет хоботни изглежда са част от мащабните миграции на бозайници от западна Азия към Европа около границата на влезия и турола.