FOSSIL MAMMALS OF ASIA

NEOGENE BIOSTRATIGRAPHY AND CHRONOLOGY

Edited by Xiaoming Wang, Lawrence J. Flynn, and Mikael Fortelius

Columbia University Press *New York*

Chapter 24

Late Miocene (Turolian) Vertebrate Faunas from Southern European Russia

VADIM V. TITOV AND ALEXEY S. TESAKOV

Compared with a relatively rich and continuous record of Late Miocene mammals in the southwestern parts of the North Black Sea region, mainly Ukraine and Moldova (Korotkevich 1988; Topachevsky, Nesin, and Topachevsky 1998; Nesin and Nadachowski 2001; Vangengeim and Tesakov, chapter 23, this volume), the fossil record of more eastern areas, including the eastern coast of the Sea of Azov, the lower Don River area, and Northern Caucasus, is very patchy and relatively unstudied. The rare occurrence of fossil vertebrates is due in part to widespread marine deposits of the Eastern Paratethys and a limited distribution of synchronous continental sediments. Fortunately, during the last decade, the authors have managed to organize systematic excavations at a number of previously known and newly discovered localities (figure 24.1). Most localities yield sporadic remains of predominantly large mammals. Below, we briefly review the local faunas that, based on their composition, are attributable to the Turolian European Land Mammal Age. All sites are referred to or correlated to regional Stages of the Eastern Paratethys also, as the most important independent geological framework for the region (figure 24.2). We also indicate correlations with the Late Miocene mammalian complexes developed by Ukrainian paleontologists (Topachevsky, Nesin, and Topachevsky 1998).

EARLY MIDDLE TUROLIAN LOCALITIES (MAEOTIAN)

The oldest Turolian faunas in southern European Russia were found in the North Caucasus. They occur here in continental formations overlying marine Upper Sarmatian deposits of the Eastern Paratethys in the valleys of the Kuban and Belaya rivers. Paleogeographically, both fossiliferous areas occur at the southern shore of the Maeotian marine basin of the Eastern Paratethys. The Armavir Formation exposed on the right bank of the Kuban River near the town of Armavir has been known to yield a *Hipparion* fauna since the 1950s (Alexeeva 1959). The locality Forstadt (45°01'N, 41°10'E; see figure 24.1) at the upper part of the formation is associated with gray micaceous laminated sands and overlying brown clays. The fossiliferous deposits are reversely magnetized. Recent excavations provided new data on large and small mammals: *Amblycoptus* cf. *oligodon*, *Prolagus* sp., *Pseudocricetus* sp., Felidae gen., *Chilotherium* cf. *schlosseri*, Rhinocerotidae gen., cf. *Cremohipparion* sp., *Hippotherium* sp., *Gazella* cf. *pilgrimi*, *Procapreolus* sp., and *Miotragocerus* sp. [determination of artiodactyls by I. Vislobokova (2010)]. The evolutionary level of *Amblycoptus* is earlier or equal to that of *A. oligodon* from middle Turolian faunas of Hungary (Mészáros 1997). Hamsters of the *Pseudocricetus* group are known in Ukraine Maeotian and Pontian faunas correlated to middle and late Turolian. The Forstadt fauna is thus tentatively correlated to middle Turolian, mid-Maeotian.

There is a very similar geological situation for the Gaverdovskii Formation in the Belaya River valley near the city of Maikop. Here, continental variegated "ocherous" beds of sands and gravels overlie the Late

Figure 24.1 Geographic location of some Late Miocene localities in southern European Russia. (*I*) Lower Pontian; (*II*) Upper Maeotian; (*III*) Maeotian s.l. (*1*) Sinyavskaya; (*2*) Novocherkassk; (*3*) Razdorskaya; (*4*) Morskaya 2; (*5*) Yanovka-Obukhovka; (*6*) Kamenka; (*7*) Khanskaya; (*8*) Forstadt; (*9*) Solnechnodolsk.

Sarmatian marine beds. These deposits were dated to the Early–Middle Maeotian (Kolesnikov 1940; Alexeeva 1955; Beluzhenko 2000). Scanty remains of *Deinotherium* sp. and "*Mammut*" cf. *obliquelophus* were found here in the Khanskaya locality (44°38'N, 39°58'E; see figure 24.1). We tentatively date this locality to middle Turolian.

In the northern part of the studied area, north of the maximum Maeotian transgression boundary, a thick sequence of continental deposits with numerous mammal localities occurs between upper Sarmatian and lower Pontian marine deposits (Vangengeim and Tesakov 2008). In the eastern Sea of Azov area, near the city of Rostov-on-Don, these fluviatile or deltaic deposits are included to the Yanov Formation. These deposits yielded an almost complete skeleton of *Deinotherium* cf. *giganteum* found in the Obukhovka sand pit (47°29'N 40°01'E; see figure 24.1) near the city of Novocherkassk. In the neighboring Yanovka sandpit, these deposits also produced large mammal remains (figure 24.3), including Rhinocerotidae gen. indet., "*Palaeoryx*" *longicephalus* (see figure 24.3*a*), and the mastodonts "*Mammut*" *obliquelophus* and *Mammut* cf. *borsoni* (see figure 24.3*e*, *f*) (Bajgusheva, Titov, and Tesakov 2001; Bajgusheva and Titov 2006).

Another rich site in the Sea of Azov Region is Morskaya 2 near Taganrog city (47°17N 39°06'E; see figure 24.1). This locality occurs in lacustrine greenish clay and gray sand overlying Late Miocene marine dark clays and limestones of the Middle Sarmatian. Fossiliferous deposits are capped by Upper Pliocene–Lower Pleistocene white quartz sands of the Khapry alluvial formation, red clayey beds tentatively referred to the Lower Pleistocene, a thin layer of Upper Pleistocene loess-like loams, and modern soil. This locality yielded shells of freshwater mollusks and bones of fishes, amphibians, turtles, other reptiles, and birds (Titov et al. 2006). Special publications deal with porcupines (Lopatin, Tesakov, and Titov 2003) and bats (Rossina et al. 2006). The mammal association includes *Blarinella* cf. *dubia*, *Asoriculus gibberodon*, Erinaceidae gen., *Vespertilio* cf. *villanyiensis*, *Hypolagus igromovi*, *Hystrix primigenia*, *Castor* sp., *Trogontherium* cf. *minutum*, *Tamias* sp., *Nannospalax compositodontus*, *Prospalax* sp., *Sibirosminthus* cf. *latidens*,

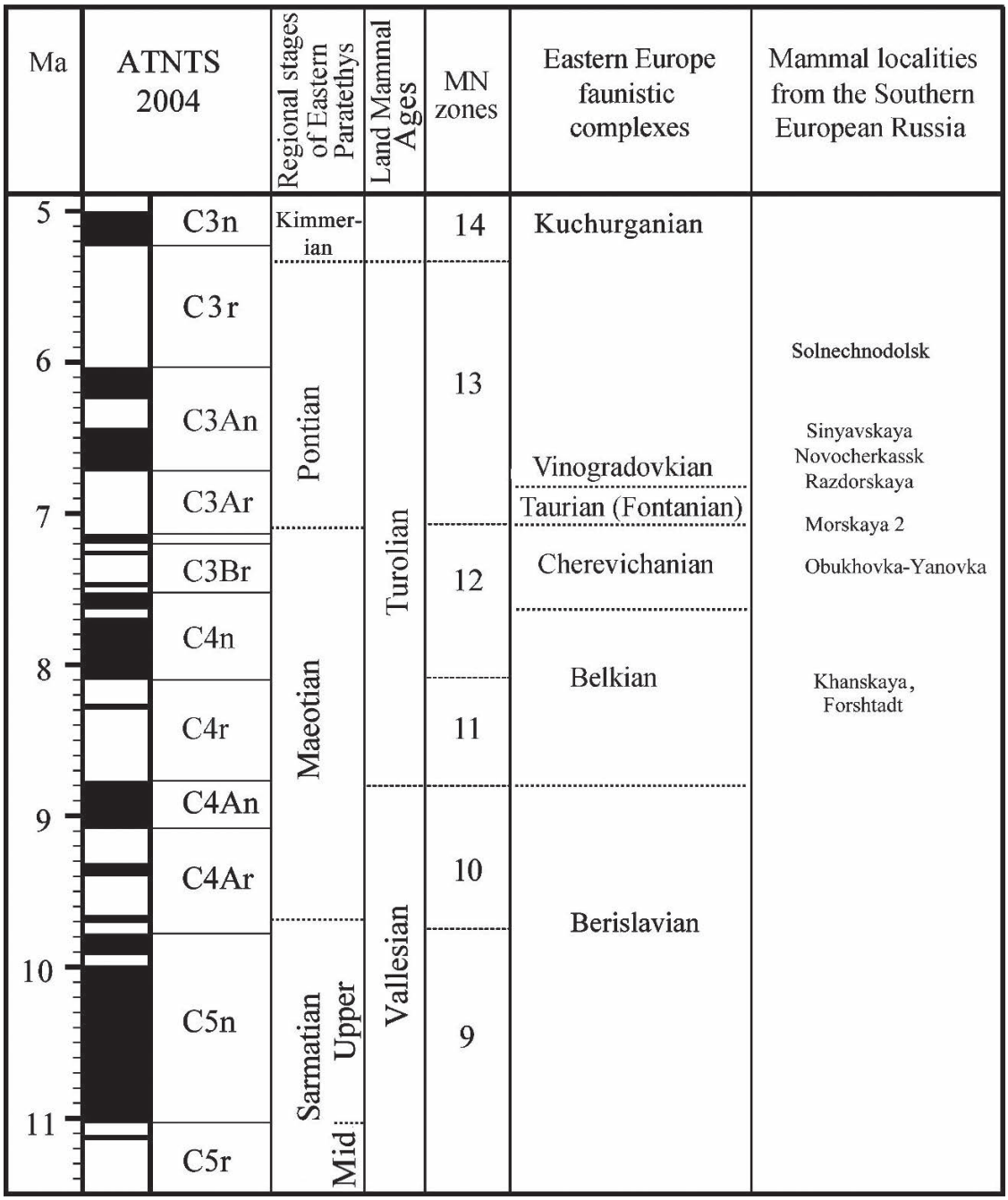

Figure 24.2 Scheme of stratigraphic position of Late Miocene localities in southern European Russia.

Pseudocricetus cf. *kormosi, Kowalskia* sp., *Allocricetus* sp., *Pseudomeriones* cf. *latidens, Apodemus* gr. *gudrunaegorafensis, Apodemus* gr. *dominans-atavus, Micromys* sp., *Hansdebruijnia* aff. *neutrum, "Mammut"* cf. *obliquelophus, Cremohipparion* cf. *moldavicum,* and Cervidae gen. Carnivora (determinations of Marina Sotnikova) include *Martes lefkonensis, Promeles* sp., ?*Enhydriodon* sp., *Promephitis* cf. *maeotica, Hyaenotherium wongii, Metailurus parvulus,* and *Felis attica.* The rabbit *Hypolagus igromovi* is the most abundant species in the assemblage. The mastodon is represented by an incomplete skeleton of an adult male (see figure 24.3*b–d*). This is the first record in Rus-

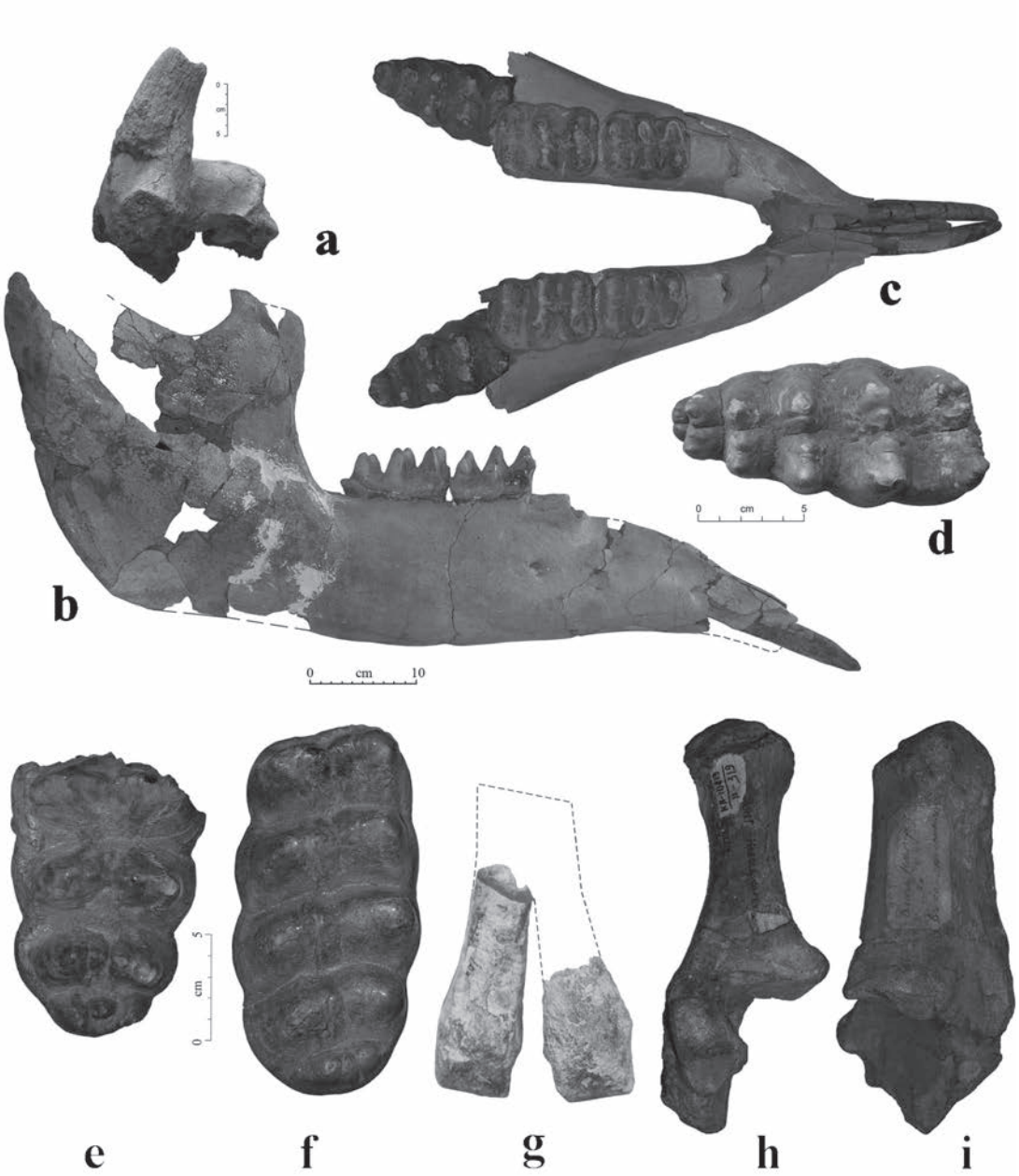

Figure 24.3 Large mammal remains from Turolian localities of the Sea of Azov region (Russia): (*a*) "*Palaeoryx*" *longicephalus*: specimen ZIN–24638 (coll. Zoological institute RAS), incomplete skull, lateral view, Yanovka-Obukhovka sand pits, Upper Maeotian; (*b*) *"Mammut" obliquelophus*: specimen SSC RAS M-2/63 (coll. Southern Scientific Centre RAS), incomplete lower jaw, lateral view, (c) dorsal view, (*d*) right unerupted m3, dorsal view, Morskaya 2, Upper Maeotian; (*e*) *"Mammut" obliquelophus*: specimen NMIDK KP-10589/P-89 (coll. Novocherkassk Museum of Don Cossacks History), fragmental left M3, dorsal view, Yanovka-Obukhovka sand pits, Upper Maeotian; (*f*) *Mammut* cf. *borsoni*: specimen NMIDK KP-10528/P-25 (coll. Novocherkassk Museum of Don Cossacks History), right M3, dorsal view, Yanovka-Obukhovka sand pits, Upper Maeotian; (*g*) *Paracamelus* cf. *aguirrei*: specimen AKM OP-27213/53 (coll. Azov Museum-reserve), distal part of metapodials, cranial view, Sinyavskaya, Lower Pontian; (*h*) *Paracamelus* cf. *aguirrei*: specimen NMHDC–5747, right calcaneus, medial view, (*i*) anterior view, Novocherkassk, Lower Pontian.

sia of an almost complete mandible with p4–m3 tooth rows and small, relatively straight tusks. In this specimen, p4 is nearly shed, and m3 is not erupted. A large share of small mammal material belongs to remains of Muridae typical for the European Turolian. The lower stratigraphic limit of this fauna is controlled by the presence of the genus *Apodemus* with incompletely developed t7, which appeared in southern Europe by the middle Late Miocene (Storch and Dahlmann 1995). The murid *Hansdebruijnia* from this site shows well-developed stephanodonty. The

upper stratigraphic limit is most precisely indicated by the presence of two taxa. The first is the complex-toothed mole rat *Nannospalax compositodontus*, which is known from the Cherevichanian and Fontanian faunal assemblages of southern Ukraine (Nesin and Nadachowski 2001) correlated to the upper Maeotian, lower Pontian, and MN 12 (Pevzner, Semenenko, and Vangengeim 2003). The second taxon is *Hyaenotherium wongii*, which has not been recorded in Europe later than the Middle Turolian (MN 12; Werdelin and Solounias 1991). The skunk genus *Promephitis*, the large *Aonyx*-like otter Lutrinae gen. (*?Enhydriodon* sp.), and the small lynx-like felid (*Felis attica*) frequently occur in Turolian faunas of Eurasia (Semenov 2001). Mastodon molars, tusks, and medium-size symphysis indicate a close similarity with zygodont mastodons of the European Turolian attributed by Markov (2008) to *"Mammut" obliquelophus* Mucha 1980. Available data suggest that the fauna of Morskaya 2 can be dated to the middle Turolian (MN 12–?MN 13) of the European biochronological scale. Predominance of freshwater taxa among mollusks and fishes indicate the strictly continental origin of the locality, without a direct contact with the sea. Terrestrial conditions favoring the formation of shallow lakes could occur in the region during a regressive phase of the Late Miocene sea basin at the Maeotian–Pontian boundary.

Another isolated Late Miocene locality, tentatively dated to the Maeotian, was found in the Rostov-on-Don city in the Kamenka district during construction operations. Greenish clays at the erosional surface between Middle Sarmatian and Lower Pontian limestones yielded scanty remains of *Deinotherium* sp., juvenile *"Hipparion"* sp., and *Gazella* sp.

LATE TUROLIAN (PONTIAN)

The late Turolian mammal faunas originate in the region from the shallow-water limestone deposits of the lower Pontian (Novorossian Substage) of the Black Sea marine stratigraphic scheme. They overlie upper Miocene terrestrial and marine sediments (Sarmatian and Maeotian) and are usually overlain by Pliocene continental deposits. The mammal remains in these marine deposits are scanty. Several localities are known from the Azov Sea region and from the lower course of the Don River at the northern shore of the Pontian marine basin: Sinyavskaya (47°17'N 39°18'E), Novocherkassk (47°30'N 40°03'E), and Razdorskaya (47°32'N 40°33'E) (see figure 24.1). The combined faunal list includes *Hypolagus igromovi*, *Machairodus sp.*, *Hippotherium* sp., *Paracamelus* cf. *aguirrei* (see figure 24.3*g*, *h*), Bovinae gen. indet. (Titov and Logvinenko 2006).

The finds of camels in Pontian localities enable their correlation with Asian sites. The oldest remains of large camels were reported from the Kazakhstan locality Pavlodar (=Gusinyi Perelet; Havesson 1954). The fossiliferous deposits are reversely magnetized and are correlated to MN 12–13 and the Lower Pontian (Vangengeim et al. 1993; Vislobokova, Sotnikova, and Dodonov 2001). *Paracamelus* remains were also listed for reversely magnetized lower levels of the Mongolian locality Khirgis Nur-2 (Titov 2008); its age is estimated as the latest Miocene, late Turolian, MN 13 (Pevzner et al. 1982; Vislobokova, Sotnikova, and Dodonov 2001). Based on the similarities of the camelids, the three studied localities could be dated to late Turolian, MN 13.

The position of the Pontian in the chronostratigraphic scale of the Eastern Paratethys is a matter of a long-standing discussion due to ambiguity of its correlations with Mediterranean stratigraphy. According to Pevzner, Semenenko, and Vangengeim (2003), the lower Pontian is correlated with the upper part of the Tortonian; the upper boundary of the lower Pontian coincides with the Tortonian–Messinian boundary. Using nannofossils, fission-track dates, and paleomagnetic data, the stratigraphic range of lower Pontian deposits is determined as 7.5–7.1 Ma (Pevzner, Semenenko, and Vangengeim 2003). The alternative correlation places the Pontian in the lower Gilbert (C3r) interval with the estimated range of 6.1–5.3 Ma (Trubikhin 1989; Popov et al. 2006), correlating it with the upper Messinian. Both views have strong and weak points. In the case of the first correlation option and having in mind MN zone boundary estimates (Steininger 1999), the lower Pontian of the Black Sea region is correlated to MN 12. However, the small mammal assemblages from the lower Pontian deposits at its lectostratotype in Odessa (16th Station of Bolshoy Fontan) and from the Vinogradovka locality (Odessa region, Ukraine) have a substantially late Turolian ("MN 13") appearance with common advanced *Apodemus*, primitive small *Micromys* (Topachevsky et al. 1994; Nesin and Storch 2004), and the characteristic microtoid cricetid *Baranarviomys admirabilis* (Nesin 1996), a form very similar to *Microtodon atavus* from Ertemte.

Likewise, the placement of the whole Pontian close to the Miocene–Pliocene boundary in C3r would imply an unusually fast transformation in many mammalian lin-

eages at the Turolian–Ruscinian transition. The recent dating of this transition in the Ptolemais Basin in Greece (Steenbrink et al. 2006; de Bruijn and Hordijk 2009) at ca. 5.3 Ma gives a very important benchmark both chronologically and regarding evolutionary levels of reference mammalian lineages.

According to the biozonal analysis of the Ukrainian fossil record (Topachevsky, Nesin, and Topachevsky 1998; Nesin and Nadachowski 2001), the Early Pontian small mammals indicate zone MN 13 and can be correlated with the base of Messinian. The "long" Pontian of this scheme ranging from 7.1 to 5.5 Ma seemingly leaves enough space for gradual evolution of late Turolian mammalian assemblages, including the transformation of the Lower Pontian microtoid hamsters into the primitive *Promimomys* of the Lower Ruscinian.

More detailed studies on Pontian small mammal faunas are necessary to provide a stronger evidence for biozonal assignment and chronostratigraphic position of these faunas.

The final site of this review is the recently discovered Solnechnodolsk locality (45'18°N, 41°33'E) situated in the Northern Caucasus, 40 km NW of the city of Stavropol (see figure 24.1). The site is situated at the southern shore of the Pontian marine basin. The mammalian fauna was collected here from fluviatile and lacustrine beds incised in the Middle Sarmatian limestones.

The fauna includes a primate, a talpid, *Blarinella* sp., *Asoriculus gibberodon*, *Amblycoptus* cf. *jessiae*, *Prolagus* gr. *michauxi-sorbini*, *Hypolagus* cf. *igromovi*, *Hystrix primigenia*, *Trogontherium* sp., *Nannospalax* cf. *macoveii*, *Pliopetaurista* sp., *Spermophilinus turolensis*, *Tamias* sp., *Dryomys* sp., *Micromys* sp., *Apodemus* cf. *gorafensis*, *A.* gr. *dominans*, *Hansdebruijnia* sp., *Pseudocricetus* cf. *kormosi*, *Allocricetus* sp., *Kowalskia* sp., cf. *Microtodon* sp., *Pseudomeriones* cf. *latidens*, *Parameles* sp., *Baranogale adroveri*, a hyaenid, *Felis* cf. *attica*, a proboscidean, *Hipparion* cf. *Cremohipparion* sp., a rhinocerotid, *Muntiacus* sp., *Cervavitus* sp., *Gazella* sp., and a tragoportacine.

This farthest eastern Turolian fauna in Europe has strong European affinities. The evolutionary level of *Amblycoptus* is very close to that known in Maramena. Spalacids in Solnechnodolsk are more evolved than in faunas correlated with the Maeotian and lowermost Pontian of the Ukraine (Nesin and Nadachowski 2001). *Microtodon*-like hamsters have not been known in the region in deposits older than the Early Pontian of Odessa, Ukraine. We correlate this fauna with the Late Turolian, MN 13, and with the Pontian stage of the Eastern Paratethys.

CONCLUSION

The easternmost European region, where Late Miocene mammals are known in a number of localities, is obviously important for Euro-Asian correlations. The current regional knowledge of the Latest Miocene terrestrial record represented by Turolian mammal faunas indicates the presence of still poorly defined early-middle Turolian faunas and well-expressed faunas of the Late Turolian. In terms of marine regional stages of the Eastern Paratethys, these faunas correspond to the Maeotian and Pontian, ca. 9–5.5 Ma. The majority of the reviewed Late Miocene (Turolian) mammal faunas indicates a savanna-like landscape combining open and wooded areas. Most faunas have strong European affinities, indicated, for example, by mastodons and the lagomorph *Prolagus*. Apart from species and genera that have large trans-Palaearctic ranges, the presence of lophodont lophocricetines (*Sibirosminthus*), microtoid hamsters, and camels (*Paracamelus*) mark immigrations from Asia.

ACKNOWLEDGMENTS

We thank Ray Bernor, George Koufos, and Nikolai Spassov for the useful and professional reviews of the manuscript. We are grateful to the organizers of the International Asian Mammal Biostratigraphy Conference, June 8–14, 2009, in Beijing, Xiaoming Wang, Deng Tao, Li Qiang, Mikael Fortelius, and employees of the Institute of Vertebrate Paleontology and Paleoanthropology for the opportunity to discuss many issues of the mammalian biostratigraphy and biochronology in Eurasia. We are indebted to Larry Flynn for the final polishing of the text. We thank Jan van Dam for important comments on soricids from Armavir, and Marina Sotnikova for the work with carnivoran material. This study was supported in part by the Russian Foundation for Basic Research (projects 07-05-00400-a, 09-05-10024-k, 09-05-00307-a, 12-04-01691-a).

REFERENCES

Alexeeva, L. I. 1955. Late Neogene mastodons from the territory of the USSR. Ph.D. diss., Paleontological Institute, Moscow (in Russian).

Alexeeva, L. I. 1959. The significance of mammal fauna of Armavir suite for stratigraphy of terrestrial strata of Northern Caucasus. *Proceedings of Geological Institute* 32:185–191 (in Russian).

Bajgusheva, V. S. and V. V. Titov. 2006. About teeth of *Deinotherium giganteum* Kaup from Eastern Paratethys. *Hellenic Journal of Geosciences* 41:177–182.

Bajgusheva, V. S., V. V. Titov, and A. S. Tesakov. 2001. The sequence of Plio-Pleistocene mammal faunas from the south Russian Plain (the Azov Region). *Bollettino Società Paleontologica Italiana* 40(2):133–138.

Beluzhenko, E. V. 2000. Subcontinental Upper Miocene-Pliocene deposits of Belaya River (Gaverdovskii Formation). In *Geology and Mineral Resources of North Caucasus*: *Materials of 9th International Scientific and Practical Geological Conference*, ed. G. I. Arutyunov, pp. 85–94. Essentuki: Ofset (in Russian).

de Bruijn, H. and K. Hordijk. 2009. The succession of rodent faunas from the Mio/Pliocene lacustrine deposits of the Florina-Ptolemais-Servia Basin (Greece). *Hellenic Journal of Geosciences* 44:21–103.

Havesson, J. I. 1954. Tertiary camels of the Eastern Hemisphere (genus *Paracamelus*). *Proceedings of Paleontological Institute* 67:100–161 (in Russian).

Kolesnikov, V. P. 1940. Upper Miocene. In *Stratigraphy of the USSR*, ed. A. D. Arhangelskiy, pp. 229–373. Moscow: AS USSR press (in Russian).

Korotkevich, E. L. 1988. *The History of the Forming of Hipparion Faunas in Eastern Europe*. Kiev: Naukova dumka (in Russian).

Lopatin, A. V., A. S. Tesakov, and V. V. Titov. 2003. Late Miocene–early Pliocene porcupines (Rodentia, Hystricidae) from south European Russia. *Russian Journal of Theriology* 2(1):26–32.

Markov, G. N. 2008. The Turolian proboscideans (Mammalia) of Europe: Preliminary observations. *Historia Naturalis Bulgarica* 19:153–178.

Mészáros, L. G. 1997. *Kordosia*, a new genus for some late Miocene Amblycoptini shrews (Mammalia, Insectivora). *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* 2:65–78.

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,* ed. I. Ya Yatsko, pp. 19–26. Kishiner: Shtiintsa (in Russian).

Nesin, V. A. 1996. An ancient fossil vole species (Rodentia, Cricetidae) from the Lower-Pontian of the South Ukraine. *Vestnik Zoologii* 3:74–75.(in Russian).

Nesin, V. A. and A. Nadachowski. 2001. Late Miocene and Pliocene small mammal faunas (Insetivora, Lagomorpha, Rodentia) of southeastern Europe. *Acta Zoologica Cracovvensia* 44(2): 107–135.

Nesin, V. A. and G. Storch. 2004. Neogene Murinae of Ukraine (Mammalia, Rodentia). *Senckenbergiana Lethaea* 84(1–2): 351–365.

Pevzner, M. A., V. N. Semenenko, and E. A. Vangengeim. 2003. Position of the Pontian of the Eastern Paratethys in the magnetochronological scale. *Stratigraphy and Geological Correlation* 11(5):482–491.

Pevzner, M. A., E. A. Vangengeim, V. I. Zhegallo, V. S. Zazhigin, and I. G. Liskun. 1982. Correlation of the upper Neogene sediments of Central Asia and Europe on the basis of paleomagnetic and biostratigraphic data. *International Geology Review* 25:1075–1085.

Popov, S. V., I. G. Shcherba, L. B. Ilyina, L. A. Nevesskaya, N. P. Paramonova, S. O. Khondkarian, and I. Magyar. 2006. Late Miocene to Pliocene palaeogeography of the Paratethys and its relation to the Mediterranean. *Palaeogeography, Palaeoclimatology, Palaeoecology* 238:91–106.

Rossina V. V., S. V. Kruskop, A. S. Tesakov, and V. V. Titov. 2006. First record of Late Miocene bat from European Russia. *Acta Zoologica Cracovensia* 49(1–2):125–133.

Semenov, Y. A. 2001. Stratigraphic distribution of the terrestrial carnivores in the Vallesian and Turolian of Ukraine. *Beiträge zür Paläontologie* 26:139–144.

Steenbrink J., F. J. Hilgen, W. Krijgsman, J. R. Wijbrans, and J. E. Meulenkamp. 2006. Late Miocene to Early Pliocene depositional history of the intramontane Florina–Ptolemais–Servia Basin, NW Greece: Interplay between orbital forcing and tectonics. *Palaeogeography, Palaeoclimatology, Palaeoecology* 238:151–178.

Steininger, F. F. 1999. The continental European Miocene. Chronostratigraphy, geochronology and biochronology of the Miocene "European Land Mammal Mega-Zones" (ELMMZ) and the Miocene "Mammal-Zones" (MN-Zones). In *Land Mammals of Europe*, ed. G. E. Rössner and K. Heissig, pp. 9–24. Munich: Dr. Friedrich Pfeil.

Storch, G. and T. Dahlmann. 1995. Murinae (Rodentia, Mammalia). In *The Vertebrate Locality Maramena (Macedonia, Greece) at the Turolian-Ruscinian Boundary (Neogene)*, ed. N. Schmidt-Kittler, pp. 121–132. *Münchner Geowissenschaftliche Abhandlungen* (A) 28.

Titov, V. 2008. Earliest *Paracamelus* of the Old World. In *33rd International Geological Congress Abstracts*, August 6–14, 2008, Oslo, p. 1173.

Titov, V. V. and V. V. Logvinenko. 2006. Early *Paracamelus* (Mammalia, Tylopoda) in the Eastern Europe. *Acta Zoologica Cracovensia* 49(1–2):163–178.

Titov, V .V., A. S. Tesakov, I. G. Danilov, G. A. Danukalova, E. N. Mashchenko, A. V. Panteleev, M. V. Sotnikova, and E. K. Sychevskaya. 2006. The first representative vertebrate fauna from the Late Miocene of southern European Russia. *Doklady Biological Sciences* 411:508–509.

Topachevsky, V. A., V. A. Nesin, and I. V. Topachevsky. 1998. Biozonal microtheriological scheme (stratigraphic distribution of small mammals, Insectivora, Lagomorpha, Rodentia) of the Neogene of the northern part of the Eastern Paratethys. *Vestnik Zoologii* 32(1–2):76–87 (in Russian).

Topachevsky, V.A., A. L. Tchepalyga, V. A. Nesin, L. I. Rekovets, and I. V. Topachevsky. 1994. Small mammal communities of the Pontian regional stage of Eastern Europe and their possible continental analogs. In *Voprosy Teriologii. Paleotheriology*, ed. L. P. Tatarinov, pp. 107–112. Moscow: Nauka (in Russian).

Trubikhin, V. M. 1989. Paleomagnetic data for the Pontian. In *Pontien-Pl1 (sensu F. Le Play, N.P. Barbot de Marny, N.I. Andrusov),* ed. P. M. Stevanović, L. A. Nevesskaja et al., pp. 76–79. Serie Chronostratigraphie und Neostratotypen, Neogen der Westlichen ("Zentrale") Paratethys 8., Zagreb/Belgrade: JAZU and SANU.

Vangengeim, E. A. and A. S. Tesakov. 2008. Maeotian mammalian localities of eastern Paratethys: Magnetochronology and position in European continental scales. *Stratigraphy and Geological Correlation* 16(4):437–450.

Vangengeim, E. A., I. A. Vislobokova, A. Y. Godina, E. L. Dmitrieva, V. I. Zhegallo, M. V. Sotnikova, and P. A. Tleuberdina. 1993. On the age of mammalian fauna from the Karabulak formation of the Kalmakpai River (Zaisan depression, Eastern Kazakhstan). *Stratigraphy and Geological Correlation* 1(2): 165–171.

Vislobokova, I. A., M. V. Sotnikova, and A. E. Dodonov. 2001. Late Miocene–Pliocene mammalian faunas of Russia and neighboring countries. *Bollettino Società Paleontologica Italiana* 40(2): 307–313.

Werdelin, L. and N. Solounias. 1991. The Hyaenidae: Taxonomy, systematics and evolution. *Fossils and Strata* 30:1–104.