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Late Miocene Mammals from Kocherinovo, Southwestern Bulgaria

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Abstract: The fauna from the late Miocene localities of Kocherinovo (KCH), SW Bulgaria, is briefly described. Their faunal features and geologic situation suggest that all of these localities (KCH-1, KCH-2, KCH-3) are roughly contemporaneous. The evolutionary stages of several taxa (*Choerolophodon, Microstonyx, Palaeoreas*) the presence of an archaic aardvark*,* as well as the presence of *C*. cf. *macedonicum* are features indicative of an earlier age than the other Bulgarian Turolian localities, suggesting an early Turolian age. Hipparions, *Gazella* and spiral-horned bovids (especially *Palaeoreas* sp.) make up the bulk of the bone sample, a faunal assemblage that is typical, from a palaeoecological point of view, for the Turolian palaeocoenoses of Southern Bulgaria. This indicates that open woodland and shrubland represented the dominant landscape in the region, and shows that it was present in the area as early as the early Turolian. The zoogeographic relationships of the fauna are similar to those of other Turolian localities of Bulgaria, although individuals identified as "? *Samotherium*" and the aardwark tentatively referred to *Amphiorycteropus* cf. *browni* attest to an eastern influence.

Key words: Bulgaria, Kocherinovo, Mammalia, Late Miocene, biochronology

Introduction

The establishment in late 1990s of the Assenovgrad Palaeontological Museum (branch of the National Museum of Natural History – Sofia), where more than 30 000 bones of late Miocene mammals are stored, was a strong stimulus for our palaeontological and stratigraphic surveys initiated by the NMNH – Sofia in the Upper Miocene deposits of the Middle Struma basin. These investigations led to the discovery and excavations of new palaeontological localities, improving our knowledge of the Neogene stratigraphy and palaeogeography of Southern Bulgaria, and the fauna of the late Miocene Balkan-Iranian zoogeographic province (Boev, Spassov 2009, Clavel *et al*. 2012, Geraads *et a*l. 2001, 2003, 2005, 2006a, 2006b, 2008, 2011; Geraads, Spassov 2008, 2009, Hristova 2012, Hristova *et al.* 2002, 2003, Hristova, Spassov 2005, Markov 2004, 2008, Merceron *et al*. 2006, Spassov 2002, Spassov, Geraads 2004, Spassov, Koufos 2002, Spassov *et al*. 2005a, 2005b, 2006 , 2012, Tzankov *et al*. 2005).

The present study of the fauna from the Kocherinovo localities follows these field investigations. Three fossiliferous spots, which we called Kocherinovo 1-3, are now recorded in the Miocene continental deposits of Middle Struma, in the area of Gradishteto (Kamarata) Hill between Mursalevo and Kocherinovo villages. The first (Kocherinovo-1, KCH-1: Spassov *et al*. 2006) was found by I. Nikolov in the early 1970s. His unpublished notes list the following taxa: *Indarctos* sp., Proboscidea indet., *Hipparion mediterraneum*, *Dicerorhinus* sp., *Microstonyx major*, *Helladotherium* sp., *Gazella* sp.

(see also Nikolov 1985, p. 52: loc. 60, Kocherinovo). Most of the material is unavailable (probably stored in the collections of the Palaeontological museum of the Sofia University "St. Kl. Ohridski"). Only some fossils were described recently (Spassov *et al.* 2005a, 2006). The exact location of the site was lost after Nikolov's death. After several surveys by N. Spassov and T. Tzankov, a new locality, KCH-2, was discovered in 2001 immediately to the north of the Gradishte Hill by N. Spassov and D. Geraads. The presence of the same green alluvial sandy clays indicates that this locality must be stratigraphically close to KCH-1, a conclusion supported by the biochronology of its fauna. It is located between the villages of Kocherinovo and Mursalevo and a preliminary faunal list was given, without description, by Tzankov *et al.* (2005) and Spassov *et al.* (2005b). In 2010, another fossiliferous spot (Kocherinovo-3, KCH-3) was discovered by N. Spassov and J. Prieto, during a survey organized by N. Spassov with a team from the University of Tübingen. This locality is situated about 30 meters to the west of KCH-2 and a few meters below it. The description of the fauna from KCH-2 and KCH-3 with a revision of the one from KCH-1 is the scope of this paper. All the material from KCH-2 and KCH-3 is stored in the National Museum of Natural History, Sofia (NMNHS) and the indications and numbers follow the official nomenclature of the fossil collections of the museum.

Abbreviations:

DTK – Dytiko, Greece
GR – Grebeniki, Ukraine
HD – Hadjidimovo, SW Bulgaria1
FM – Fossil Mammal collection, NMNHS
KAL – Kalimantsi, SW Bulgaria
KCH-1, KCH-2, KCH-3 – Kocherinovo 1, 2 and 3, SW Bulgaria
KTD – Kemiklitepe D, Turkey
LGPUT – Laboratory of Geology and Palaeontology, Aristotle University of Thessaloniki, Greece
MNHN – Muséum National d'Histoire Naturelle, Paris
NHMW – Naturhistorisches Museum Wien.
NHM – Natural History Museum, London
NIK 1, 2 – Nikiti 1, 2, Greece
NMNHAs – Palaeontological Museum (Branch of NMNHS), Assenovgrad.
NMNHS – National Museum of Natural History, Sofia.
PER – Perivolaki, Greece
PIK – Pikermi, Greece
RZO – Ravin des Zouaves-5, Greece
STR – Strumyani, SW Bulgaria
VTK – Vathylakkos, Greece

APD = antero-posterior diameter; ET = enamel thickness; H = height; L = length; Lfr = length of fragment; max. = maximum; TD = transverse diameter.

Upper teeth are given in upper case, lower teeth in lower case. Measurements are in mm. Dental nomenclature for Proboscidea follows Tassy (1996). The terminology and measurements for hipparions are according to Eisenmann *et al.* (1988) and Bernor *et al.* (1997).

Geology and stratigraphy

The localities of Kocherinovo are situated in the uppermost green sandy clays of the Gradishte Benchmark Group of strata (Spassov *et al.* 2006) (Fig. 1). This stratigraphic unit is represented by a bundle of mostly grey-green to olive green, rarely yellow-brown clays with various thickness, up to 10-15 m (rarely more). The lower boundary is transitional with the rocks of the Slatino Genetic Lithocomplex. The upper boundary is also transitional with the lower parts of the Strumyani Genetic Lithocomplex. According to Tzankov *et al.* (2005), the Gradishte Benchmark Group outcrops as big spots or short bands in the area of Dzherman (south of Dupnitsa), from Mursalevo through Elenov Vrah peak as far as the Gradishteto peak (the type area of this genetic lithocomplex), in the area of Blagoevgrad and Sandanski, and of the villages of Novo Delchevo, Spatovo, Hotovo, Harsovo, Kalimantsi and Katuntsi. This unit consists of lacustrine-marshy or fluvial deposits formed by braided rivers (Tzankov *et al.* 2005). All Kocherinovo localities belong to this unit and are probably roughly contemporaneous.

Systematic palaeontology

Order Proboscidea Illiger, 1811

Suborder Elephantiformes Tassy, 1988
Superfamily Elephantoidea Gray, 1821
Family Choerolophodontidae Gaziry, 1976
Genus *Choerolophodon* Schlesinger, 1917
Choerolophodon sp. "KTD-type"

The only identifiable proboscidean fossils from Kocherinovo are four choerolophodont teeth, one from KCH-2, discovered in 2002, and three from KCH-3, in 2010:

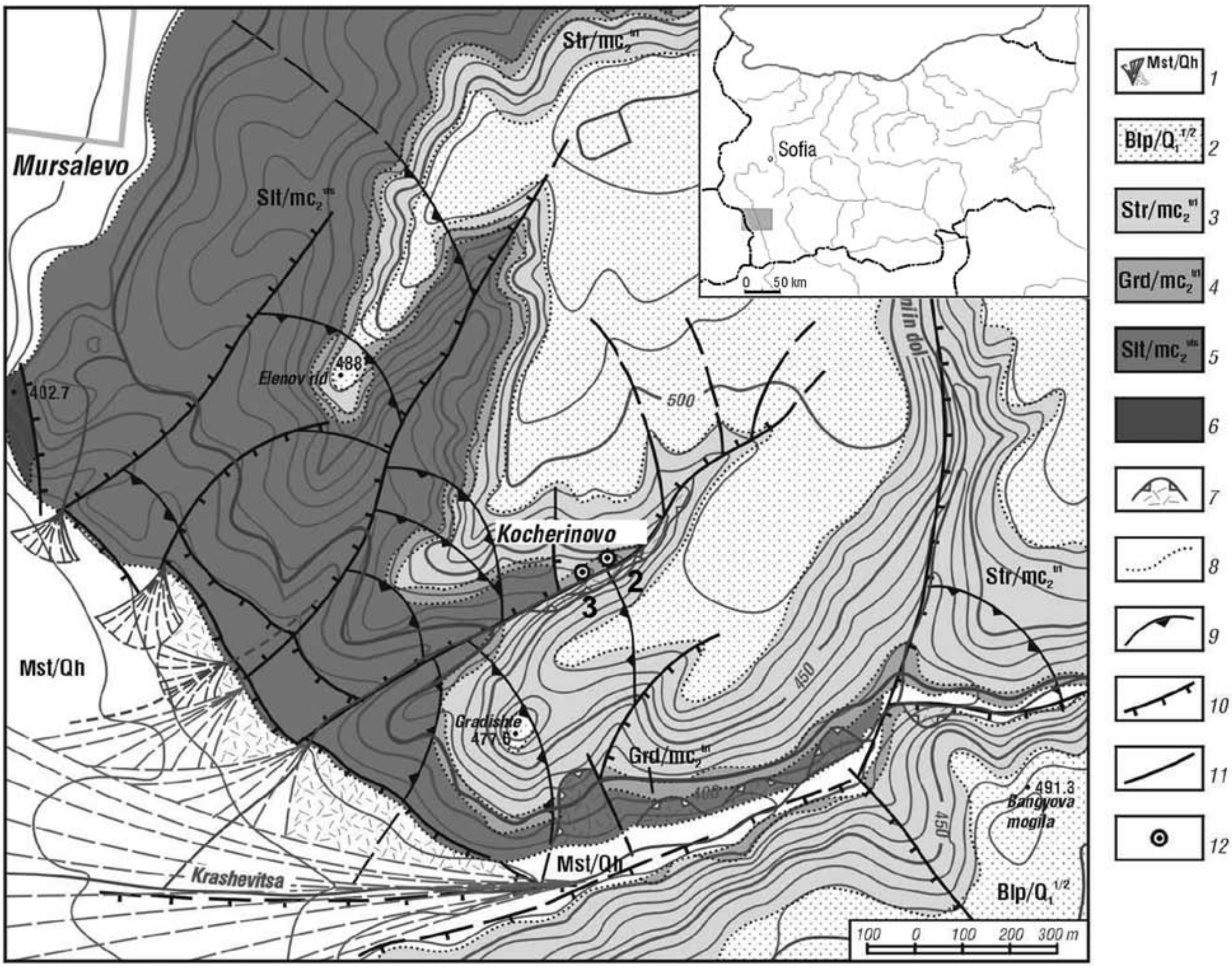

Fig. 1. Geological map of the Kocherinovo fossil localities area (SSE from the village of Mursalevo, district of Blagoevgrad), modified after Tzankov *et al*. 2005: 1: Middle Struma Holocene river valley clay-sandy-gravel-alluvial-proluvial genetic lithocomplex (Mst/Qh) – graves, sands and clay sands of the high (over flood-plain) river terrace. 2: Belo pole Lower Pleistocene flat land clay-sandy-gravel proluvial and proluvial-alluvial genetic lithocomplex (Blp/$Q1^{1/2}$) – unstructured gravel and conglomerates, yellow-orange-reddish sandy clays. 3: Strumyani early-middle Turolian park-woodland to open flat country clay-sandy-conglomerate alluvial-proluvial genetic lithocomplex (Str/mc_2^{trl}) – clayey sandstones, alleurites, lens or beds of unscreened incoherent conglomerates or sandy clays. 4: Gradishte early Turolian humid woodland sandy-clay river swampy lacustric bench mark group of strata (Grd/mc_2^{trl}) – grey-blue unclear banded clays. 5: Slatino Vallesian humid woodland sandy-clay-conglomerate alluvial-proluvial genetic lithocomplex (Slt/mc_2^{vls}) – loosely cemented sandstones, clayey sandstones, alleurites, seldom lavishy sandy clays. 6: rocks of the Pre-Neogene basement. 7: slides. 8: contact between the genetic lithocomplexes. 9: listric fault. 10: high-angle fault. 11: fault. 12: Kocherinovo 2 and 3 fossil localities

FM1986, left dp3, KCH-2 (Fig. 2A). The specimen, briefly mentioned by Markov (2004) and Spassov *et al*. (2006), preserves its entire crown and parts of its two roots. Consisting of two lophids and a postcingulum, the tooth is almost entirely unworn: dentine is only slightly exposed on the first posttrite. Strongly wrinkled enamel with cement deposits. The narrow first lophid has two cusps of which the posttrite is posteriorly displaced. This, as well as the cross-contact in the interlophid involving the posterior posttrite conule of the first and the anterior pretrite conule of the second lophid, are typically choerolophodont characters: Tassy (2005). The second lophid is transversally enlarged; the posterior cingulum is prominent but there is no entoflexus separating it from the lophid. In this aspect, as well as in its dimensions, FM1986 is very close to the left dp3 in the KTD66 mandible from the lower level of Kemiklitepe (KTD, MN11) described by Tassy (1994, Fig. 2B) as *Ch. pentelici* ssp. indet. L: 46; W: 29.7; H: 22.

At KCH-3, three teeth were found in close proximity to each other and probably belong to one individual:

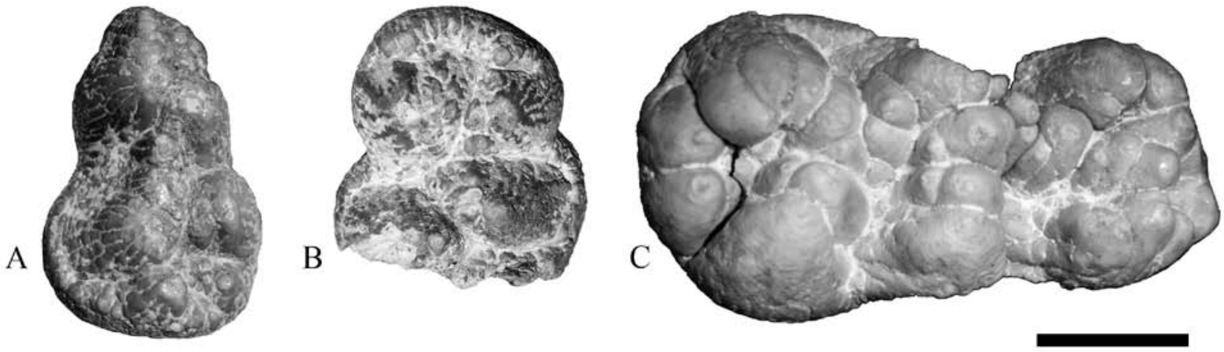

Fig. 2. *Choerolophodon* sp. "KTD-type", Kocherinovo: A: FM1986, left dp3, KCH-2. B: FM2861, right DP3, KCH-3. C: FM2862, left dp4, KCH-3. All specimens in occlusal view. Scale bar: 2 cm

FM2861, right DP3. (Fig. 2B). With a crown posteriorly damaged, the tooth has two lophs and two roots. The enamel is strongly wrinkled, with deposits of cement. Dentine is only slightly exposed on the first posttrite, otherwise the tooth is practically unworn. The anterior cingulum is separated from the first loph. The second pretrite cusp is strongly displaced anteriorly in relation to the posttrite, blocking the interloph. Although the crown is damaged, just enough is preserved to demonstrate the absence of a second entoflexus behind the second loph. In this aspect, FM2861 differs from typical *Ch. pentelici* and is close in shape to the DP3 from Yassiören (see Tassy 1994, Fig. 3). Larger than the latter, it is very close to a DP3 from Kayadibi (Gaziry 1976, Pl. 9, Fig. 5: – listed as a DP3 sin but the textual description obviously refers to a right one). No DP3 has been described from KTD but the combination of primitive morphology and large size (compared to Yassiören) observed in FM2861 and the Kayadiabi DP3 – and the dp3s from KCH-2 and KTD – is precisely what could be expected for the KTD *Choerolophodon*. Since the base of the root is preserved, it is possible to broadly estimate the tooth's length, and the maximum width of the second loph is measurable. Lfr: 41.5 (ca. 44e); W: 29/37.5; H: 26.5; ET: 1.5

FM2862, left dp4. (Fig. 2C). Partially damaged, the tooth has three lophids and a posterior cingulum consisting of two cusps. The first lophid is damaged on the lingual side of the crown, the second on both the lingual and the labial. The anterior cingulum is partially preserved and is the only element of the crown bearing traces of wear. Wrinkled enamel, traces of cement. Displacement of the mesoconelets in regard to the main cusps, resulting in the typical V-shape, is well pronounced on the third lophid; interlophids are blocked by additional cusps. Larger than the KTD dp4s described by Tassy (1994), FM2862 falls within the size variation for Kayadibi (see Gaziry 1976; Sanders 2003). L: 72; W: 32/ca.37e/40; H: 29

FM2863, anterior fragment (2 lophids) of a right lower tooth germ. Higher and wider than FM2862, this is either a dp4 of another individual, or a first molar. L: > 53 (ca. 80e); W: > 38.5; H: > 33.5

Status and taxonomy of the late Miocene cheorolophodonts of the Mediterranean, and more specifically of the Vallesian and early Turolian forms, are debatable. Gaziry (1976) referred Vallesian as well as Turolian choerolophodonts to *Ch. pentelici*, the type species of the genus. A similar approach was adopted by e.g. Tassy *et al.* (1989) and Tassy (1994) who, however, accepted separate subspecific status for earlier (pre-Pikermian) choerolophodonts. Sanders (2003) regarded *Ch. pentelici* as a strictly Turolian (MN12-MN13) species, referring Vallesian and early Turolian choerolophodonts (including the KTD material) to *Ch. anatolicus* (Ozansoy 1965). Markov (2008), while accepting the separate status of the Vallesian species, disagreed with the attribution of KTD to *Ch. anatolicus*, regarding it as an early form of *Ch. pentelici* s. str. In a recent study, Konidaris, Koufos (2013) restricted *Ch. anatolicus* to MN9, referring not only KTD (MN11) but also late Vallesian material to *Ch. pentelici*. As a result, views on material from KTD and the Turkish locality Kayadibi (from both of which specimens directly comparable to the Kocherinovo finds are known), vary: Both KTD and Kayadibi were included in *Ch. anatolicus* by Sanders (2003) as late (MN11) examples of the species' occurrence, for Tassy (1994) KTD and the earlier Yassiören material apparently represented the same, primitive subspecies of *Ch. pentelici*. As said, KTD was regarded as an early form of *Ch. pentelici*

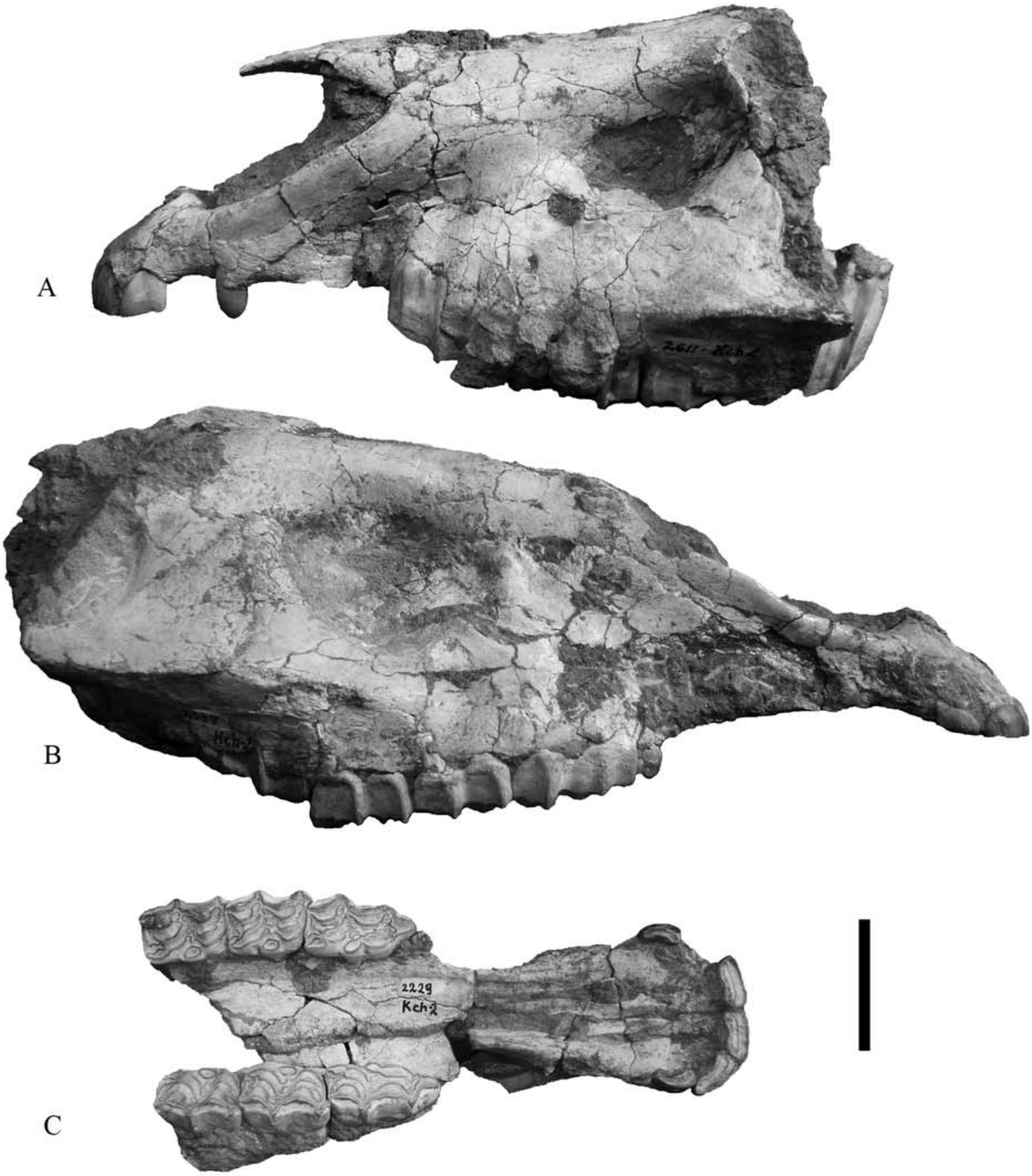

Fig. 3. Hipparion skull specimens from Kocherinovo 2: A: *Hippotherium brachypus*, FM2611. B: *Hippotherium brachypus*, FM 2547. C: *Cremohipparion* cf. *macedonicum*, FM2229. Scale bar: 4 cm

by MARKOV (2008) and KONIDARIS, KOUFOS (2013); while not explicitly discussing the age of Kayadibi, KONIDARIS, KOUFOS (2013) referred its choerolophodonts to *Ch*. *anatolicus* (a strictly MN9 species, according to them). It is possible that the Kayadibi fauna is of mixed age (see SICKENBERG *et al*. 1975), with at least part of the proboscidean material being not earlier than MN10, probably even MN11, considering the large size of deinothere teeth from this locality (SANDERS 2003; MARKOV 2008; GAREVSKI, MARKOV 2011) and of some Kayadibi choerolophodonts like the DP3 figured by GAZIRY (1976, Pl. 9, Fig. 5). It is worth noting that the latter specimen was not included in *Ch*. *anatolicus* by KONIDARIS, KOUFOS (2013) – although it appears on the diagram, Fig. 6, apparently by mistake (G. Konidaris, pers. comm. to GM 2012), – nor in *Ch*. *pentelici*, staying in a kind of taxonomic limbo.

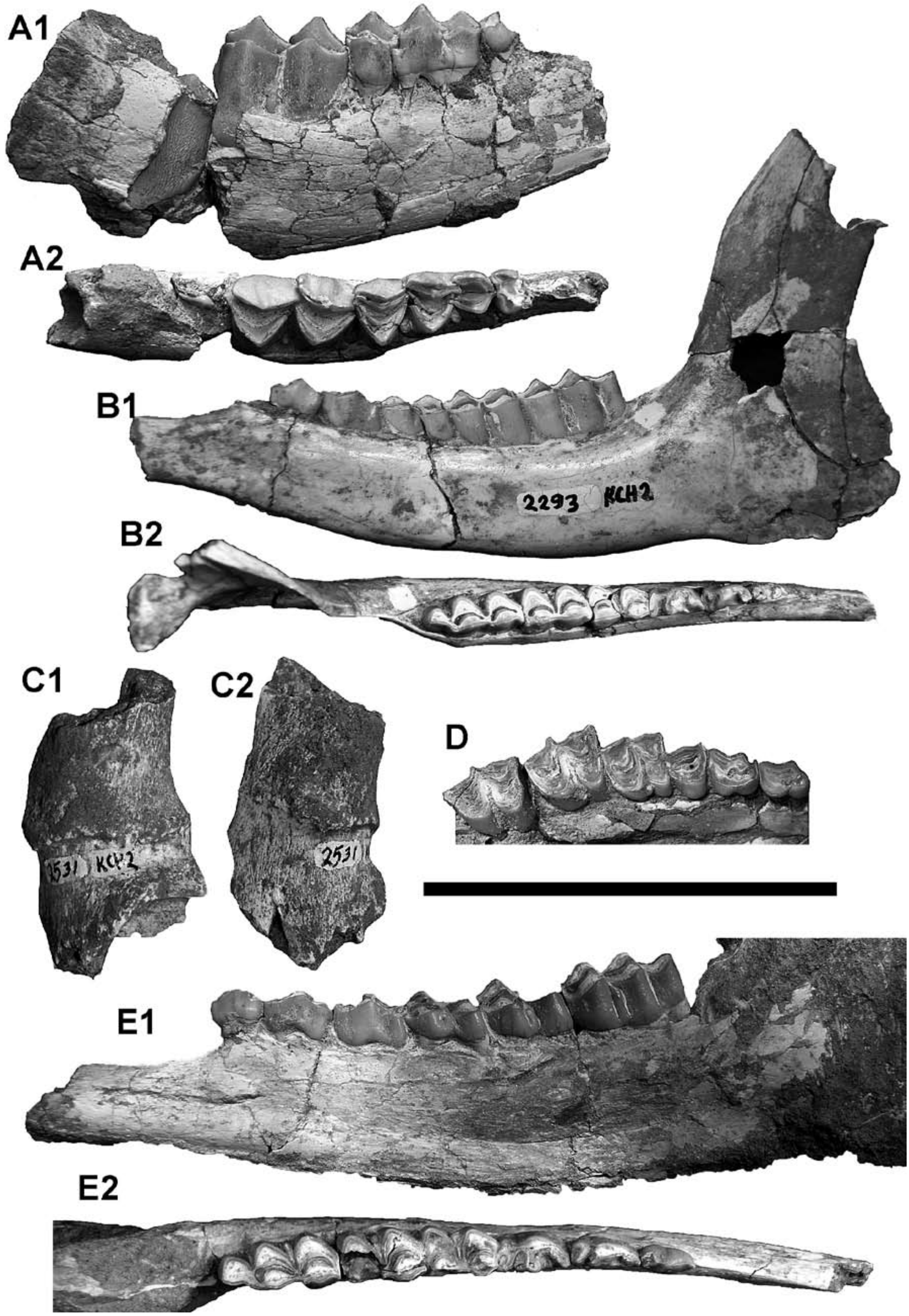

Fig. 4. A: ? *Samotherium* sp., right mandible FM-2879 with complete dp4-m1 in A1 - buccal and A2 - occlusal views. B: ? *Palaeoreas lindermayeri*, left mandible FM-2293 in B1 buccal and B2 - occlusal views. C: ? *Palaeoreas lindermayeri*, base of left horn-core FM-2531 in C1 - lateral and C2 - anterior views. D: ? *Palaeoreas lindermayeri*, right upper tooth row FM-2481 in occlusal view. E: *Miotragocerus (Pikermicerus)* sp., left mandible FM 2482 in E1 - buccal and E2 - occlusal views. Scale bar: 7.5 cm for Figs A, C; 10 cm for all others

In summary, the Kocherinovo choerolophodonts belong to a form present at KTD and, possibly, Kayadibi, the status of which is doubtful: it could be either a late form of *Ch. anatolicus*, or an early stage of *Ch. pentelici* s. str. (A third possibility would involve co-occurrence, and even possible hybridization, of *Ch. anatolicus* and *Ch. pentelici* around the Vallesian / Turolian boundary: a scenario similar to that proposed for European mammoths by Lister *et al.* 2005). Obviously, this problem could only be solved by the (nearly miraculous) discovery of well dated, associated adult mandible (permitting observations on the symphyseal shape; ideally with a skull permitting direct comparisons with the Akın skull published by Gaziry 1976) and deciduous teeth (permitting observations on the morphology of dp3/DP3; again, ideally, with a mandible). In any case, what can be said about the Kocherinovo material is that its size and morphology indicate an age definitely earlier than Pikermi (MN12) and most probably later than Yassiören (MN9), the type localities of *Ch. pentelici* and *Ch. anatolicus*, respectively. An allocation of the Kocherinovo choerolophodonts to *Ch. pentelici* ssp. KTD type (based on size) or to *Ch.* cf. *anatolicus* (based on morphology, and the diagnoses of the two species as provided by Konidaris, Koufos 2013) would be equally valid, for this reason we refer them to *Choerolophodon* sp. “KTD-type”.

Order Tubulidentata Huxley, 1872

Family Orycteropodidae Gray, 1821

Genus *Amphiorycteropus* Lehmann, 2009

Amphiorycteropus cf. *browni* (Colbert, 1933)

An aardwark skull from KCH-1 was determined as *Orycteropus* cf. *browni* (Spassov *et al.* 2006). The species *O. browni* Colbert, 1933 is known from the Siwaliks, where it is best known from the first half of the late Miocene, but a skull tentatively dated at 7.9 Ma could be younger and its age corresponds to the early Turolian (Barry *et al.* 2002). The species was recently referred, together with several other late Miocene forms, such as *O. gaudryi, O. mauritanicus* and probably *O. pottieri,* to the genus *Amphiorycteropus* Lehmann (Lehmann 2009). Identification is hampered by the fact that only photos of the skull are available, but they display several features of *Amphiorycteropus* (e.g. post-palatine torus). In any case, the skull demonstrates, in the strength of the temporal lines that almost meet caudally, and in the morphology of its M3, less 8-shaped than in later forms, some more archaic features than the typical middle Turolian *A. gaudryi* (Spassov *et al*. 2006), and indicates an older age.

Order Perissodactyla Owen, 1848

Suborder Hippomorpha Wood, 1937

Family Equidae Gray, 1821

Hipparion finds from the localities are several cranial and mandibular remains, some of them badly preserved. There are also postcranial materials, some of them in good preservation. Most of the materials are from KCH-2, but a few tarsals and metatarsal fragments from a small to medium-sized hipparion included in bone breccia are from KCH-1. A single, unworn molar is from KCH-3. The only fossils that could be identified are from KCH-2.

Genus *Hippotherium* Kaup, 1833

Hippotherium brachypus (Hensel, 1862)

Four skull fragments, two mandibles and some postcranial bones can be assigned to this species.

The skull fragments are from juvenile and adult individuals. The cranial fragment FM2611 (Fig. 3A) is from an adult male individual. The preorbital bar is not preserved, but it seems to be wide – the posterior border of the preorbital fossa is above the middle of M2. The preorbital fossa is deep (about 20 mm), with well delineated borders, anteroventrally oriented. The posterior pocket is shallow, about 5 mm deep. The preorbital fossa is located high above the facial crest (m36 = 33.5 mm), which ends above the anterior end of M1. The nasal notch ends above the anterior part of P2. The muzzle is short (m1 = 116 mm) and wide (m15 = 53 mm). The tooth row is 143.6 mm; the premolar length is 78.5 and the molars – 66.5 mm. The enamel plication is moderate – 17-23 plis, the pli caballin is complex. The hypoconal groove is deep, the lingual one is well developed on M3, but rudimentary on the other cheek teeth. The protocone is lingually flattened – labially rounded, with spur on P2.

The other adult skull fragment (FM2955) preserves M1-M3. The enamel plication is rich (26-31 plis), with thin enamel and deep folds. The hypoconal groove is deep; on M3 the hypocone is angular, with deep lingual groove. The posterior wall of the tooth is also plicated. The protocone is lingually flattened – labially rounded.

The specimen FM2547 (Fig. 3B) is from a juvenile individual, with dP1-dP4 and M1 in the process of eruption, only about 5 mm of which are visible outside the bone. The preorbital bar is wide (m32 = 40.5mm), with lacrimal placed on more than the half of the bar length. The preorbital fossa is large, well outlined, anteroventrally oriented. There is a moderate posterior pocket. The anterior border is well delineated, and anteriorly to it is a shallow depression. The foramen is close to the anteroventral border of the fossa. The preorbital fossa is close to the facial crest (m36 = 18 mm), which ends above the anterior end of dP4. The nasal notch seems to end above the anterior part of dP2.The muzzle is long, about 130 mm, and narrow (42 mm).The enamel is richly plicated, the pli caballin is complex, the protocone rounded. The hypoconal groove is deep. The posterior wall of the dP4 is also folded.

FM2546 is a juvenile individual, with M1 erupted, slightly worn, M2 is in the alveolus. DP1 is present. The preserved part of the preorbital fossa is situated far from the orbit (m32 = 49.5mm), and high above the facial crest (m36 is greater than 30 mm). Its posterior and anterior borders are preserved and are well outlined. There is a moderate pocket, about 8 mm deep. The deciduous premolar row is about 96 mm long, the enamel is richly plicated, the pli caballin is single to double.

The larger mandibles are from adult individuals. FM2538 is from a subadult individual (m3 not in attrition yet), with a long tooth row (about 161.7 mm) and curved incisor line. The rostral part is 111 mm long; the width at the incisors is c. 56 mm. The enamel is plicated; the anterostylid is angular and elongated. The preflexids and postflexids are plicated; the metaconid is rounded on p2 and p3, while on the other teeth it is angular. The metastylid is rounded on p2, 3 but irregularly shaped on p4 and square on the m1, 2. The premolar ectoflexid does not separate the metaconid and metastylid, while it does on the molars. The pli caballinid is rudimentary on p3, 4. The m1 has a protostylid. The linguaflexid is v-shaped and deep on the premolars and molars.

The second large mandibular fragment preserves only the molars and belongs to the same individual as the cranial fragment FM2955. The enamel of the preflexid and postflexid is plicated on m1, 2. The metaconid is rounded, the metastylid is quadrangular, and the pli caballinid is rudimentary on all molars as well of the preserved posterior half of p4. The linguaflexid of m1 and m2 separate the metaconid and metastylid, but not on m3. There is a protostylid on m1. The linguaflexid is deep and v-shaped.

The comparison with other hipparions shows greatest resemblance with *Hippotherium* (Bernor *et al*. 1988, 1997, Koufos 1987a, b, 2000, Vlachou and Koufos 2002, 2009). Although the skull fragments are not well preserved, the similarity is expressed in: the relatively long deciduous and permanent tooth rows, moderately to highly plicated enamel on the deciduous and permanent teeth. The anterior border of the preorbital fossa, which is not so well delineated as in *H. primigenium*, the deeper nasal notch which ends above P2 (instead of between P2 and C in *H. primigenium*), and the shallow pocket, distinguish the specimens from Kocherinovo from *H. primigenium* and relate them to *H. brachypus*. This species is widespread during the early and middle Turolian in the Balkan Peninsula (Hadjidimovo, Pikermi, Kalimantsi, numerous localities from the Republic of Macedonia) and perhaps also includes *H. giganteum* from the Northern Black Sea (Grebeniki). The relatively deep preorbital fossa, the deeper posterior pocket and well delineated anterior border on the specimens from Kocherinovo show greater similarity with earlier populations of *H. brachypus* from Hadjidimovo and Grebeniki.

The proportions of the mandible are close to those of some *Hippotherium* species. The rostral part length, its width at the incisors and the length of the symphysis are about the size of *H. primigenium* from Nikiti1, while depths of the horizontal ramus are close to the mean value for *H. brachypus* of Hadjidimovo and Pikermi. The dimensions and enamel features definitely distinguish the mandible from the other hipparion genera, such as *Hipparion* and *Cremohipparion*.

The comparison of a large astragalus (FM2231) shows affinities to *Hippotherium* from different localities and *C. proboscideum* from Vozarci (Republic of Macedonia). With no data showing the presence of *C. proboscideum* at KCH, the astragalus could also be assigned to *H. brachypus*.

Genus *Cremohipparion* Qiu, Huang et Guo, 1987

Cremohipparion cf. *Cremohipparion macedonicum* Koufos, 1984

The specimen FM2229 (Fig. 3C) is a young individual, preserving part of the skull with deciduous teeth only. The muzzle is short and narrow (m1 = 88, m15 = 45.5), with not much curved incisor row. The length DP2-DP4 is 78 mm, there is a DP1. The enamel plication is simple, the pli caballin is single; the protocone is elliptical to lingually flattened – labially rounded. The hypoconal groove is deep, on DP3 and DP4 it is confluent with the postfossette. It is difficult to use that specimen for comparison because of its bad preservation and young age. The muzzle length and width would be larger in an adult individual, and together with features such as elliptical to lingually flattened – labially rounded protocone and straighter incisor line, the specimen seems to be closer in its features to *C. macedonicum* than to *C. matthewi* (Koufos 1987c, 1988a, b, c, 2000, Vlachou and Koufos 2006, 2009).

The mandibular fragment FM2485 is of a small hipparion with preserved p2-m2. Its enamel is slightly crenulated and plicated, the metaconid rounded to elongated on p3, and the metastylid is rounded. The premolar ectoflexid does not separate metaconid and metastylid, while the molar ectoflexid penetrates the isthmus and reaches the linguaflexid. The pli caballinid is rudimentary on p3, 4. The linguaflexid is V-shaped on the molars and U-shaped on the molars. There is protostylid on p3-m2. The premolar length is 67.7 mm, close to the size of *C. macedonicum* from PER. The other two measurements (m11 and m12) are close to the samples of *C. macedonicum* from NIK-1, RZO and VTK, as well as of *C. matthewi* from DTK. Despite the length tooth row, slightly too large for *C. macedonicum*, the crenulated enamel on the flexids shows greater similarity with this species than with *C. matthewi*. (Koufos 1984, 1987c, 1988b, Vlachou, Koufos 2006, 2009).

Two small metacarpals from KCH-2 could possibly be added to this sample. Only one of them is well preserved, FM2488. Its length is close to those of *C. macedonicum* from NKT2 and PER, but is more robust. It is close but is slightly longer and has larger distal dimensions.

"Hipparion" sp., medium-sized

The skull fragment (FM2951) is of a juvenile specimen of a medium-size species; M1 is slightly worn, M2 is just erupted and only its tips are visible from the alveolus. The area of the preorbital bar is deformed, but seems to be wide. The DP2-DP4 tooth row is about 86 mm long, with moderately plicated enamel, and a double pli caballin.

Some postcranial remains could belong to this species. The three metatarsal fragments, two proximal (FM2492, FM2493) and one distal (FM2230), by their size and proportions, as well as two astragali of medium size (FM2490, FM2499) and three medium-sized first phalanges (FM2491, FM2828A, FM2952) could be assigned to a slender-legged hipparion species of *Cremohipparion* or *Hipparion*.

Family Rhinocerotidae Gray, 1821

? *Acerorhinus* sp.

FM2959 (KCH3) is a mandibular fragment with p4-m3 (m1-m3 c. 124; mandibular depth below m1 and m3 = 92 and 104 mm respectively; width at the bases of the i2 alveolus is c. 93). Although the front part is missing, it is clear than the corpus was not tapering forwards, in contrast to that of horned rhinos, and the symphysis as well as the i2 alveolar bases (which are preserved) must have been rather broad, as in *Acerorhinus* and *Chilotherium*.

Order Artiodactyla Owen, 1848

Family Suidae Gray, 1821

cf. *Microstonyx* sp.

Suids are represented by a distal tibia FM 2232 (KCH-2) (TD = 49.0; APD = 44.5) (the size of a specimen from the late Miocene of Hadjidimovo is TD = 44.5; APD = 39.5;) as well as by a tooth, a P3 FM2958 (KCH-3), remarkable by its large size (L = 20, W = 18.7), slightly larger than all *Microstonyx major / erymanthius* P3s that we could measure. The difference is not great but, together with the large size of the tibia, it is perhaps indicative of an age somewhat different from that of the bulk of later Miocene sites of the Balkano-Iranian province. The Vallesian *Hippopotamodon antiquus* is larger, but the evolution of these forms is still too poorly understood, in spite of their abundance, to draw reliable conclusions from a single tooth.

Family Giraffidae Gray, 1821

? *Samotherium* sp.

A juvenile mandible with dp3-m1 FM2879 (KCH-2) (Lm1 = 35; Wm1 = 21.5, H of unworn m1 = 25.5) (fig. 4 A1, A2), half a lower molar FM2532 (KCH- 2) (W = 22), and a proximal metacarpal FM2960 (KCH- 2) (proximal TD = 80) belong to a larger giraffid, probably a medium-sized giraffid of the *Palaeotragus / Samotherium* group; larger and more hypsodont than *Bohlinia attica*. (Fig. 4). *Samotherium* has not been recorded from the late Miocene of Bulgaria but is known from the Southern Balkans, pointing to eastern influences in the Turolian faunas (Geraads 1978; Kostopoulos *et al.* 1996).

Family Bovidae Gray, 1821

Tragoportax sp.

FM2024 (KCH-1) is a skull fragment of a relatively large bovid (width over pedicles = 92) but the horn-cores themselves are quite small (28 x 19). Spassov *et al.* (2005a) assigned it to a female *Tragoportax*, of which it is one of the few known examples (perhaps including some specimens reported as *Graecoryx*). This skull is associated with a few teeth, including m2 and m3, but no other fossil from Kocherinovo can be referred to this taxon.

Miotragocerus (Pikermicerus) sp.

A maxilla FM2884 (KCH-2) and both sides of a mandible FM2482 (KCH- 2) (fig. 4 E1, E2) belong to a small Boselaphini. The lower molars are similar to those of *Tragoportax*, but are much smaller. They must belong to the small genus (or subgenus) reported from many other localities, but the absence of horn-cores prevents any precise identification.

A few phalanges are too large for *Palaeoreas* or *Prostrepsiceros*, and could also belong here.

Palaeoreas lindermayeri ?

The most common bovid at Kocherinovo is a small form represented by several upper and lower tooth-rows (Fig. 4 B1, B2, D1, D2). Although the molars are about as long as those of *Prostrepsiceros rotundicornis*, the premolars are distinctly shorter (compare Table 2 with Kostopoulos 2005, table 9). Instead, they are of the right size and morphology for *Palaeoreas lindermayeri*, a species well-known in Bulgaria, especially at Kalimantsi and Hadjidimovo (Geraads *et al*. 2003). More specifically, they are more or less intermediate in size between the fossils from this latter site and those from Pikermi, but there are too few specimens for inferring an age estimate from this observation.

The identification of the single horn-core from Kocherinovo, FM2531 (KCH-2) (fig. 4C1, C2), is less secure. It is the base of a left horn-core with clockwise torsion (i.e., heteronymous); it has a slightly compressed oval cross-section (38 x 32.7, but the horn-core is hard to orientate with precision) and is strongly spiralled (but only the first 3 cm are preserved). The lack of compression and lack of keel suggest affinities with *Prostrepsiceros rotundicornis*, but we consider this identification unlikely, as it would imply the less parsimonious hypothesis that teeth and horn-core belong to different taxa. Anyway, positive identification of such a small piece would be premature; we may note that the postero-lateral keel may be weak in *Palaeoreas lindermayeri*, but even the small specimens from Pikermi are larger than FM2531 (KCH- 2) (Geraads *et al*. 2003).

Gazella sp.

It is not easy to separate the small *Palaeoreas* from large gazelles postcranials, but it seems that a number of postcranials (at least 4 individuals after the number of the radii) are of the right size for *Gazella* (see table 3).

Biochronology, Palaeoecology, and Palaeozoogeographic affinities

The mammalian fauna as a whole indicates a Turolian age. After their faunal composition, the localities of Kocherinovo are certainly the earliest Turolian localities from Bulgaria. Choerolophodont teeth from KCH-2 and KCH-3 show strong affinities with material from the localities KTD and Kayadibi in Turkey, suggesting a similar age, most probably MN11, for Kocherinovo.

The hipparions *C.* cf. *macedonicum* and *H. brachypus* from Kocherinovo, with morphology more archaic than that typical for MN12 and closer to the oldest samples of the species, such as Grebeniki and Hadjidimovo, also suggest an earlier (MN11) age. *Palaeoreas*, if correctly identified, is smaller than that from Pikermi, and the single *Microstonyx* tooth is larger than those from the middle Turolian of the Balkans. The aardvark from KCH-1 differs from *O. gaudryi*, known from the Turolian (mostly middle

Table 1. Comparative check-list of the fauna from KCH 1- 3

	Kocherinovo 1	Kocherinovo 2	Kocherinovo 3
Choerolophodon sp.		+	+
Amphiorycteropus cf. *browni*	+		
Acerorhinus sp.			+
Hippotherium brachypus		+	
Cremohipparion cf. *macedonicum*		+	
Hipparion sp.		+	
Equinae indet. (hipparions)	+		+
cf. *Microstonyx* sp.		+	+
? *Samotherium* sp.		+	
Tragoportax sp.	+		
Miotragocerus (Pikermicerus) sp.		+	
Palaeoreas lindermayeri ?		+	
Gazella sp.		+	

Table 2. Measurements of bovid tooth rows, Kocherinovo 2

Upper		P2-P4	M1-M3	P2-M3
FM2884	*Miotragocerus* sp.	37.2	47.8	-
FM2481	*Palaeoreas lindermayeri* ?	28	38.3	67
Lower		**p2-p4**	**m1-m3**	**p2-m3**
FM2482	*Miotragocerus* sp.	37	51	87.8
FM2293	*Palaeoreas lindermayeri* ?	c. 24.5	41.3	
FM2535	*Palaeoreas lindermayeri* ?	27.2	39.3	65.5
FM2534	*Palaeoreas lindermayeri* ?	-	42.7	-
FM2533	*Palaeoreas lindermayeri* ?	25.3	41.2	66.8

Table 3. Comparative measurements of *Gazella* metapodials from KCH-2, STR 1, 2 (middle Turolian, Geraads *et al*. 2011), HD (end of early Turolian) and the Villafranchian of South Europe (after De Giuli, Heintz 1974)

	L	prox. TD	TD shaft	dist. TD
Strumyani				
Mt FM2249 (Str-1)	-	20. 6	11.6	
Mt FM2008 (Str-2)	148	16	10	-
Mc FM2009 (Str-2)	144	17	10.2	18.4
Hadjidimovo (a complete skeleton)				
Mt		21.1		22
Mc		21.2		22
Kocherinovo 2				
Mt FM2484	159(160)	18.4	10.3	20.0
Mt FM2963			10.7	
Mc FM2961	-		-	19.0
Mc FM2962		17.4		
Gazella borbonica (Villafranchian of France, Italy and Spain).				
Mt (n=35)		16.2-19.5		

Turolian) of the Balkans, and displays archaic characters. It is tentatively referred to *Amphiorycteropus* cf. *browni*, which also supports an early age. As a whole the fauna is indicative of an early Turolian age (possibly the beginning of the early Turolian?).

The relatively small bone sample (about 200 identifiable bones) consists mostly of hipparions, *Gazella* and spiral-horned bovids (especially *Palaeoreas* sp.), making up an assemblage typical of the Turolian palaeocoenoses of Southern Bulgaria. This indicates that the open woodland and shrublands represented the dominant landscape in the region, and that this rather common landscape during the middle Turolian of Bulgaria and the Balkans was already present in the area in the early Turolian. The zoogeographic aspect of the fauna is also characteristic for the Turolian of Bulgaria, although ? *Samotherium* and *Amphiorycteropus* cf. *browni* possibly attest to eastern influences.

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