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Giraffidae (Artiodactyla, Mammalia) from the late Miocene of Kalimantsi and Hadjidimovo, South-Western Bulgaria

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*Abstract:* The various late Miocene localities around the villages of Hadjidimovo and Kalimantsi in south-western Bulgaria yielded a rich collection of giraffes, including *Helladotherium duvernoyi*, *Bohlinia attica* and *Palaeotragus rouenii*. These are the same species as at Pikermi, suggesting that there is no great age difference between these localities, but the limb-bones of both former species are stouter at Kalimantsi than in the Greek site, a difference which is perhaps of ecological origin. The absence of *Samotherium*, known in the geographically close sites of Greek Macedonia might be a consequence of the isolation of the river basins.

*Key words:* Mammalia, Artiodactyla, Giraffidae, late Miocene, Bulgaria

## INTRODUCTION

The giraffids represent a typical faunal element of the "Pikermian biome" of the late Miocene Balkano-Iranian province and an important indicator of the landscape. The various forms may also have zoogeographic and, to some extent, biochronological significance. Only a few late Miocene Giraffids were described from Bulgaria from very partial remains (Бакалов, 1953; Бакалов и Николов, 1962) or were merely mentioned without description in faunal lists (Nikolov, 1985; Spassov, 2002). Meanwhile, a huge collection of giraffid remains has been accumulated recently after the field campaigns of one of us (D. K.) in the late 70s, the 80s and the 90s, mainly from the localities of Hadjidimovo and Kalimantsi, and stored in the Paleontological museum of Assenovgrad (division of the National Museum of Natural

History – Sofia). This material is described here (the material marked with initials HD and K or as Hadjidimovo and Kalimantsi), together with some other remains from the collections of the University of Sofia and from the NMNH – Sofia (marked with initials FM).

The Hadjidimovo fossiliferous area is situated in the Mesta river valley near the Hadjidimovo town (Gotse Delchev district) and the Bulgarian-Greek border; it is a late Miocene fossil site with 4 localities of vertebrate fauna. Intensive investigations of the fauna of Hadjidimovo started recently (Spasov & Ginsburg 1999; Geraads et al. 2001; Kostopoulos et al. 2001; Kovachev, 2001; Hristova et al. 2002; Христова и др. 2002; Geraads et al. 2003; Koufos et al. 2003; Spasov & Geraads, 2004). Most of the giraffid remains were discovered in the main locality Hadjidimovo –1 (where about 30 mammalian species are reported), placed at the MN11/12 boundary (Spasov, 2002). Two *Helladotherium* metacarpal fragments were found in Hadjidimovo-Tumbichkite (HD-2), a locality of the same or somewhat later age.

The fossiliferous area of the Kalimantsi village is the richest in the Middle Struma basin and the best known of the Bulgarian late Miocene vertebrate localities. In fact, the name Kalimantsi refers to a large area (~ 6 km<sup>2</sup>) of late Miocene fossiliferous deposits with more than 10 known fossil mammal localities. The recent revision of their biochronology demonstrates that all Kalimantsi sites (scattered over a thickness of more than 100 m) are of Turolian age and that there is no evidence of any Vallesian fauna in this area. Kalimantsi-1 (KAL-1), which seems to belong to the newly established Gradishte lithocomplex, is more likely to yield a fauna of early Turolian age, while other Kalimantsi faunas (referred to the Strumyani lithocomplex) are probably of middle Turolian age. (Цанков и др., под печат; Spasov et al. 2004; Spasov et al. in press). The giraffid remains from the Kalimantsi area come from Kalimantsi-1 (MN11 ?), Kalimantsi-Pehtsata (MN12) and from other localities with fauna considered to belong to the middle Turolian.

Abbreviations: K = Kalimantsi; HD = Hadjidimovo; AUT = Aristotle University of Thessaloniki; BMNH = Natural History Museum, London; IPUW = Paläontologisches Institut Universität Wien; MNHN = Muséum National d'Histoire Naturelle, Paris; NHMW = Naturhistorisches Museum Wien.

## SYSTEMATIC STUDY

*Helladotherium duvernoyi* (Gaudry & Lartet, 1856)

*Helladotherium duvernoyi*: Бакалов, 1953, с. 93, табл. III, рис. 1-4

*Helladotherium duvernoyi*: Бакалов, Николов, 1962, p. 75, pl XXX, fig. 2-5

TYPE . No type-specimen was designated by Gaudry and Lartet (1856). Since the type-series was later mixed with specimens found subsequently, a lectotype cannot be designated. This would be useless, anyway, as all large Giraffids from the type-locality belong to this species  
TYPE-LOCALITY: Pikermi.

STRATIGRAPHIC AND GEOGRAPHIC RANGE. Late Vallesian to Late Turolian of South Europe and the Balkano-Iranian Late Miocene zoogeographic province and the North Pontic region

### Skull and teeth

1) Kalimantsi. The best specimen is K-5156, from Pehtsata. It includes the anterior part of a skull with both tooth-rows (Pl. 1, Fig. 1-2), and associated mandible K-5159. It is of very large size, as in *Samotherium* and *Helladotherium*, but the muzzle is broad and low as in the latter genus, while *Samotherium* has a rather deep snout. Enough of the supra-orbital area is preserved to be sure that there were no supra-orbital horns, and they must have been more posterior, or absent. A narrow ethmoidal fissure was probably present. The nasal bones are broad, straight in profile, and almost fused medially. The precise extent of the other bones of the facial region is hard to estimate.

The teeth are very worn but most of them are well-preserved. Only p2 is missing. The premolars are large relative to the molars, although less so than in the Plio-Pleistocene *Sivatherium*. They are reduced, instead, in similar-sized *Samotherium*: in this genus, the premolar / molar index is always smaller than 70. P4 is almost as broad as M1, as in *Helladotherium*, whereas it is clearly narrower in *Samotherium*. On the mandible, p4 is strongly molarized with an antero-posteriorly lengthened metaconid, as in all giraffids, but p3 has a wide open anterior valley, with bulbous metaconid, and a large talonid in which the entoconid is antero-posteriorly directed. It is always more molarized in large *Samotherium*, and the talonid is smaller.

Some measurements on this skull fragment and associated mandible are:

width of nasal bones = 90

length from front of orbit to front of P2 = 200

Length P2-P4 = ca. 95 ; length M1-M3 = 121 (index = ca. 80)

Width of P4 = 40.4 ; width of M1 = 41.7

Length p3-p4 = 71.5 ; length m1-m3 = 148

Length of p4 = 39.3 ; length of m3 = 61

Many of the tooth-series from Kalimantsi are deciduous, and we assign them all to *Helladotherium*. DP3 (K-3710) has a long first lobe and bifurcated parastyle, as in *Helladotherium*, whereas it is short and simple in *Samotherium*. On dp3, the metaconid is usually small and slanting posteriorly (Pl.2, Fig.6); only in one case (K-5210) is it isolated and antero-posteriorly lengthened, still leaving an open valley between it and the paraconid. In large *Samotherium*, instead, it always forms a complete lingual wall (Geraads, 1994, fig.1; Bohlin, 1926, pl.5, fig.5; pl.7, fig.3.). On dp4, the paraconid usually (K-5203, K-5204, K-5212) has two posterior wings, the lingual wall being usually the largest. *Samotherium* has no labial wing (Bohlin, 1926, pl.7, fig.3).

2) Hadjidimovo. HD-5157 is a nice mandible with left p2-m3 (Pl.1, Fig.4-5) and all front-teeth (Pl.1, Fig.3). HD-5201 is an isolated m3.

Measurements of HD-5157:

Length p2-p4 = 93.5 ; length m1-m3 = 139; length of p4 = 39.3 ; length of m3 = 59

The cheek-teeth are less worn than in K-5159, but display the same features. The most interesting teeth are the incisors and canines. They are morphologically similar to those of the well-preserved *Samotherium major* from Vathylakkos-3 (Geraads, 1978), but more worn, although the cheek-teeth are less so. Another difference is that, while this *Samotherium* has medially worn i1s, no such wear is visible in the *Helladotherium* from Hadjidimovo (HD-5157), but there is instead a wear notch between the first and second lobes of both the left and right canines. Comparison with the modern giraffe is difficult, because most museum specimens either are not from wild animals, or have their front teeth lost or too much worn. There is only one useful specimen in this respect in the MNHN, N°1928-307, which is an adult female. The central incisors are broken. The cutting edge of the other front teeth is notched by at least 4 wear grooves which obviously were used as a comb to pluck the leaves from small ploughs (Lydekker, 1903). There is one groove across the second lobe of the canine, one between the two lobes of this tooth, one between the canine and i3, one between i3 and i2, plus probably one more between i2 and i1, and perhaps one between both (missing) central incisors: this makes a likely total of 11 notches, making this set of teeth a very efficient comb.

Incisors and canines of fossil giraffes have received little attention. There are some indications in the literature of the occurrence of notches similar to those mentioned above (e.g. Rodler & Weithofer, 1884, pl.4, fig.2-3, in *Samotherium neumayri*), but most of the other illustrated teeth are only slightly worn and do not display any conspicuous wear notches. This might suggest that, when present, they were restricted, like at Kalimantsi and Vathylakkos, to only one pair of teeth. Perhaps food intake in fossil giraffes was less selective than in *Giraffa*, either because they picked more whole twigs, and/or because they incorporated some grasses in their diet.

Pending more general results, a preliminary hypothesis would be that *Helladotherium* was mostly a grazer (hence the strong wear on its front teeth) that occasionally (but regularly) picked out small leaves.

*Samotherium* was said by Solounias & al. (1988) to be a grazer, but we are not fully convinced by their argumentation. First of all, their reconstruction of the premaxillary shape of *S. boissieri* (BMNH M4215) is more square than the fossil shows. Actually, the curvature of the anterior part of the premaxillae extends definitely beyond the level of the rostral end of the palatine foramina, and is not followed posteriorly by a constriction. Furthermore, while the cheek-teeth of this specimen are well-worn, the incisors and canines are still very high, an unlikely feature for a grazer. Even *S. major*, said by Solounias et al. (2000) to be more a grazer than its ancestor, was probably still largely browsing, as shown by the unpublished premaxilla of *S. major* from Vathylakkos which, albeit deformed, is pointed anteriorly, although much less so than in typical browsers.

Only a thorough revision of the various collections, together with ongoing studies of microwear, could shed new lights on the subject, which also has important implications on the origin of the giraffid bilobate canine.

### **Post-cranials**

There are many limb bones from both Kalimantsi and Hadjidimovo, but most of them are incomplete and it is not always easy to estimate their dimensions. There are five complete metacarpals, large and stout. Those from Kalimantsi are larger than those from Hadjidimovo (Fig.1), but the difference is slight for the specimen from Kalimantsi-1 (unnumbered). However, they all plot out of the range for *Samotherium major*, a species known in Greek Macedonia, Samos and Turkey. All Bulgarian specimens plot within the range of *Helladotherium* from various localities, and they can confidently be assigned to this genus.

Some other complete limb-bones are also of very large size, similar to that of *Helladotherium*, as far as we know from the scarce comparative material. Both the humerus and radius are longer than in *Samotherium*; *Helladotherium* was probably heavier, and had legs of a more graviportal type, with relatively longer stylopod (Table 2).

Therefore, there is no evidence for more than one very large Giraffid, both in Kalimantsi and Hadjidimovo, and we assign all very large specimens to *Helladotherium duvernoyi*. This species was first described from Pikermi, and has been reported from several other late Miocene localities of the Aegean region but, as no male horned skull is known, there remains a doubt concerning the validity of this generic name, which could well be a junior synonym of *Bramatherium* (Geraads & Güleç, 1999).

*Bohlinia attica* (Gaudry & Lartet, 1856)

?*Camelopardalis parva* (pars): Бакалов, 1953, стр. 92, табл. I, рис. 2-5

?*Camelopardalis parva* (pars): Бакалов, Николов, 1962, стр. 76, табл. XXXI, рис. 6-7

?*Orasius speciosus*: Бакалов, Николов, 1962, стр. 77, табл. XXXI, рис. 10-12

?*Orasius* aff. *atticus*: Бакалов, 1953, стр. 92, табл. III, рис. 5

?*Orasius* cf. *atticus*: Бакалов, Николов, стр. 78, табл. XXX, рис. 13

TYPE. Geraads (1979: 378) incorrectly designated as lectotype a specimen that was not part of the type-series (Gentry, 2003: 344). At the present time, no type can be designated.

STRATIGRAPHIC AND GEOGRAPHIC RANGE. Late Vallesian to Late Turolian of the Balkano-Iranian Late Miocene zoogeographic province

## Material

A few metapodials from Kalimantsi definitely attest the occurrence of the long-limbed *Bohlinia*, a close relative of the modern giraffe. However, while the lengths of these bones are very similar to those of other specimens from several localities of the Eastern Mediterranean, their transverse diameters are noticeably larger (Table 1; Fig.2-3), i.e. the bones are stouter, more like those of the Recent giraffe. A few fragmentary bones from Kalimantsi-1 look somewhat smaller. Two tali, smaller than those of *Helladotherium*, but somewhat larger than the few known specimens definitely referable to *Bohlinia*, could perhaps also be referred to the latter taxon (Fig.4).

The teeth of *Bohlinia* are very poorly known (Bohlin, 1926; Arambourg & Piveteau, 1929; Geraads, 1979). The best known specimen is still the maxilla published by Wagner

(1861) as *Orasius speciosus* (*Orasius eximius* in the figure legend). It is similar to *Palaeotragus rouenii*, but the teeth are larger and more brachyodont, the premolars are relatively longer, P4 is broader relative to M1, the parastyle is double on the premolars and encloses an enamel island on the molars, and there is a lingual cingulum. It is mainly on the basis of size that we refer to this genus two mandibles with poorly preserved and much worn molars, K-5206 (length m1-m3 = ca. 92), and K-5209 (length m1-m3 = ca. 85). A maxilla with well-preserved slightly worn teeth, K-5521 can also be referred to this species (Pl.2, Fig.5). The teeth are brachyodont, and larger than those of *P. rouenii*. The premolars much resemble those of the holotype of *Orasius speciosus* in Munich by their strong styles, incomplete fusion of paracone and metacone, long internal spur parallel to the hypocone. Dimensions: length of premolar series = 61.2; length of molar series = 77.5

There is only slight evidence of *Bohlinia* at Hadjidimovo. A complete metatarsal (Fig.3) could be from this locality rather than from Kalimantsi. Some fragmentary epiphyses are also likely to be of this genus (Table 1). Alternatively, they could be referred to *Samotherium*, but this is a less parsimonious hypothesis, not substantiated by any tooth remain.

The very long limb bones, seemingly unique to *Bohlinia* among late Miocene giraffids of this area, leave no doubt about their assignment to this genus, but their greater massiveness implies some distinction from the classic form. Whether it reflects a chronological or ecological difference is hard to tell at present.

#### *Palaeotragus rouenii* (Gaudry, 1861)

? *Palaeotragus roueni*: Бакалов, 1953, стр. 94, табл. IV, рис. 2-5, табл. VII, рис. 1

? *Palaeotragus roueni*: Бакалов, Николов, 1962, стр. 75-76, табл. XXXI, рис. 1, 3-5

? *Camelopardalis parva* (pars): Бакалов, Николов, 1962, стр. 76, табл. XXXI, рис. 8-9

HOLOTYPE. Skull from Pikermi (Gaudry, 1861, pl. 7, fig.1-3).

STRATIGRAPHIC AND GEOGRAPHIC RANGE. Late Vallesian to Late Turolian of the Balkano-Iranian Late Miocene zoogeographic province, plus the North Pontic region, perhaps extending as far as Spain and Afghanistan, and very close to the Chinese *P. microdon*.

#### **Material**



The best specimen is a mandible from Hadjidimovo, HD-5190, with both complete tooth-rows (Pl.2, Fig.1-2). Its dimensions (Table 3) are similar to those of the Pikermi and Ditiko specimens. The p2 is large, with well-developed lingual crests. The p3 is rounded, and has distinct parastylid and paraconid, and a large metaconid forming an incomplete lingual wall, while p4, of similar outline and size, is fully molarized.

We also refer to *P. rouenii* : a poorly preserved posterior part of a skull from Kalimantsi (Coll. Museum of Assenovgrad), showing a typically giraffid occipital morphology; another molar series from Kalimantsi (Pl.2, Fig.3-4) (the noted mandibular fragment from the collection of Bakalov and Nikolov, but not mentioned in their monography: Бакалов, Николов, 1962 as giraffid remain); a mandible fragment with m2-m3 (figured as Pl. XXXI-3 in Бакалов, Николов, 1962), ( the fossils are preserved in the collections of the University of Sofia).

Very few metapodial diaphyses, but no complete limb-bone, can be assigned to this species, the limb-bones of which are as slender as those of *Bohlinia*, but much smaller.

There remains an unsolved problem concerning the relative preservation of jaws and limb-bones in *Bohlinia* and *Palaeotragus*. As in several other sites, the former is mostly illustrated by bones, the latter by teeth. It might be that in some instances, teeth of *Bohlinia* have been mistaken for those of *Palaeotragus*, but this probably does not fully account for the difference. Perhaps the length and conspicuous size of *Bohlinia* limb-bones made them preferentially collected ?

## CONCLUSIONS

There appears to be no difference in the list of giraffids from the Kalimantsi fossiliferous area and Hadjidimovo. Both include *Helladotherium duvernoyi*, *Bohlinia attica* and *Palaeotragus rouenii*, although the latter species has not yet been found in the lowest level of Kalimantsi. These are exactly the species present at Pikermi. There is no evidence in Bulgaria of *Samotherium*, definitely present in the MN 12 fauna of Vathylakkos (Geraads, 1978). At first sight, this might look surprising, given the geographic proximity of these areas, but the Greek sites belong to a different fluvial basin, which might have been inhabited by different contemporaneous biocenoses. The somewhat larger size of *Helladotherium* and *Bohlinia* from the Kalimantsi localities of the MN12 zone in comparison with the specimens from Hadjidimovo (MN11/12 boundary) and Kalimantsi-1 (MN11?) possibly indicates a size increase with time. More material is needed to support this hypothesis, because the

*Helladotherium* from Kalimantsi is also larger than the roughly contemporaneous one from Pikermi, perhaps reflecting different ecological conditions.

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## CAPTIONS TO FIGURES

Fig. 1. Plot of length vs. distal width of the metacarpal in *Samotherium* and *Helladotherium*. All measurements ours. *Samotherium major* from Samos, Greek Macedonia, and Kemiklitepe; *S. neumayri* from Maragha; *Helladotherium* from Pikermi, Maragha, Gülpinar, and Ravin des Zouaves. The shorter Mc from Kalimantsi is from KAL-1.

Fig.2. Plot of length vs. width of shaft of the metacarpal in *Bohlinia attica* and the modern giraffe (measurements ours, and from Singer & Boné, 1960).

Fig.3. Plot of length vs. width of shaft of the metatarsal in *Bohlinia attica* and the modern giraffe (measurements ours, and from Singer & Boné, 1960).

Fig. 4. Plot of medial height vs. distal width of the talus in large late Miocene Giraffids. All measurements ours, except *S. sinense*, from Bohlin, 1926. *Samotherium major* from Samos and Kemiklitepe; *S. neumayri* from Maragha; *Helladotherium* from Pikermi and Maragha.

## CAPTIONS TO PLATES

Plate 1. *Helladotherium duvernoyi*. Fig.1: K-5156 from Kalimantsi, upper tooth-row. Fig.2: same specimen, dorsal view of muzzle. Fig.3: HD-5157 from Hadjidimovo, front teeth. Fig.4: same specimen, labial view of cheek-teeth. Fig.5: same specimen, occlusal view of cheek-teeth. Scale = 10 cm for Figs 1, 4, 5; 20 cm for Fig.2; 5 cm for Fig.3.

Plate 2. Fig.1-4: *Palaeotragus rouenii*. Fig.1: mandible HD-5190 from Hadjidimovo. Fig.2: same specimen, right premolars in occlusal view. Fig.3: Right molar series, labial view (University of Sofia). Fig.4: same specimen, occlusal view. Fig.5: *Bohlinia attica*, (K 5521) from Kalimantsi, occlusal views of the premolar and molar series. Fig.6: *Helladotherium duvernoyi*, K-5204 from Kalimantsi, occlusal view of dp3-m1. Scale = 10 cm for Figs 1, 3-6; 5 cm for Fig.2.

Table 1 Comparative measurements of limb-bones of *Bohlinia* from Kalimantsi (upper levels), Kalimantsi-1 (lowest level, river bank) and Hadjidimovo

<b>Metacarpal</b>	Length	Proximal breadth	Min. width of shaft
Kalimantsi	550++ (700 ?)	90	60
Kalimantsi	695	98	60.5
Kalimantsi	730	93	57
Kalimantsi-1	-	-	50
Kalimantsi-1	-	86	-
Kalimantsi-1	-	86	-
Pikermi, MNHN	710	83	47
Vathylakkos, AUT	693	88	50
Vathylakkos, AUT	661	82	45

<b>Metatarsal</b>	Length	Min. width of shaft	Distal breadth
Hadjidimovo FM2025		~ 56	~ 97.5
? Kalimantsi	695	52.5	95
Pikermi, MNHN	690	-	75
Maragha, MNHN	675 ?	52	-
Slq-682, MNHN	680	46	75
Ditiko, AUT	658	49	76

Table 2. Comparative measurements of limb-bones of *Helladotherium* from Kalimantsi (upper levels) and Kalimantsi-1 (lowest level, river bank)

<b>Humerus</b>	Bi-articular length	Distal articular breadth	Minimum diameter of trochlea
Kalimantsi-1	480	141	53
Kalimantsi, K-156	510	-	-
<i>Helladotherium</i> , PIK-1506, MNHN	460	134	53
<i>S. major</i> , Kemiklitepe B, MNHN	410	122	52
<i>S. sinense</i> (Bohlin, 1926)	427	133	-
	445	146	-

  

<b>Radius</b>	Length	Maximum distal breadth
Kalimantsi 149	600	127
<i>Helladotherium</i> , Pikermi, NHMW	600	-
<i>Helladotherium</i> , Slq-689, MNHN	610	-
<i>Helladotherium</i> , Samos (Bohlin, 1926)	610	138
<i>Helladotherium</i> , Pikermi, MNHN	565-575	-
<i>S. sinense</i> (Bohlin, 1926)	548-571	127-132
<i>S. major</i> (Bohlin, 1926)	530	127

Table 3. Measurements of lower tooth series of *Palaeotragus rouenii*.

	premolar length	molar length
HD-5190	51.8	78
Kalimantsi (level unknown), Univ. Sofia		72.8
Pikermi PIK-1671, MNHN	48	72
Pikermi PIK-1674, MNHN	-	74
Pikermi PIK-1675, MNHN	52	-
Pikermi, IPUW	46	72
Ditiko, AUT	48.5	77.5