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Palaeontology of the upper Miocene vertebrate localities of Nikiti (Chalkidiki Peninsula, Macedonia, Greece) Rhinocerotidae[☆]

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ABSTRACT

Although the Nikiti 2 (NIK) mammal collection is rich in large fossil vertebrates, rhinocerotid's remains are restricted to both tooth rows of a mandible. The teeth are heavily worn and the preservation quite well. The morphology of the teeth indicate close similarities to the horned-rhinoceros "Diceros" neumayri (Osborn, 1900). The metrical comparison of the NIK teeth with the two well-known rhinocerotids from the late Miocene of Greece, "D." neumayri and *Dihoplus pikermiensis*, confirms its attribution to the first one. "D." neumayri is well known from the Vallesian and Turolian of Greece and adjacent countries. The geographic extension of "D." neumayri indicates that it is mainly known from the Balkan Peninsula and Asia Minor; it is also referred from Moldova and Ukraine as well as from Iran.

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1. Introduction

Since the beginning of the 1990s the locality of Nikiti 2 (NIK; Macedonia, Greece) provided a rich mammal fauna which includes a number of specimens and taxa, mainly equids and bovids. Although the long-time excavations in NIK, rhinocerotid specimens remained very scarce. This article is dealing with the description, comparison and determination of the rhinocerotid material found in NIK. More information about the stratigraphy, fauna and age of the NIK locality is given in Koufos (2016) and Koufos et al. (2016).

2. Material and methods

The measurements were taken using a digital caliper; all are given in mm with an accuracy of 0.1 mm. The dental nomenclature follows Peter (2002). The studied material is housed in the Laboratory of Geology and Palaeontology, University of Thessaloniki (LGPUT).

Abbreviations: AMPG, Athens Museum of Palaeontology and Geology; HLMD, Hessisches Landesmuseum, Darmstadt, Germany; IPUW, Institut für Paläontologie der Universität Wien; LGPUT, Laboratory of Geology and Paleontology, University of Thessaloniki; PIK, Pikermi; MRG, Maragheh; NHMW, Naturhistorisches

Museum Wien; NIK, Nikiti 2; NKT, Nikiti 1; PMMS, Palaeontological Museum Mytilinii, Samos; PNT, Pentalophos 1; SAM, Samos.

3. Systematic palaeontology

Order Perissodactyla Owen, 1848
 Family Rhinocerotidae Owen, 1845
 Subfamily Rhinocerotinae Owen, 1845
 Genus *Diceros* Gray, 1821
 "*Diceros*" *neumayri* (Osborn, 1900)

Locality: Nikiti 2 (NIK), Chalkidiki, Macedonia, Greece.

Age: Early Turolian, MN 11, late Miocene.

Material: Right and left lower tooth row of the same mandible, NIK-1669.

Measurements: See Table 1.

Description: The available material includes the two lower tooth rows of the same mandible, without the mandibular bone (Fig. 1). The mandible was found near the surface, just below a lentisk shrub, the roots of which crushed and destroyed the bone. The mandible belongs to an old individual and the teeth are heavily worn (Fig. 1(b, d)).

p2. The two p2 are well preserved, having triangular occlusal outline. The paraconid is well developed and acute. The talonid is wider than the trigonid. The occlusal surface is entirely worn and the enamel restricted to its borders.

p3. Both p3 are heavily worn and lack part of their distal end. The trigonid and talonid are slightly angular and the previous is

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Table 1

Measurements and indices for the lower teeth of various rhinocerotids. L: length; W: width.

	<i>C. simum</i>		<i>"Diceros" neumayri</i>				<i>Dihoplus pikermiensis</i>			<i>Dihoplus schleimacheri</i>
	Recent	Nikiti 2	Samos, ?Mytilinii 1, MTLA	Pentalophos 1	Maragheh	Kerassia	Pikermi	Pikermi	Eppelsheim	
		NIK-1669	PMMS-106	PMMS-108	PNT-34	MRG-A4791, TYPE	K4D-387	IPUW-PIK-342	AMPG-PIK-3691/91	HLMD-DIN-1929
	Guérin (1980)	This work	Giaourtsakis (2009)		Geraads and Koufos (1990)	Giaourtsakis et al. (2006)				
Lp2	35.8	28.6	–	30.8	26.6	31.7	–	–	33.2	31.2
Lp3	41.1	38.2	34.7	38.1	36.1	41.5	37.3	37.5	37.4	36.5
Lp4	44.6	41.5	41.3	40.7	39.3	46.0	40.2	38.2	44.3	42.3
Lm1	49.2	46.2	43.2	45.5	44.6	49.1	46.0	43.2	46.5	45.4
Lm2	55.5	52.2	50.2	50.9	48.2	54.1	48.4	47.9	52.3	47.8
Lm3	57.8	50.1	53.3	52.4	52.1	56.2	47.6	44.3	51.3	46.9
Wp2	22.2	18.3	21.5	21.5	19.1	16.7	–	–	22.9	21.0
Wp3	26.7	29.0	27.5	29.2	31.5	28.2	29.5	24.2	–	27.2
Wp4	29.2	32.2	31.2	32.95	33.9	31.0	33.1	28.5	33.5	30.2
Wm1	30.8	35.4	33.9	31.6	32.9	33.3	37.2	29.8	35.8	33.6
Wm2	30.8	34.3	37.5	35.9	33.3	35.3	35.5	34.3	35.4	34.8
Wm3	30.1	30.5	33.6	33.5	29.8	33.8	30.3	31.4	32.6	30.8
Lp2-p4	114.7	104.8	102.0	106.2	102.5	116.3	110.0	–	116.8	109.6
Lm1-m3	153.1	137.0	144.9	150.8	143.1	158.9	141.4	135.8	150.4	143.8
Lp2-m3	264.3	241.0	247.0	256.0	243.7	278.0	252.0	–	270.5	250.1
Lp2/Lp3	–	74.9	–	80.8	73.6	76.4	–	–	88.8	85.48

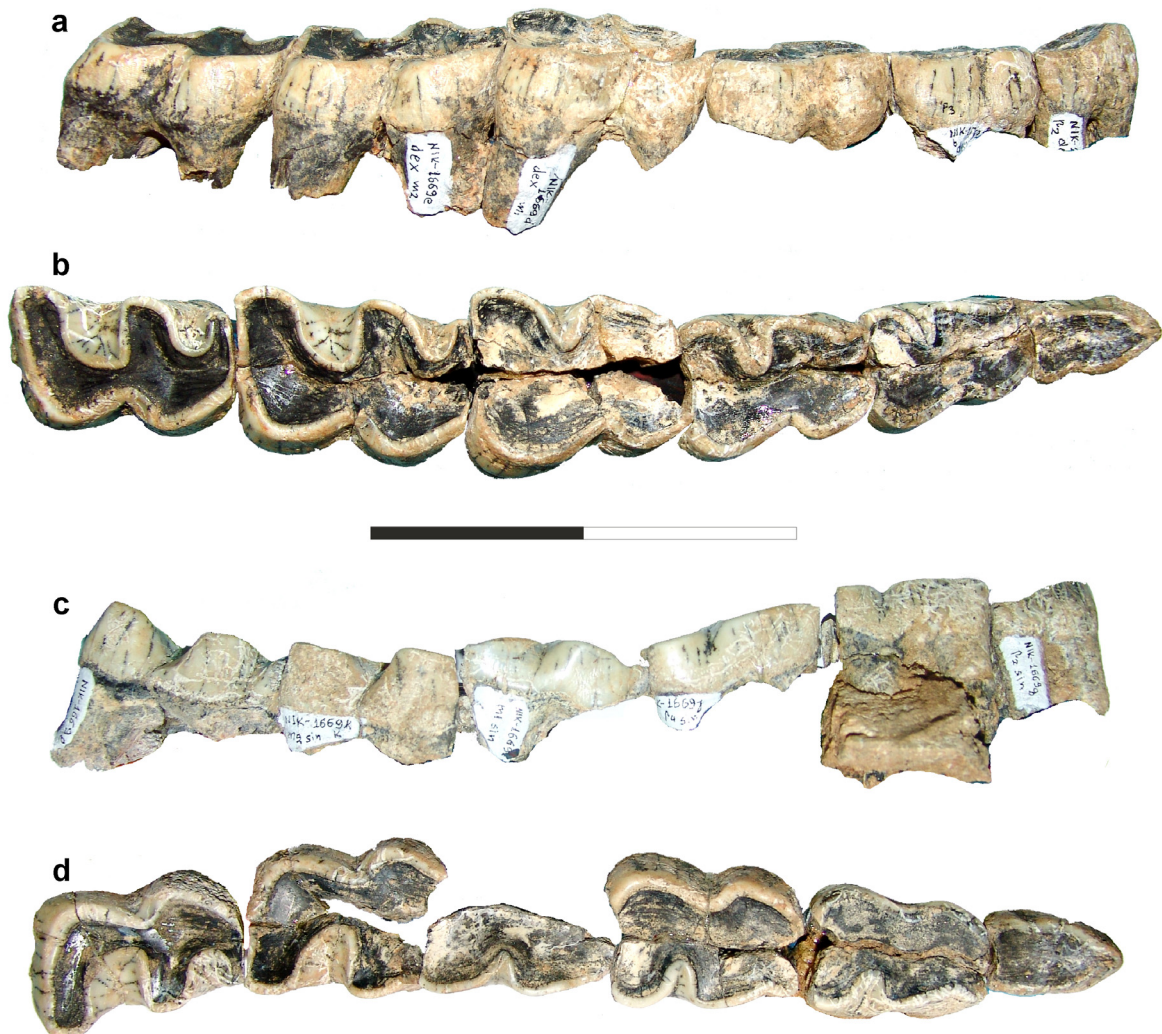


Fig. 1. *"Diceros" neumayri*, Nikiti 2 (NIK), Chalkidiki, Macedonia, Greece; Early Turolian, MN 11. **a, b.** Right lower tooth row, NIK-1669; **a:** buccal view; **b:** occlusal view. **c, d.** Left lower tooth row, NIK-1669; **a:** lingual view; **b:** occlusal view. Scale bar: 10 cm.

narrower than the latter. The trigonid valley almost disappears but the talonid valley is small and has a U-shape. The buccal groove is angular and shallow.

p4. Both are slightly broken mesially. The trigonid is more angular than the talonid; the trigonid valley is just distinguished and has an open U-shape, like the talonid one, which is deeper. The buccal groove is angular and deep.

m1. The left m1 is broken and only its lingual half is preserved; the right m1 is almost complete, lacking a part of its mesial margin (Fig. 1(b, d)). The talonid is wider than the trigonid. The advanced attrition removed the trigonid valley but the talonid valley is deep and has an angular shape.

m2. The left m2 lacks its mesial part with the paralophid; the right one is more complete, lacking only a small part of the paralophid (Fig. 1(b, d)). It is narrower and more elongated than the m1. The trigonid is angular; the talonid is wider and less angular than the trigonid. The trigonid and talonid valley are wide and U-shaped. The buccal groove is angular and deep.

m3. It is elongated and narrow. Its morphology fits to that of the m2; however as it is less worn, some additional features can be distinguished. The paralophid is well marked and elongated, extending up to the lingual margin of the tooth. The tooth bears a mesio-buccal, relatively weak cingulum and a small distal cingular cuspid situated in the middle of the distal wall.

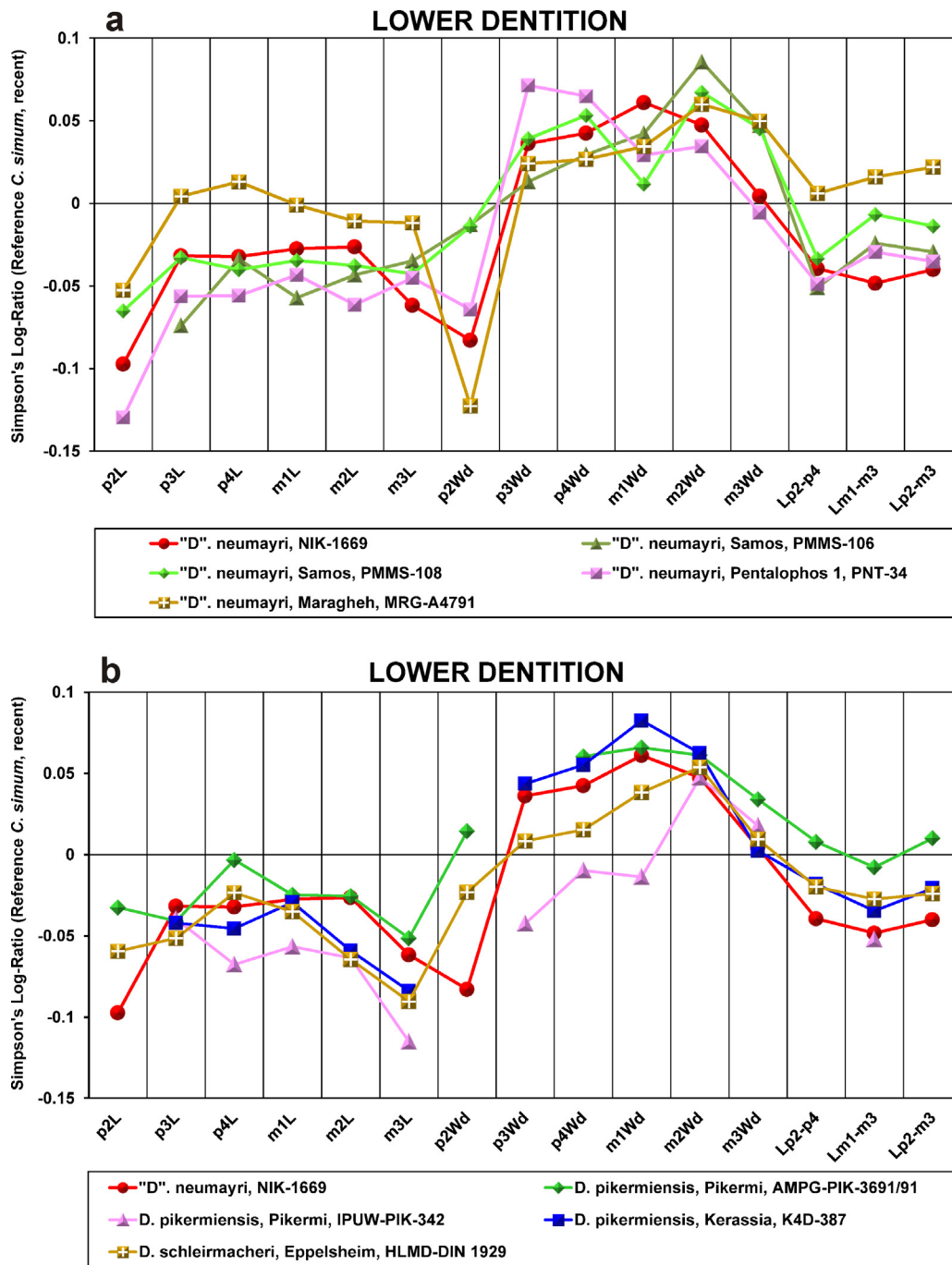


Fig. 2. a. Simpson's Log-ratio diagram based on the dimensions of the lower teeth of "*Dicerops*" *neumayri* from various localities (Table 1). Reference: *Ceratotherium simum*, recent (Guérin, 1980). b. Simpson's Log-ratio diagram based on the dimensions of the lower teeth of "*Dicerops*" *neumayri* from Nikiti 2 (NIK) and *Dihoplus pikermiensis* from various localities (Table 1). Reference: *Ceratotherium simum* (Guérin, 1980).

Remarks: The first evidence for the presence of a rhinocerotid in the late Miocene of Greece originates from Pikermi, where Wagner (1848) recognized a fossil relative of the extant African species and named it "*Rhinoceros pachygnathus*", now known as "*D.*" *neumayri*. Later on, the same species was also recognized in Pikermi by Gaudry (1862–1867). Except Pikermi, the species was found in several late Miocene mammal localities of Greece, such as Samos, Axios Valley, Halmypopotamos, Kerassia, Perivolaki (Forsyth-Major, 1894; Weber, 1904, 1905; Arambourg and Piveteau, 1929; Melentis, 1967; Koufos, 1980, 2006; Geraads and Koufos, 1990; Giaoutsakis, 2003, 2009; Giaourtsakis et al., 2006). It is also well known from the adjacent countries (Heissig, 1975, 1996; Geraads, 1994; Fortelius et al., 2003; Antoine and Saraç, 2005; Geraads and Spassov, 2009). The type material of "*D.*" *neumayri* is a well-preserved mandible from Maragheh, housed in NHMW (Osborn, 1900). The species has a long taxonomic history, referred under various specific and generic names (Geraads, 1988; Giaourtsakis, 2003, 2009; Giaourtsakis et al., 2006). As a taxonomy review is not the subject of this article we shall follow here the last referred name: "*D.*" *neumayri* (Giaourtsakis, 2009). A second horned-rhinoceros from the late Miocene of Greece is *Dihoplus pikermiensis*, found originally in Pikermi and later in several late Miocene localities of Greece and neighboring countries.

The comparison of the lower teeth of *D. pikermiensis* from Pikermi and Kerassia with "*D.*" *neumayri* indicates that the latter preserves notable traces of cement in the buccal wall, has more hypsodont teeth, more angular trigonid, U-shaped and wider trigonid and talonid valleys, as well as deeper and more angular buccal groove (Giaourtsakis et al., 2006). The hypsodonty is a character depending on the wearing stage of the teeth and needs large samples and unworn teeth for reliable comparisons. The presence or absence of cement depends on several parameters; it can be moved during the fossilization process or by weathering, but also during the cleaning of the fossils. In the NIK teeth, it is absent but this is probably due to the weathering and plant-roots action. The trigonid of the studied teeth is angular, like in "*D.*" *neumayri*, especially in the m2,3. The U-shaped and wide trigonid and talonid valleys of the studied teeth also suggest similarities to

"*D.*" *neumayri*. Finally, the buccal groove, although the advanced attrition of the studied teeth, is clearly angular and deep, like in "*D.*" *neumayri*.

A comparison of NIK-1669 with some well-known specimens of "*D.*" *neumayri* provides more evidence for this similarity. A complete mandible of "*D.*" *neumayri* is known from the Vallesian locality of Pentalophos 1 (PNT) in the Axios Valley (Geraads and Koufos, 1990); its dentition is more or less at the same wearing stage to the studied teeth. A direct comparison of the NIK lower teeth with the teeth of the PNT mandible indicates that their morphological characters, including the more angular trigonid than talonid, the angular and deep buccal groove, the U-shaped trigonid and talonid valleys, and the elongated m2,3 in comparison to the m1, are similar. The dental dimensions and proportions of the studied teeth are also similar to those of the PNT mandible (Fig. 2).

Several mandibles or mandibular fragments of *D. pikermiensis* are known from various Greek localities (Pikermi, Samos, Kerassia). The teeth NIK-1669 have been compared to those of *D. pikermiensis* from Kerassia (Giaourtsakis et al., 2006; fig. 4) and from the Bulgarian localities of Strumyani and Hadjidimovo (Geraads and Spassov, 2009; pl. 1, figs. I, J; pl. 3, figs. e, f). The comparisons indicate that the talonid of *D. pikermiensis* is more angular than in "*D.*" *neumayri*. The angular character of the talonid is well expressed in the little worn dentition of the mandible HD-607, but in the more worn mandible FM-2470 from Stumyani the talonid is less angular and more U-shaped (see illustrations in Geraads and Spassov, 2009). The buccal groove is deeper in "*D.*" *neumayri*. In the Kerassia lower dentition of *D. pikermiensis*, which is almost in the same wearing stage as NIK-1669, the hypolophid remains separated from the paralophid, while in NIK-1669 they are connected.

The metrical comparison of the dental dimensions of the two species provides some clearer distinctive features (Fig. 2). Generally, the mean premolar row length of *D. pikermiensis* is longer than that of "*D.*" *neumayri*. The length of the NIK-1669 premolar row is closer to "*D.*" *neumayri* (Fig. 2), suggesting a higher similarity to this taxon. The molar row length, in comparison to the premolar

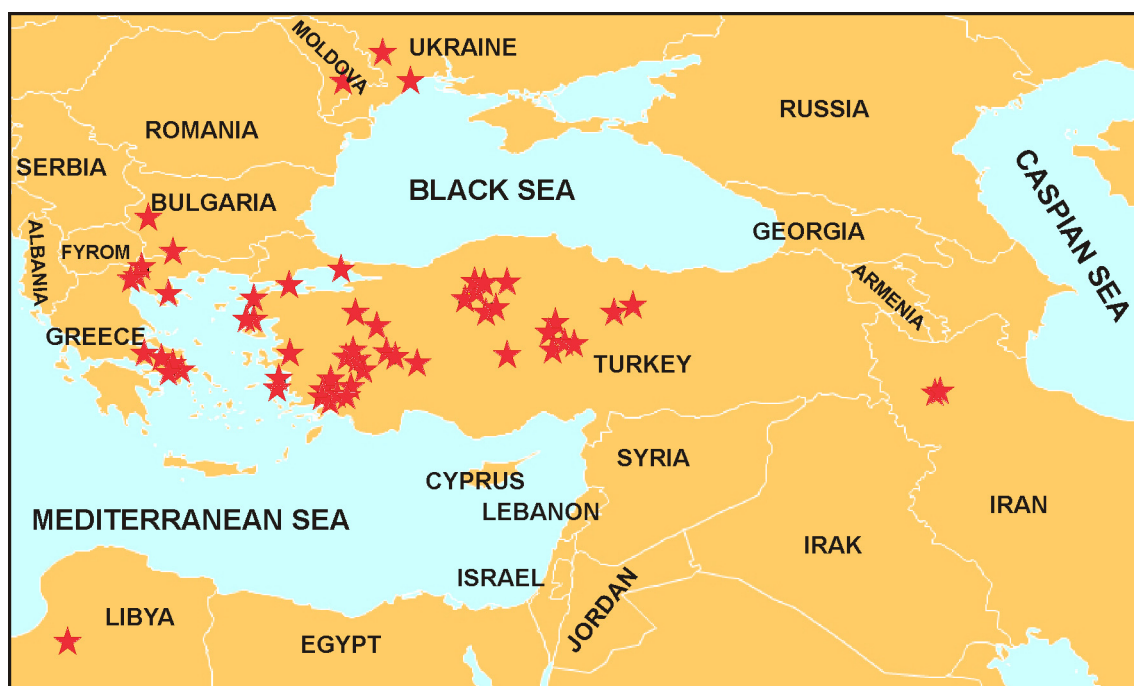


Fig. 3. Geographic distribution of "*Dicerops*" *neumayri* in Eastern Mediterranean and Western Asia. Data from Heissig (1975), Geraads (1994), Bernor et al. (1996), Giaourtsakis (2003, 2009), Saraç (2003), Giaourtsakis et al. (2006), and Geraads and Spassov (2009).

one, is shorter in *D. pikermiensis* than in “*D.*” *neumayri* (Fig. 2(a)). The p2 size seems to be more distinctive for the two species. The p2 of “*D.*” *neumayri* is shorter and narrower than *D. pikermiensis*, separating well the two species; the dimensions of the studied p2 are closer to those of “*D.*” *neumayri* (Fig. 2). The ratio of the p2 length to that of p3 is also significant for the distinction between the two species: the mean ratio $Lp2 \times 100 / Lp3$ is 76.4 (73.5–80.8) for “*D.*” *neumayri* versus 87.1 (85.5–88.8) for *D. pikermiensis* (Table 1). Overall, the studied dentition NIK-1669 shares several morphological and metrical similarities with “*D.*” *neumayri* and can be assigned to this taxon.

The main geographic distribution of “*D.*” *neumayri* is restricted to the Balkan Peninsula and Asia Minor (Fig. 3), where its presence is recorded in numerous late Miocene mammal localities. Actually, the extended fieldworks in the late Miocene of this area led to the discovery of numerous localities from which a great amount of fossils, including “*D.*” *neumayri*, has been unearthed. Certainly, the species was very common in the late Miocene and in the wider Greco-Iranian palaeoprovince. Indeed, “*D.*” *neumayri* is also known from Maragheh, Iran (type locality; Osborn, 1900; Bernor et al., 1996). It has been reported from the localities of Cimislia (Moldova), as well as from Grossulovo and Odessa 2 (Ukraine; Borissiak and Belyaeva, 1948), but the determinations are old and need revision. The species is also reported from the African locality of Sahabi (Bernor et al., 1987), where the only known specimen is an extremely worn P2, the limited occlusal morphology of which makes questionable its presence in Africa. Concerning the biostratigraphy of “*D.*” *neumayri*, it is known from the Vallesian and Turolian of the Greco-Iranian province.

4. Conclusions

The poor available material of rhinocerotids from Nikiti 2 (NIK) and its comparison with the known material from Greece and neighboring areas indicate that it shares more similarities (angular trigonid, U-shaped and wide trigonid and talonid valleys, angular and deep buccal groove, hypolophid connected with the parolophid, as well as short and narrow p2, short premolar row, shorter molar row in comparison to the premolar one, shorter p2 relatively to the p3 than in *D. pikermiensis*) with the horned-rhinoceros “*D.*” *neumayri* and can be assigned to this species. “*D.*” *neumayri* is well known from Greece, where it was known during the Vallesian and Turolian. Its first local appearance is traced back in the early Vallesian locality of Pentalophos 1 (PNT; Geraads and Koufos, 1990) and the last local occurrence is recorded in the late Turolian localities of Dytiko and Samos Q5 (Koufos, 1980; Bernor et al., 1996). “*D.*” *neumayri* is mainly known from the Balkans and Asia Minor but there are indications for its occurrence in the Peri-Pontic Region and possibly also in northern Africa.

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