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Original article

Stephanorhinus hundsheimensis (Mammalia, Rhinocerotidae) from the late early Pleistocene deposits of the Denizli Basin (Anatolia, Turkey)[☆]



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ABSTRACT

Pleistocene rhinoceroses are poorly documented in Turkey where they have been reported only from the late early Pleistocene (1.3–1.1 Ma) travertine deposits of the Denizli Basin. In this work, new rhinoceros remains collected from this basin are assigned to a relatively large-sized *Stephanorhinus hundsheimensis* on the basis of their morphology and morphometry. The first Turkish record of this species is approximately coeval with the first appearance of *S. hundsheimensis* in Europe, chronologically referred to the late early Pleistocene, ca. 1.2 Ma. During that time, *S. etruscus* still survived in Iberian Peninsula, central Italy and Dacian Basin. The presence of two successive evolutionary morphs for *S. hundsheimensis* during the Pleistocene is not confirmed.

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1. Introduction

Compared to the Miocene record, Pleistocene large mammals are scarcely documented in Turkey where they are reported only in a few localities within the Anatolian area (Sickenberg and Tobien, 1971; Sickenberg et al., 1975; Erten et al., 2005; Boulbes et al., 2014; Demirel and Mayda, 2014). Among other taxa, Pleistocene rhinoceroses are rare and still poorly investigated (Sickenberg and Tobien, 1971; Sickenberg et al., 1975). In particular, they are recorded in the Denizli Basin where they are represented by fragmented and poorly preserved remains previously assigned to *Stephanorhinus* cf. *etruscus* (Boulbes et al., 2014).

The Denizli Basin is composed of terrestrial sediments aged from MN6 to MNQ19 units (early middle Miocene to early Pleistocene; Fig. 1; Erten et al., 2014). The Pleistocene Tosunlar Formation, which unconformably lies on the middle Miocene-Pliocene units, has been described by Şimşek (1984). The bottom part of the formation is composed of conglomerates, sandstones and siltstones that are covered by travertines.

The Denizli Basin is a significant place both in Turkey and worldwide because of its travertines that are intensively exploited and exported all over the world. Besides the current touristic

Pamukkale travertines, old travertine formations are common in different parts of the basin, especially along its northern part. Travertines are observed in various segments of the Pamukkale fault system (Fig. 1). While Pamukkale travertines still continue their sedimentation today thanks to hot water springs, the older travertines (where the fossils studied here come from) have completed their formation and hot water springs can be no longer observed in that region. The total surface of old and new travertines in the basin covers more than 100 km² and their thickness sometimes exceeds 75 m (Erten et al., 2005; Özkul et al., 2013).

In Denizli Basin, large mammals are generally found in the travertines. In the first study on fossils from these travertine deposits, Erten et al. (2005) reported on *Equus* aff. *suessenbornensis*, *Bos* sp. and *Dama* sp. Boulbes et al. (2014) recorded more remains of large mammals from these travertines and they revised the fossils previously described by Erten et al. (2005). The new faunal list includes *Mammuthus meridionalis meridionalis*, *Stephanorhinus* cf. *etruscus*, *Equus* cf. *altidens* s.l., *E. cf. apolloniensis*, *Metacervoceros rhenanus*, *Palaeotragus* sp., and a Bovinae gen. and sp. indet. Additionally, the first *Homo erectus* from Turkey (Kappelman et al., 2008) has been described from the same travertine area. Lebatard et al. (2014) dated the *H. erectus*-bearing travertines in Denizli at least at 1.1 Ma. Erten et al. (2015) described *Dryomys tosaensis*, *Dryomys* sp., *Mus denizliensis*, and *Apodemus sylvaticus-flavicollis* in the Gökpınar locality, located in the fluvial unit under the

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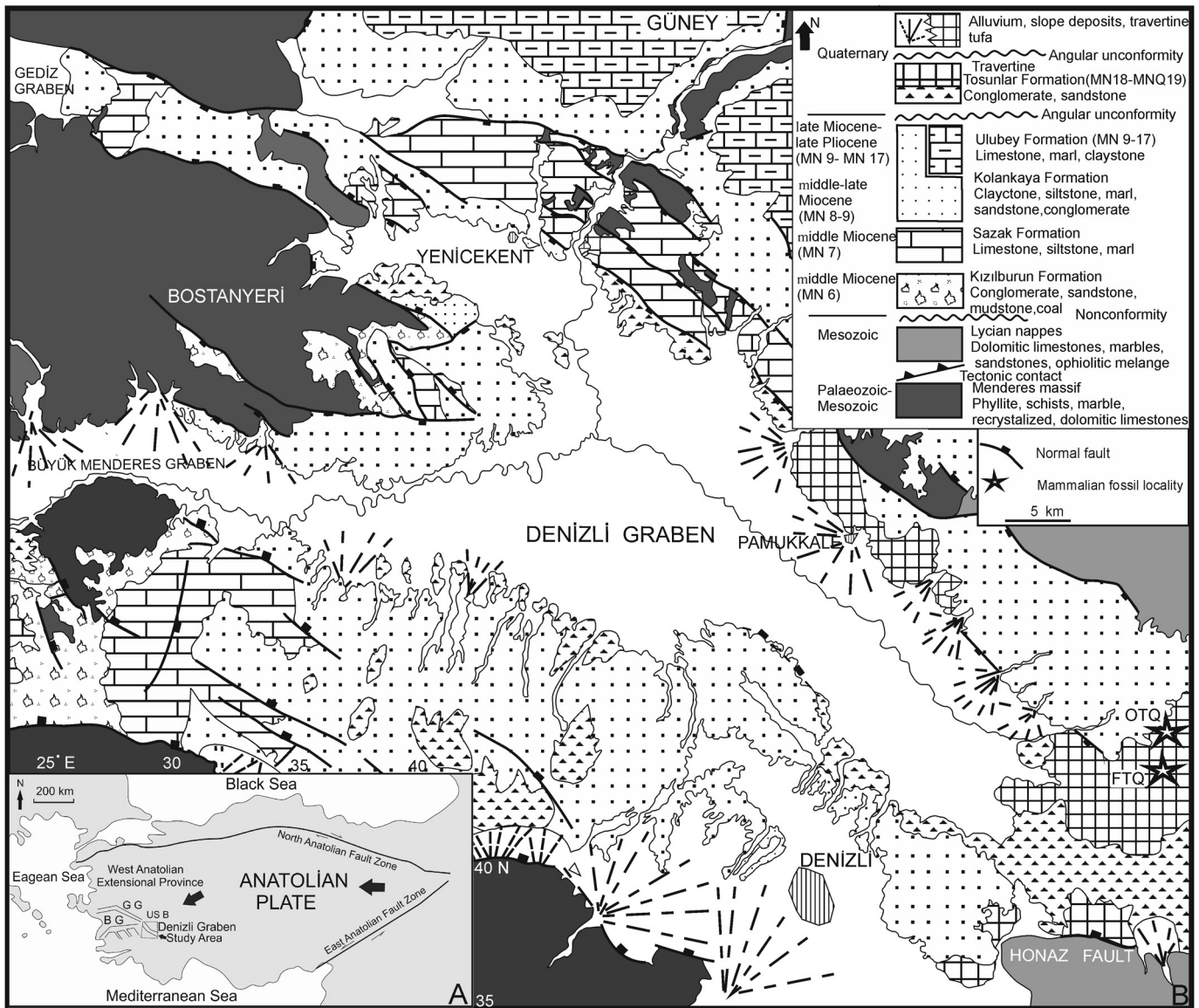


Fig. 1. A. Location of the Denizli Basin in western Turkey, modified from [Bozkurt \(2003\)](#). B. Geological map of the Denizli Basin, modified from [Erten et al. \(2014, 2015\)](#), with the position of mammal localities: OTQ, Özhan travertine quarry; FTQ, Faber travertine quarry.

travertines and dated as MNQ18–19. New rhinoceros findings from the Denizli basin are described in this paper. The paleobiogeographic and biochronological implications of these findings are also discussed.

Institutional abbreviations: DGEPU, Department of Geological Engineering, Pamukkale University, Kınıklı/Denizli, Turkey; HNHM, Magyar Természettudományi Múzeum (Hungarian Natural History Museum), Budapest, Hungary; IGF, Museo di Storia Naturale, sezione di Geologia e Paleontologia, Florence, Italy; IQW, Institute für Quartärpaläontologie, Weimar, Germany; MFGI, Magyar Földtani és Geofizikai Intézet (Geological and Geophysical Institute of Hungary), Budapest, Hungary; MfN, Museum für Naturkunde, Berlin, Germany; MNCN, Museo Nacional de Ciencias Naturales, Madrid, Spain; MNHN, Muséum National d'Histoire Naturelle, Paris, France; MPI, Museo Paleontologico di Isernia La Pineta, Isernia, Italy; MPLBP, Museo di Paleontologia Luigi Boldrini di Pietrafitta, Perugia, Italy; MSTB, Museo di Scienze della Terra, Università degli Studi di Bari "Aldo Moro", Bari, Italy; NHML, Natural History Museum, London, England; NHMW, Naturhistorisches Museum, Wien, Austria; NMB, Naturhistorisches Museum, Basel, Switzerland.

2. Systematic paleontology

Class Mammalia Linnaeus, 1758
 Order Perissodactyla Owen, 1848
 Family Rhinocerotidae Gray, 1821
 Subfamily Rhinocerotinae Gray, 1821
 Tribe Rhinocerotini Gray, 1821
 Genus *Stephanorhinus* Kretzoi, 1942

Type species: *Stephanorhinus etruscus* (Falconer, 1868) from the early Pleistocene of Upper Valdarno (Italy).

Referred species: *Stephanorhinus kirchbergensis* (Jäger, 1839), *S. hemitoechus* (Falconer, 1859), *S. hundsheimensis* (Toula, 1902), *S. yunchuchenensis* (Chow, 1963), *S. jeanvireti* (Guérin, 1972), *S. lantianensis* (Hu and Qi, 1978), maybe *S. miguelcrusafonti* (Guérin and Santafé-Llopis, 1978), and with more uncertainty *S. africanus* (Arambourg, 1970).

Stephanorhinus hundsheimensis (Toula, 1902)

Holotype: Almost complete skeleton, including partial skull and mandible (2013/0282/0001), housed at the Natural History Museum, Wien (Austria).

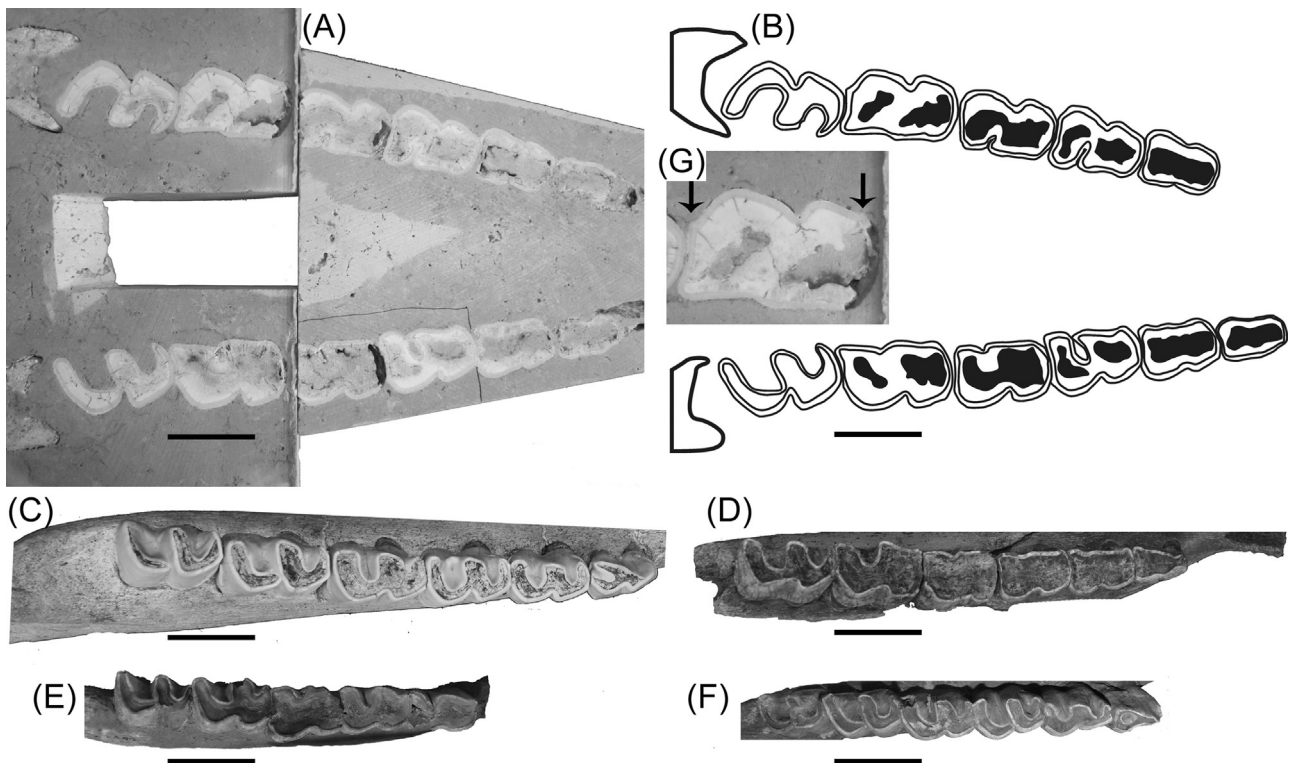


Fig. 2. **A and B.** *Stephanorhinus hundsheimensis*, mandible with right and left p2-m3 from Denizli Basin, OTQR001. **A.** Original specimen embedded in travertine. **B.** Drawing of the same specimen, in occlusal view. **C.** *S. hundsheimensis* from Süssenborn (Germany; IQW 1964/678), occlusal view. **D.** *S. hundsheimensis* from Voigtsted (Germany; IQW 1966/5611), occlusal view. **E.** *S. etruscus* from Upper Valdarno (Italy; NMB VA1817), occlusal view. **F.** *S. etruscus* from Upper Valdarno (Italy; NMB VA1189), occlusal view. **G.** Left m2 of OTQR001; black arrows indicates the presence of cingula. Scale bars: 5 cm; G not to scale.

Type locality and horizon: Hundsheim (Lower Austria, Austria), early middle Pleistocene (Marine Isotopic Stage 15 or 13).

Occurrence: From the late early Pleistocene to the early middle Pleistocene in Europe. *S. hundsheimensis* (= *Dicerorhinus etruscus brachycephalus sensu Guérin, 1980*) is reported in Western Asia (Caucasus) during the late middle Pleistocene (Guérin, 1980; Baryshnikov and Guérin, 1986).

Referred specimens: An almost complete mandible embedded in travertine (Özhan travertine quarry, OTQR001; Fig. 2), and a fragment of mandible with p3 and damaged p4-m2 (Faber travertine quarry, FTQR001; Fig. 3). The specimens are housed at DGEPU.

Measurements: see Table 1.

Description: A few morphological characters can be observed on the studied specimens. OTQR001 is represented by a cross section of the lower tooth rows and the ascending rami (Fig. 2(A and B)). The tooth rows include three molars and three premolars. In both OTQR001 (Fig. 2(A and B)) and FTQR001 (Fig. 3), the teeth display a closed, deep and sharp (V-shaped) vestibular groove and a rounded trigonid; metaconids and entoconids are not constricted. The posterior lingual valley is deeper than the anterior one on p4 of OTQR001 and on p3 and m2 of FTQR001 (Fig. 3(A and B)). On m3 of OTQR001, the posterior valley is larger than the anterior one and both valleys are U-shaped in occlusal view. Enamel

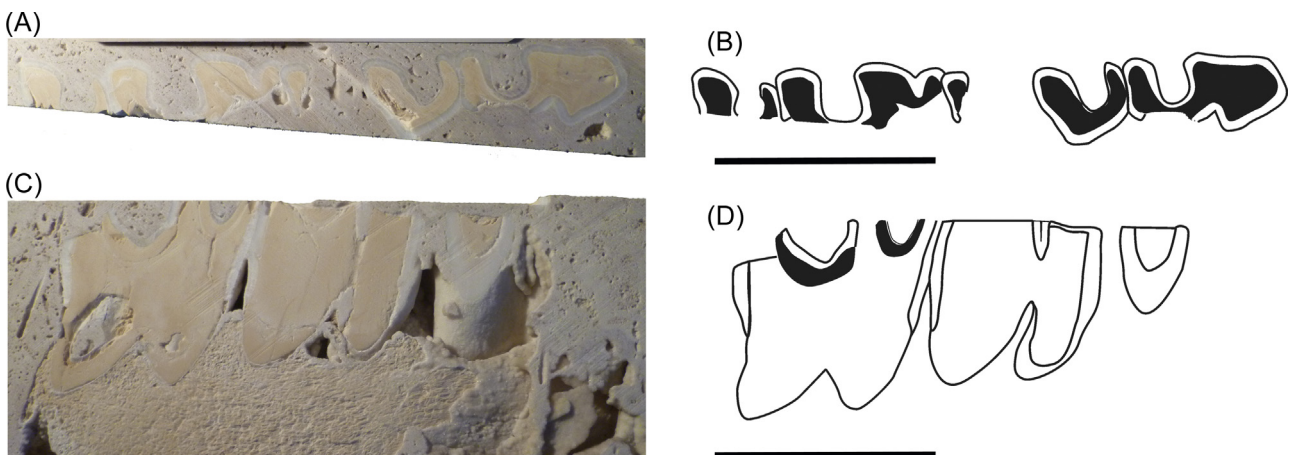


Fig. 3. *Stephanorhinus hundsheimensis*, fragment of mandible with damaged right p3-m2 from Denizli basin, FTQR001. **A and B.** Occlusal view of the original specimen embedded in travertine (A) and drawing of the same specimen (B). **C and D.** Buccal view of the original specimen embedded in travertine (C) and drawing of the same specimen (D).

Table 1
Comparative dimensions (lengths, in mm) of the specimens collected from Denizli Basin (Turkey) and those of *S. etruscus* and *S. hundsheimensis* collected from several early and early middle Pleistocene European localities.

	Taxon	Ltot	Lm	Lp	Lp3-p4	p2	p3	p4	m1	m2	m3	References/Museum
Denizli	OTQR001	252	147	104	75	30	35	40	43	52	53	DGEP
Denizli	FTQR001						38					DGEP
Senèze	<i>S. etruscus</i>	218–222	122.1–122.7	96–96.4	68.6–70.1	25.7–27.3	31.3–38.65	35.05–34.4	40.8–45.3	41.6–43.2	42.6–43.2	Lacombat (2005, 2006)
Valdarno	<i>S. etruscus</i>					27.2–30.4	32.3–39.7	34.7–39.6	35.2–43.7	40.35–46	41.1–48.4	Lacombat (2005, 2006)
Ceyssaguet	<i>S. hundsheimensis</i>	231.7	129.5	103.3	71.1	29.6	34.5	34.9	40.9			Lacombat (2005, 2006)
Vallonnet	<i>S. hundsheimensis</i>					27.4–32.3	31.2–35.6	34–37	38.3–47.35	40.2–47.2	45.1–45.7	Lacombat (2005, 2006)
Tour de Grimaldi	<i>S. hundsheimensis</i>					28.6	37.4				43.7	Lacombat (2005, 2006)
Soleilhac	<i>S. hundsheimensis</i>			107.2	74.8	29.95	35.8–36.9	38.4	42.3	46.4	46.3	Lacombat (2005, 2006)
Isernia	<i>S. hundsheimensis</i>		132.4–143		71.2–77	25.2–30.4	32.7–37.5	36.7–40.2	40.1–48	41.3–50.1	40.8–51.6	Lacombat (2005, 2006)
Durfort	<i>S. hundsheimensis</i>									44.2	49.05	Lacombat (2005, 2006)
Various localities	<i>S. etruscus</i>	210–251.5	121–143	87–108	63–80.5	25–33	31.5–37	35–39.5	37–43	40.5–47.5	41–50	Guérin (1980)
Various localities	<i>S. hundsheimensis</i>	228–263.5	119–163.5	99–116	63–84	27–39	33–42.5	33–45	37–57	42–57.5	44–59	Guérin (1980)
Monte delle Piche	<i>S. etruscus</i>	ca. 240	ca. 135	ca. 105		36.4	31.8	36	43.6	46.3	45.6	Pandolfi et al. (2015)
Valdarno	<i>S. etruscus</i>	211–225	118–139	92–104								Mazza (1988)
Pietrafitta	<i>S. etruscus</i>	223.3	127.1	98.3	70.7	28.7	34.15–35	37.2–39.3	39.4–41.9	43.9–46.1	44.2–47.3	MPLBP
Pietrafitta	<i>S. etruscus</i>	225.2	126	103.2	70.4							MPLBP
Pietrafitta	<i>S. etruscus</i>	237.45	132	104.3	75.4	30.2	37.15	38.2	43.3	44.6	41.8	MPLBP
Pietrafitta	<i>S. etruscus</i>	225.8	127.6	99.8	73.8	27.8	33.1–36.4	38.2–38.6	41–41.5	43.3–43.4	44–46.4	MPLBP
Tegoleto	<i>S. cf. hundsheimensis</i>		155.6		(76.5)		37.2	43.1	47.6	54.3	(55.8)	MGPPD
Castellana	<i>S. cf. etruscus</i>	207.3	122.5	82.95	61.8	ca. 23	28.75	34	39.05	42.5	47	MSTB
Castellana	<i>S. hundsheimensis</i>	ca. 238.7	ca. 141.2	ca. 98	ca. 77							MSTB
Castellana	<i>S. hundsheimensis</i>		ca. 147									MSTB
Castellana	<i>S. hundsheimensis</i>									49.1	51.95	MSTB
Aivaliki	<i>S. cf. etruscus</i>	227.2	123.6	104.2		28.5	35.1	38.8	39.4	42.7	41.8	Symeonidis et al. (2006)
Capitone	<i>S. etruscus</i>	ca. 226	ca. 130	ca. 93	ca. 73							MPUR
Süssenborn	<i>S. hundsheimensis</i>	234.5–252.9	130–154.6	96.5–120.1		26.5–34.6	30–39.8	35.3–44.2	39–45	39.8–48.8	41.7–48.2	Kahlke (1969)
Voigsted	<i>S. hundsheimensis</i>	248.9	137.3	109.2		27.2	34.8	38.3	40.5	45.8	45.3	Kahlke (1965)
Mosbach	<i>S. hundsheimensis</i>	213.7	124.8	102.8								Kahlke (1969)
Mosbach	<i>S. hundsheimensis</i>	242	135.8	89.2								Kahlke (1969)
Mosbach	<i>S. hundsheimensis</i>			112.7		30.3–30.4	31.4–34.6	38.5	41.6–41.2	43.1–43.5		Koenigswald et al. (2007)

Ltot: total length; Lm: molar length; Lp: premolar length; Lp3-p4: length of p3-p4; p: premolar; m: molar. See text for institutional abbreviations.

thickenings on the distal and vestibular sides of OTQR001 m2s suggest the presence of distal and vestibular cingula (Fig. 2(G)). Enamel thickenings also occur on the vestibular side of the left m1, the distal side of left p4 and the vestibular side of left p3 in OTQR001 (Fig. 2(A and B)). A mesial cingulum can be observed on m1 of FTQR001 (Fig. 2(C and D)). A long paralophid is evident on m3 of OTQR001 and p4 and m2 of FTQR001. In OTQR001, the molar length is 58.3% of the total tooth row length.

Remarks: Deep and sharp vestibular grooves are commonly recorded in *S. hundsheimensis* (Lacombat, 2006). This character has been indeed observed in several specimens from the middle Pleistocene of Germany (e.g., Süssenborn and Voigstedt; IQW). In *S. etruscus* the vestibular grooves are normally open and shallow, as observed in different specimens from Upper Valdarno (Italy, early Pleistocene; IGF, NMB) and Senèze (France, early Pleistocene; MNHN, NMB). According to Lacombat (2006), the ratio between the heights of the bottoms of the lingual valleys on p4 is high in the early *S. hundsheimensis* from Vallonnet and Ceyssaguet (France, late early Pleistocene) and low in the middle Pleistocene sample, whereas *S. etruscus* has a lower ratio. According to Guérin (1980) the difference in height between the bottoms of the lingual valleys is variable in *D. etruscus brachycephalus* (= *S. hundsheimensis in partim*), whereas in *D. etruscus etruscus* (= *S. etruscus*) it is low or medium. Vestibular cingulum is absent on p3 of *S. etruscus* but its presence can be observed in *S. hundsheimensis* (Lacombat, 2006). The presence of vestibular cingula is a variable character in *S. etruscus* (Guérin, 1980); nevertheless in this species the cingula are generally absent or poorly developed. Vestibular and mesial cingula are usually present in the m1 of *S. hundsheimensis*; they are more often absent in *S. etruscus* (Lacombat, 2006). Distal cingulum on m2 is normally present in *S. hundsheimensis* (Lacombat, 2006). The dimensions of OTQR001, and in particular the length of the molars, are larger than in *S. etruscus* and they fall within the range of *S. hundsheimensis* from the early middle Pleistocene of Süssenborn (Table 1). The dimensions of m2 and m3 are close to the maximal

values of *S. hundsheimensis* from the early middle Pleistocene of Castellana and Isernia (Table 1).

3. Discussion and overview on the chronology and distribution of the late early Pleistocene European rhinoceroses

Two species are commonly reported in Europe during the late early Pleistocene: *Stephanorhinus etruscus* and *S. hundsheimensis*. Two size-morphs of the latter species have been recognized by some authors (Fortelius et al., 1993; Lacombat, 2005): a small-sized morph chronologically related with the late early Pleistocene, and a large-sized morph chronologically referred to the early middle Pleistocene. Nevertheless large-sized specimens of *S. hundsheimensis* have been also collected from late early Pleistocene deposits of Central Europe (e.g., Untermassfeld, ca. 1 Ma; Kahlke, 2001), suggesting a geographic pattern of distribution of both sizes during the late early Pleistocene, as argued by Guérin (1980) for its junior synonym, *Dicerorhinus etruscus brachycephalus*. Morphology and morphometry of rhinoceros remains collected from the Denizli Basin suggest a referral to a relatively large-sized *S. hundsheimensis*. This species was previously unknown in Anatolia and Western Asia during the late early Pleistocene. *Stephanorhinus cf. etruscus* has been recently recorded by Boulbes et al. (2014) in the Denizli Basin. Unfortunately, the poor preservation of the specimens described by these authors does not allow for appreciating their morphological details – we agree with their taxonomic considerations.

3.1. Iberian Peninsula

In the Iberian Peninsula, *Stephanorhinus etruscus* is commonly reported during the late Villafranchian; here the species became extinct during the early Galerian (Cerdeño, 1993; Van der Made, 2010). The presence of the Etruscan rhino can be indeed confirmed at Huescar 1 (ca. 0.9 Ma; Cerdeño, 1993; Van der Made, 2010; L.P. pers. obs. at MNCN) and Cueva Victoria (Murcia, ca. 1 Ma; Cerdeño, 1993) (Fig. 4). Moreover the Etruscan rhino was also reported at

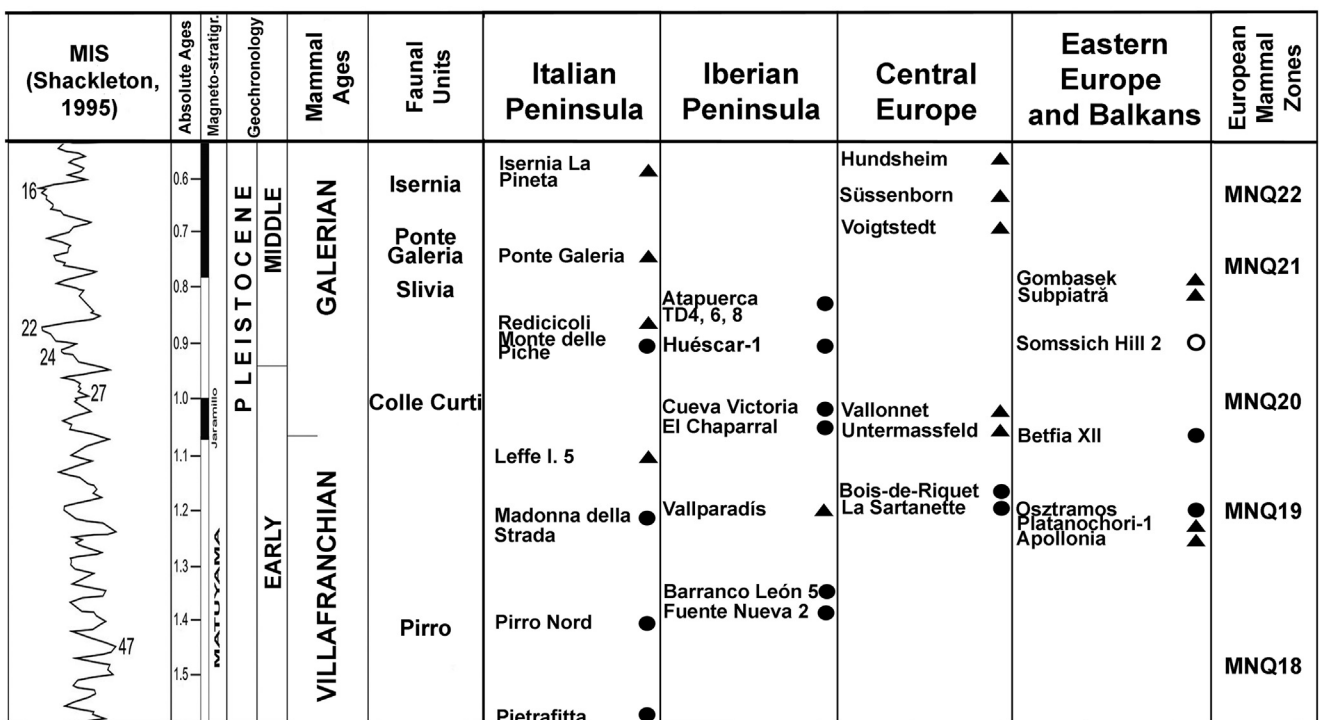


Fig. 4. Chronological and biochronological distribution of *Stephanorhinus etruscus* and *Stephanorhinus hundsheimensis* in Europe (see text for details on localities and ages). Black circle: presence of *S. etruscus*; empty circle: *S. aff. etruscus*; Black triangle: presence of *S. hundsheimensis*.

Atapuerca TD4, TD6 and TD8 (Brunhes-Matuyama transition) by Van der Made (1998, 1999, 2010). A small-sized *S. etruscus* has been recently recorded at El Chaparral (Villaluenga del Rosario, Cádiz, ca. 1 Ma; Pacheco et al., 2011). According to Pacheco et al. (2011), *S. etruscus* with small-sized postcranial elements occurred in Europe between 1.4 Ma and 0.78 Ma (first documented from Pietrafitta and last from Atapuerca TD8). The first occurrence of *Stephanorhinus hundsheimensis* in the Iberian Peninsula seems to be placed during the late Villafranchian, ca. 1.6 Ma, at Venta Micena (Orce; Madurell-Malapeira et al., 2014). However, the morphological characters and dimensions of the specimens from Venta Micena reported by Santafé and Casanovas (1987) suggest instead an assignment to *S. etruscus* (Cerdeño, 1993; Van der Made, 2010). A small-sized *S. hundsheimensis* was also reported at Barranco León 5 and Fuente Nueva 2 (Guadix-Baza basin, ca. 1.4–1.3 Ma; Lacomat, 2010; Madurell-Malapeira et al., 2014); nevertheless Lacomat (2010) also suggested that the specimens from both localities are similar to the specimens identified at Pietrafitta (Perugia, central Italy), which are morphologically close to *S. etruscus* (Van der Made, 2010; Pandolfi and Petronio, 2011; Pandolfi et al., 2015, L.P. pers. obs. at MPLBP). *S. hundsheimensis* is well-documented in the Vallès-Penedès basin (Vallparadís Estació Lower and Middle Units and Cal Guardiola Lower and Upper Units, from ca. 1.2 to 0.78 Ma; Madurell-Malapeira et al., 2010, 2014) where, among others, the species is documented by a relatively well-preserved skull (Madurell-Malapeira et al., 2010: Fig. 4B). The skull belongs to a large-sized *S. hundsheimensis* (the estimated values of the lengths are longer than in *S. etruscus* and are close to the mean values of *D. etruscus brachycephalus* given by Guérin, 1980), suggesting that large-sized *S. hundsheimensis* occurred in different areas of Europe during the late early Pleistocene. Accordingly, *S. hundsheimensis* and *S. etruscus* seem to be chronologically coeval in the Iberian Peninsula during the late early Pleistocene, whereas *S. hundsheimensis* is confined to the northeastern area (Pyrenees) of the Peninsula (Fig. 4).

3.2. Italian Peninsula

According to Pandolfi and Petronio (2011), the latest Villafranchian Italian rhinoceroses from Pirro Nord (ca. 1.5 Ma), Madonna della Strada (ca. 1.2 Ma) and Imola Basin (latest Villafranchian) can be ascribed to *Stephanorhinus etruscus* (Fig. 4). The remains from Pietrafitta (latest early Pleistocene), ascribed as *Stephanorhinus* cf. *S. hundsheimensis* by Mazza et al. (1993), were assigned to *S. etruscus* by Van der Made (2010), Pandolfi and Petronio (2011), and Pandolfi et al. (2015). Indeed, the specimens from Pietrafitta are morphologically and morphometrically more similar to *S. etruscus* than to *S. hundsheimensis*. In particular, the dorsal profile of a neurocranial portion of a skull from Pietrafitta (MPLBP) is very close to that of the lectotype of *S. etruscus*, while in *S. hundsheimensis* it is more concave. The dimensional characters of the skull from Pietrafitta are close to those of the specimen from Senèze and fall within the size range of *S. etruscus* given by Guérin (1980). Therefore, the presence of *S. hundsheimensis* or of related forms during the latest Villafranchian in Italy is not supported by clear evidences. According to Pandolfi and Petronio (2011) the first occurrence of *S. hundsheimensis* in Italy was during the early Galerian at Cava Redicicoli (North of Rome). Recent studies suggested a younger age for this locality (Marra et al., 2014) and placed the occurrence of *S. hundsheimensis* in the Slivia FU, around the early-middle Pleistocene transition (Fig. 4; Pandolfi and Petronio, 2011; Petronio et al., 2011; Pandolfi et al., 2013; Pandolfi and Marra, 2015). Nevertheless, some rhinoceros remains collected from the Lefte Basin (Vialli, 1956) display morphological characters which suggest an attribution to *S. hundsheimensis*. An

adult individual (individual B in Vialli, 1956) has been collected from a lignite bed chronologically close to the beginning of the Jaramillo subchron (Fig. 4; level 5 in Vialli, 1956 = unit 7 of Ravazzi et al., 2009). The upper tooth row belonging to this individual and figured by Vialli (1956: pl. 1, figs. 4–6) displays marked and continuous lingual cingula on the premolars, a protoloph not joined to the ectoloph on P2, a double crista on P2, and crista and double crochet on P3. The presence of internal folds and marked lingual cingula on the premolars occur in several middle Pleistocene specimens of *S. hundsheimensis* collected at Isernia La Pineta (Italy; MPI), Mosbach 2 and Voigsted (Germany; IQW, MNHN, MfN; NHML) and these features have been not observed in *S. etruscus* from Upper Valdarno, Senèze, and other localities. The occurrence of *S. hundsheimensis* at Lefte would be the earliest record of this species in the northern area of the Italian Peninsula, whereas in central Italy *S. etruscus* still persisted until the end of the early Pleistocene (e.g., Monte delle Piche, Rome; Pandolfi and Marra, 2015). The occurrence of large-sized *S. hundsheimensis* at ca. 1 Ma in Italy is approximately coeval with other European records and suggests to exclude a geographic segregation of two different size ranges within this species during the late early Pleistocene.

3.3. France and Germany

S. etruscus is recorded in numerous Villafranchian French localities (Guérin, 1980) which yielded a considerable number of remains. Guérin (1980) referred an isolated metapodial bone from La Sartanette (MN19; Bonnet and Malaval, 1976) to *D. etruscus brachycephalus*; later, Palombo and Valli (2004) listed *S. etruscus* within the faunal assemblage of this locality. *S. etruscus* is certainly recorded at Bois-de-Riquet (Hérault; 1.3–1.1 Ma; Bourguignon et al., 2015), suggesting the persistence of this taxon in southern France (Fig. 4). During the early Galerian (from ca. 1 Ma), only *S. hundsheimensis* has been reported in France (e.g., Sainzelles, Saint-Prest, Ceyssaguet, Vallonnet, Tour de Grimaldi; Guérin, 1980; Guérin et al., 2003; Palombo and Valli, 2004; Lacomat and Moullé, 2005; Moullé et al., 2006). The specimens from the late early Pleistocene localities of Ceyssaguet (firstly assigned to *S. cf. hundsheimensis*), Vallonnet and Tour de Grimaldi were referred to the first evolutionary stage of *S. hundsheimensis*, characterized by a small size in respect to early middle Pleistocene specimens (Lacomat, 2005). Nevertheless, the difference in size between specimens grouped in the two chronological samples is mainly based on teeth dimensions, whereas postcranial remains do not show significant differences (e.g., humerus, third metacarpal; Lacomat, 2005). More complete material, however, is needed to solve this issue. *S. hundsheimensis* is confidently recorded in several German localities close to the Jaramillo subchron, such as Untermaassfeld, and referred to the early middle Pleistocene, such as Mosbach, Süssenborn, Voigtstedt, and Mauer (Fig. 4; Kahlke, 1965, 1969, 2001; Guérin, 1980; Fortelius et al., 1993; Schreiber, 2005; Lacomat, 2005; Kahlke and Kaiser, 2011; Kahlke et al., 2011).

3.4. Eastern Europe, Balkans and Western Asia

In Slovakia, *S. cf. hundsheimensis* is documented by a few isolated teeth at Levický Vápnik (Šiklôš), referred to the early middle Pleistocene (Holec, 1986; Zervanova, 2014). A few and scant remains of rhinoceros identified as *Opsiceros etruscus* has been also collected at Gombasek (Slovakia, latest early to early middle Pleistocene; Wagner and Gasparik, 2014). However, these unpublished specimens housed at HHM morphologically resemble *S. hundsheimensis*. In particular the lower D3s display a slightly concave labial wall (see Pandolfi et al., 2015) whereas on the fourth

metatarsal in medial view, the anterior articular face for the third metatarsal shows a trapezoidal shape and is higher than the posterior one, which is rather circular. *S. etruscus* has been reported at Osztramos 2 and 8 (Hungary, ca. 1.2 Ma; Jánosy, 1986; L.P. pers. obs. at HHNM and MFGI), whereas uncertain determination of Etruscan rhino are reported at Somssich Hill 2 (aff. "*Rhinoceros etruscus*", ca. 0.9 Ma), Uromhegy (*Dicerorhinus* cf. *etruscus*, latest early Pleistocene), and Budakalász (*D.* aff. *etruscus*, latest early Pleistocene) (Fig. 4).

Symeonidis et al. (2006) described two fragmentary mandibles from Aivaliki (Serres, Greece; late early Pleistocene) and assigned them to *S.* cf. *etruscus*. The morphology of the specimens is closer to that of *S. etruscus* (Symeonidis et al., 2006: 443) and they were tentatively correlated to small-sized "etruscoid" populations *sensu* Mazza et al. (1993). Nevertheless, the latter samples have been later referred to *S. etruscus* (Pandolfi and Petronio, 2011). A few isolated teeth, mandibular fragments and postcranial remains doubtfully assigned to the Etruscan rhino have been reported from an undefined locality near the Aliakmonas river, and from several early Pleistocene Greek localities (Libakos, Krimmi, Sesklo, Marathousa, Tourkovounia, Molykrio, Psychiko, and Serres; Symeonidis et al., 2006). Within the Mygdonia Basin, Konidaris et al. (2015) recently assigned a few postcranial remains and fragmented teeth from Tsiotra Vryssi (age spanning from ca. 1.8 to 1.2 Ma) to *Stephanorhinus* sp. and a juvenile maxilla fragment from Platanochori-1 (latest Villafranchian, ca. 1.2 Ma) to *S. hundsheimensis*; this species is possibly known also from Apollonia (latest Villafranchian, ca. 1.2 Ma; Konidaris et al., 2015) (Fig. 4).

Rhinoceros remains assigned to *D. etruscus* have been reported in the late Villafranchian Croatian localities of Dubci (Makarska), Marjan (Split) and Šandalja (Pula) by Malez (1961). An ulna assigned to the Etruscan rhino has been also reported from the early Pleistocene of Novo Mesto (Slovenia; Malez, 1987). In Romania, *S. hundsheimensis* is recorded at Subpiatră (Bihar country), which is close to the early-middle Pleistocene transition (Codrea and Czier, 1991; Fig. 4). The species is also certainly reported at Betfia V (Bihar Country; latest early Pleistocene), Budești (Vâlcea County; early Pleistocene), Feldioara-Cetate (Brașov Country; early Pleistocene), Feldioara-Carieră (Brașov Country; middle Pleistocene), Brașov (Brașov Country; middle Pleistocene), and Rotbav-Dealul Tiganilor (Brașov Country; middle Pleistocene) (Terzea, 1983; Rădulescu and Samson, 1985; Codrea and Ciobanu, 2003; Codrea, pers. comm.). *S. etruscus* occurs in several early Pleistocene localities of Romania; the latest records are referred to the late early Pleistocene, close to the Jaramillo subchron (Betfia XII, Bihar Country; Venczel, 2000; Terzea, 2006; Codrea, pers. comm.; L.P. pers. obs. at HHNM; Fig. 4). A well-preserved skull of rhinoceros referred to as *D. etruscus* has been collected from the gravels of Tiraspol (early middle Pleistocene, Moldova) together with several other remains (Beljaeva and David, 1975). The dorsal profile of the skull in lateral view (Beljaeva and David, 1975: pl. 1) resembles more that of *S. hundsheimensis* from Hundsheim than that of *S. etruscus* from Upper Valdarno, which is supported by the presence of a well-developed lingual cingulum on the premolars; therefore this specimen (as well as the related remains) is here referred to as *S. hundsheimensis*. Two fragmentary mandibles have been reported from the alluvial deposits of the Dnestr river near Kamenets-Podolsk (western Ukraine); they have been referred to "*R. etruscus*" by Leybman (1960: fig. 1). These specimens are too badly preserved for permitting a reliable taxonomic assignment. A few lower teeth assigned to *S.* cf. *hundsheimensis* have been briefly reported from Kurtan (Armenia), dated to the latest Villafranchian (Mkrtchyan et al., 2011). Last, the occurrence of the Etruscan rhino at Ubeidiya (Israel, 1.6–1.2 Ma) reported by Guérin (1986) is here confirmed basing on the figured material (see Guérin, 1986).

4. Conclusions

Fossil representatives of Rhinocerotidae are well-documented throughout Eurasia during the Pleistocene, but they are still poorly recorded in Turkey. A very few Pleistocene rhinoceros remains have been collected in Anatolia, all from the Denizli Basin. These remains, published by Boulbes et al. (2014), are poorly preserved and do not display useful morphological characters for ensuring taxonomical assignment at the species level. New rhinoceros remains collected from the same basin enabled us to record the first occurrence of *S. hundsheimensis* in Turkey. The fossiliferous level is chronologically referred to a time interval between 1.3 and 1.1 Ma, suggesting that the Turkish record of *S. hundsheimensis* is approximately coeval with other first European occurrences of this species such as the Greek records of Platanochori-1 and Apollonia (both chronologically dated at ca. 1.2 Ma; Fig. 4). Between 1.3 and 1.1 Ma, *S. hundsheimensis* is documented in Romania, Germany, France, northern Italy, and northeastern Spain (Fig. 4). At that time, *S. etruscus* still occurred in central Italy, Iberian Peninsula, southern France, and probably the Dacian Basin, where it survived at least until the end of the early Pleistocene. The presence of two successive evolutionary morphs of *S. hundsheimensis* is not confirmed because of the presence of large-sized specimens (comparable to that of the early middle Pleistocene ones) during the late early Pleistocene, including those from Denizli Basin.

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