

STEPHANORHINUS KIRCHBERGENSIS (JÄGER, 1839) FROM THE MIDDLE PLEISTOCENE DEPOSIT OF RIANO (ROME, CENTRAL ITALY)

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ABSTRACT: Pandolfi L., *Stephanorhinus kirchbergensis* (Jäger, 1839) from the Middle Pleistocene deposit of Riano (Rome, central Italy). In this work the rhinoceros remains discovered in the site of Riano are analyzed. The remains are preserved in Museum of Paleontology of University "Sapienza" of Rome and they have been recovered in a diatomaceous deposit together with remains of *Elephas antiquus*, *Cervus elaphus rianensis* and *Dama clactoniana*. The faunal assemblage of Riano can be correlated with Torre in Pietra Faunal Unit on the base of fossil mammal fauna and stratigraphical data. Rhinoceros remains belong to only one individual and consist of various post-cranial elements. Morphological and morphometrical characters of the remains are comparable with Eurasian rhinoceros *S. kirchbergensis*. This species has been rarely recorded, although the distribution range has been relatively wide. *S. kirchbergensis* has been discovered in a large part of Europe and in the Early and Middle Pleistocene deposits of central Asia, where the species has probably origin. Riano is one of the few European localities where post-cranial remains of *S. kirchbergensis* are reported.

RIASSUNTO: Pandolfi L., *Stephanorhinus kirchbergensis* (Jäger, 1839) dal deposito del Pleistocene Medio di Riano (Roma, Italia centrale). In questo lavoro vengono analizzati i resti di rinoceronte rinvenuti nel bacino diatomitico di Riano e conservati presso il Museo di Paleontologia dell'Università "Sapienza" di Roma. La fauna a grandi mammiferi, rinvenuta negli stessi depositi da cui proviene il rinoceronte, è composta da *Elephas antiquus*, *Cervus elaphus rianensis* e *Dama clactoniana*; il sito è correlabile, per composizione faunistica e stratigrafia, con l'Unità Faunistica di Torre in Pietra. I resti di rinoceronte, composti da diverse parti dello scheletro post-craniale e appartenenti ad un unico individuo, presentano caratteristiche morfologiche e morfometriche comparabili con la specie euroasiatica *S. kirchbergensis*. Questa specie, nonostante occupasse un vasto areale, è relativamente rara e probabilmente ha origine in Asia centrale, da dove provengono le segnalazioni più antiche riferite al Pleistocene Inferiore. La presenza di *S. kirchbergensis* nel sito di Riano rappresenta una delle poche in Europa in cui vengono descritti resti dello scheletro post-craniale di questa specie, prevalentemente conosciuta sulla base di denti isolati.

Key Words: *Stephanorhinus kirchbergensis*, Middle Pleistocene, Riano.

Parole-chiave: *Stephanorhinus kirchbergensis*, Pleistocene Medio, Riano.

1. INTRODUCTION

The site of Riano is situated 20 km north of Rome and is characterized by tufaceous-diatomitic Formation. This last is lying on the "yellow vacuolized tuff" of the Pleistocene tufaceous series of "Vulcano Sabatino" (AMBROSETTI *et al.*, 1969, 1972; ACCORDI & MACCAGNO, 1962; BONADONNA & BIGAZZI, 1969). In the past century, from the diatomaceous levels, well-preserved and almost complete vertebrate skeletons have been discovered. Among the others, the fossil fauna is represented by *Elephas antiquus* FALCONER & CAUTLEY, *Cervus elaphus rianensis* LEONARDI & PETRONIO, *Dama clactoniana* (FALCONER), several fishes, amphibians and reptiles (MACCAGNO, 1962; ACCORDI & MACCAGNO, 1962; MASTRORILLI, 1965; LEONARDI & PETRONIO, 1974; CALOI *et al.*, 1980). The fossil flora is well represented by several forest assemblages (FOLLIERI, 1958a; 1958b; 1962) that allow to well-reconstruct the climatic conditions near Riano during the Middle Pleistocene. The landscape around the site was characterized by a dense forest, with a remarkable biodiversity compared to coeval records of vegetation in central and northern Europe.

The modern analog of this landscape may be found in areas with over 2000 mm mean annual precipitation, favouring the development of such a dense forest. In particular, three forest phases are recognised: a mixed oak forest at the basis, followed by a period with dominant *Pterocarya* KUNTH, and by a final phase with a progressive increase of *Abies* MILLER and *Fagus* LINNAEUS pollen and the decrease of that of *Pterocarya* (AMBROSETTI & BONADONNA, 1967; FOLLIERI, 1962; FOLLIERI & MAGRI, 2001).

AMBROSETTI *et al.* (1972) and BONADONNA & BIGAZZI (1969) proposed, for the diatomaceous deposit of Riano, the Formation name 'Rianian' to cover the late Middle Pleistocene in the stratigraphical scheme for the Tyrrhenian margin in central Italy. On the basis of stratigraphical relationships and faunal characteristics, MALATESTA (1978) regarded these deposits as strictly representing the continental facies equivalent to the fluvio-lacustrine-brackish-marine sediments that form the Aurelia Formation and, according to CALOI *et al.* (1998), this deposit can be correlated with Torre in Pietra Faunal Unit (sensu GLIOZZI *et al.*, 1997).

2. MATERIALS AND METHODS

The nomenclature used in this work was set by FORTELIUS *et al.*, (1993). Also, according to GROVES (1983) the Pleistocene European rhinoceroses show little similarity with the genus *Dicerorhinus* GLOGER and they are ascribed to genus *Stephanorhinus* KRETZOI, as previously used by several authors (HEISSING, 1973, 1981, 1989; CERDEÑO, 1993, 1995, 1998; PROTERO *et al.*, 1986; *inter alios*).

Rhinoceros remains found in the site of Riano are preserved in the Museum of Paleontology of "Sapienza" University of Roma (MPUR). Some of the remains are unpublished while some of them are previously ascribed to *Dicerorhinus* cf. *mercki* KAUP (LEONARDI & PETRONIO, 1974; GUÉRIN, 1980). Later, the rhinoceros of Riano has been reported in literature as *Dicerorhinus* cf. *hemitoechus* FALCONER, *Stephanorhinus* sp., *Stephanorhinus* cf. *hemitoechus* (CALOI *et al.*, 1980, CALOI & PALOMBO, 1994; PALOMBO *et al.*, 2002). The remains analyzed have been found in the '70ties of the past century in the Cave of diatomaceous earth of Valle dell'Inferno (Riano) (PETRONIO, pers. com.). In the same Cave, in the '60ties of the past century, the skeletons of *Cervus elaphus rianensis* have been discovered. The rhinoceros remains belong to the same individual and some of them have been found articulated. Also, the rhinoceros lacks of the cranial portion and preserves several post-cranial elements among the os coxae, femurs, calcaneum, talus. The most of post-cranial elements are damaged or deformed by characteristics of the fossiliferous site, therefore some morphometrical characters can not be taken into account.

Morphological characters considered are those listed as diagnostics by several authors, including GUÉRIN (1980), FORTELIUS *et al.* (1993), LACOMBAT (2005). When possible, the morphometric methods are based on the works of GUÉRIN (1980), MAZZA (1988), FORTELIUS *et al.* (1993), LACOMBAT (2005).

3. SPECIMENS STUDIED AND COMPARATIONS

The rhinoceros remains from Riano are represented by several elements of post-cranial skeleton and fragments of bones. The principal elements of the skeleton are reported and described below.

3.1 Vertebrae

The vertebral column is represented by several thoracic and lumbar vertebrae (MPUR 7/1-7/16) in a different state of preservation (Fig. 1). Some of them are articulated with other vertebrae and ribs (MPUR 7/21-7/25). Also, among the vertebrae is present the proximal portion of an atlas, very damaged. Due to the deformation and damage of the remains, no morphological characters or morphometric values can be taken into account.

3.2 Scapulae (MPUR 7/54)

Two scapulae are present, one right and one left, articulated with the ribs. The scapulae are compressed latero-medially and are very damaged (Fig. 1). The left scapula preserved only the proximal portion, while, the right one preserved the proximal portion (depth of the proximal portion > 212 mm) and the spine. No diagnostic character is present in the preserved portions.

3.3 Humeri

Two humeri are present; one of them preserved only the diaphysis (MPUR 7/69) and a portion of the proximal articular surface (MPUR s.n.). The other one preserved the diaphysis and a very damaged proximal epiphysis (MPUR 7/56) (Fig. 1). The dimensions of the diaphysis (breadth = about 65 mm; depth = > 65 mm) seem not to be helpful to distinguish between the different rhinoceros species. In fact, the dimensional ranges of the diaphysis of the European Pleistocene rhinoceroses are quite similar (cfr. GUÉRIN, 1980).

The proximal articular surface is almost intact and have a circular outline. The approximate dimensions (breadth = > 80 mm; depth = > 90 mm) allow to exclude that it can be ascribed to *S. etruscus* FALCONER (cfr. FORTELIUS *et al.*, 1993).

3.4 Sacrum (MPUR 7/20)

The sacrum (maximal breadth = about 167 mm; maximal length = > 165 mm) is articulated with some lumbar vertebrae (MPUR 7/17-7/19) (Fig. 1). No morphological or morphometrical study has been done on the sacrum of European Pleistocene rhinoceroses. Considering that, the comparison with other specimens is very difficult.

3.5 Os coxae

Several fragmentary portions of the os coxae are present (MPUR 7/59-7/65). Also, the left os coxae is almost intact (MPUR 7/57) and the articular surface of the right os coxae is present (MPUR 7/58). The acetabulum is relatively broad, deep and sub-elliptical, compressed dorsally (Fig. 1). This shape seems not to be present in *S. etruscus*, *S. hundsheimensis* TOULA and *S. hemitoechus* (cfr. LACOMBAT, 2005); it is more similar to *S. kirchbergensis* JÄGER from Taubach (cfr. PORTIS, 1878). Also, posteriorly, the acetabulum is separated into two articular lips; a dorsal and a ventral one. The dorsal lip is inclined posterior-ventrally and is much wider and longer than the ventral one (Fig. 1). These characters allow to distinguish this bone from those of *S. etruscus*, *S. hundsheimensis* and *S. hemitoechus* (cfr. LACOMBAT, 2005), and seem to be present in *S. kirchbergensis* from Taubach (cfr. PORTIS, 1878). Also, unlike *S. hemitoechus*, in the os coxae from Riano the pit of acetabulum is well-evident (cfr. LACOMBAT, 2005).

The dimensions of the acetabulum are much larger than *S. etruscus* from Upper Valdarno. The value of the maximal length of the acetabulum is much greater than *S. hemitoechus* and it is more similar to the maximal values of *S. hundsheimensis* (Tab. 1). Also, the values of the diaphysis of the Ilium and the height of the acetabulum appear relatively large in the specimens of Riano (Tab. 1).

3.6 Femurs

The two distal epiphysis of the femurs (MPUR 7/66; MPUR 7/68) and a damaged portion of the right proximal epiphysis are preserved (MPUR 7/70) (Fig. 2). The proximal articular surface is partially damaged in the medial portion and seems to be slightly compressed dorso-ventrally (Fig. 2). In proximal view, it seems to be much developed and much compressed latero-medially compared with *S. hundsheimensis* from Mauer (from Fortelius *et al.*, 1993) and Ponte Molle. The articular surfaces of the distal epiphysis of the femurs, in anterior-

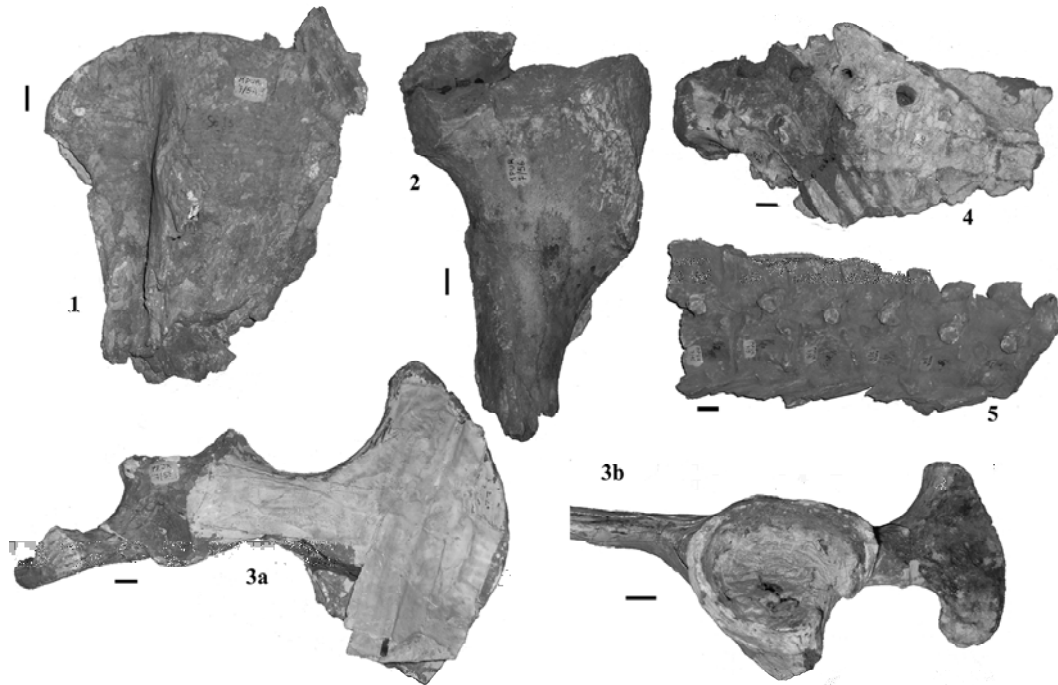


Fig. 1 - Rhinoceros remains from Riano: 1) Scapula, lateral view; 2) Humerus, posterior view; 3) Os coxae, a-dorsal view, b-lateral view of articular surface; 4) Sacrum, ventral view; 5) Thoracic vertebrae, right lateral view. The bar is of about 2 cm.

Resti di rinoceronte di Riano: 1) Scapola, visione laterale; 2) Omero, visione posteriore; 3) Bacino, a-visione dorsale, b-visione laterale della superficie articolare; 4) Sacro, visione ventrale; 5) Vertebre toraciche, visione laterale destra. La barra è di circa 2 cm.

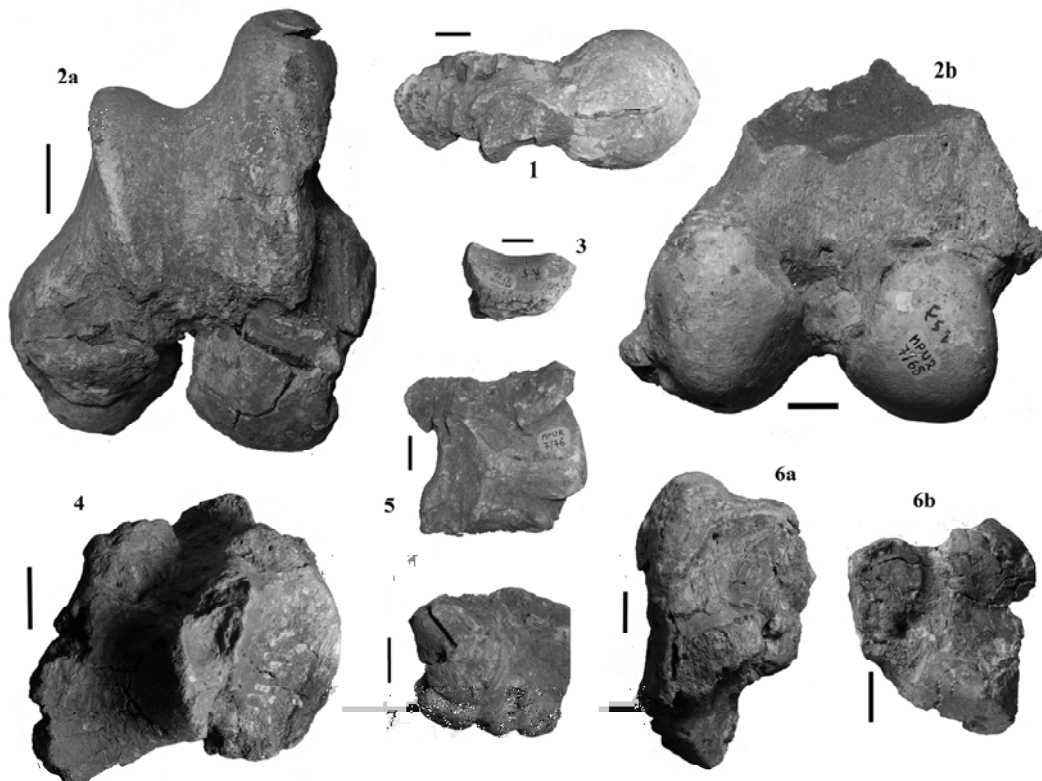


Fig. 2 - Rhinoceros remains from Riano: 1) Femur, proximal epiphysis, proximal view; 2) Femur, distal epiphysis, a-anterior-distal view, b-posterior view; 3) Patella, lateral view; 4) Tibia, proximal view; 5) Talus, anterior view; 6) Calcaneum, a-medial view, b-distal view; 7) Metapodial bone articulated with first phalanx, lateral view. The bar is of about 2 cm.

Resti di rinoceronte di Riano: 1) Femore, epifisi prossimale, visione prossimale; 2) Femore, epifisi distale, a-visione anteriore, b-visione posteriore; 3) Rotula, visione laterale; 4) Tibia, visione prossimale; 5) Astragalo, visione anteriore; 6) Calcagno, a-visione mediale, b-visione distale; 7) Metapodiale in connessione anatomica con la prima falange, visione laterale. La barra è di circa 2 cm.

Os Coxae		La	Lar	lar	Lo	Bsl	Hsi	Ha	LL
Riano	MPUR 7/57	120	100	79	96ca	40ca	71ca	90ca	>460
<i>S. etru.</i>	med	85,33	77,25		88	29,16	58,8		
	min	84	73			26	55		
	max	88	79			31	62		
<i>S. hem.</i>	med	102,93	90,51	86,81		34,4	63,17	73,36	
	min	100,4	88	83,8		28,3	56,35	73	
	max	104,4	93,17	89,83		40,5	70	73,73	
<i>S. hund. Isernia</i>	med	104,91	97,1	85,5	103,23	42,49	69,88	78,33	535
	min	95,16	83,11	74,8	97,04	36,71	59,16	63,24	
	max	116,1	110	94,14	109,42	50,8	82,2	95,9	

Tab. 1 - Comparative dimensions of os coxae from Riano and of *S. etruscus* (*S. etru.*) (data from MAZZA, 1988), *S. hemitoechus* (*S. hem.*) and *S. hundsheimensis* (*S. hund.*) from Isernia (data from LACOMBAT, 2005). La = outer length of the acetabulum; Lar = inner length of the acetabulum; lar = inner width of the acetabulum; Lo = length of the *foramen obturatum*; Bsl = breadth of the shaft of the ilium; Hsi = height of the shaft of the ilium; Ha = height of the acetabulum; LL = lateral length; ca = about.

Dimensioni comparative del bacino di Riano e di S. etruscus (S. etru.) (dati da MAZZA, 1988), S. hemitoechus (S. hem.) e S. hundsheimensis (S. hund.) di Isernia (dati da LACOMBAT, 2005). La = lunghezza esterna dell'acetabolo; Lar = lunghezza interna dell'acetabolo; lar = larghezza interna dell'acetabolo; Lo = lunghezza del foramen obturatum; Bsl = ampiezza della diafisi dell'ilium; Hsi = altezza della diafisi dell'ilium; Ha = altezza dell'acetabolo; LL = lunghezza laterale; ca = circa.

Femur		DTap	DAPap	DTD	DAPDM	DAPDL	DTtr	DTcon	DTfc
Riano	MPUR 7/66			144ca	>164	>130	87		
Riano	MPUR 7/68							>120	24
Riano	MPUR 7/70	82ca	85ca						
<i>S. etru.</i> ¹	med	75,2	71,57	118,5	140,9	116	64,5	99	
	min	69	66	115	138	111	62	95	
	max	84	82	122	143,8	121	67	103	
<i>S. hem.</i> ¹	med	98,25	92,15	145	165,16	133,66	88,33	112,5	
	min	94	91,3	142	158	128	80	108	
	max	102,5	93	148	176,5	140	96	117	
<i>S. hund.</i> ¹	med	82	80,16	130,2	154	126,5	81	109,25	
	min	75	71,5	129,5	143	125,5	80	108	
	max	90,5	90	131	164	128	82	110,5	
<i>S. kirch.</i> ¹			175	201	166	107	150		
<i>S. hem.</i> ²	med	79,7	74,97	131,9	169,13	126,82	78,11	113,86	26,43
	min	79,41		124,4	160	109,37	72,84	103,8	25,4
	max	80		151,3	178,27	139,9	81,6	133,81	27,46
<i>S. hund.</i> ²	med	84,01	79,24	132,6	146,25	123,25	78,71	112,58	31,18
	min	82,35	73,05	124	146,49	118,96	77,52	108,27	29,46
	max	86,29	85,12	147,9	147,93	126,05	79,9	120,65	32,07
<i>S. kirch.</i> ³		104,2	98,9						
		99,3	94,6						

Tab. 2 - Comparative dimensions of femurs from Riano and of *S. etruscus* (*S. etru.*), *S. hemitoechus* (*S. hem.*), *S. hundsheimensis* (*S. hund.*) and *S. kirchbergensis* (*S. kirch.*) (¹ = data from Fortelius *et al.*, 1993; ² = data from LACOMBAT, 2005; ³ = data from KAHLKE, 1977). DTap = breadth of the proximal epiphysis; DAPap = depth of the proximal epiphysis; DTD = breadth of the distal epiphysis; DAPDM = medial depth of the distal epiphysis; DAPDL = lateral depth of the distal epiphysis; DTtr = breadth of the distal trochlea; DTcon = breadth of the posterior condyles; DTfc = breadth of the intercondyloid fossa.

*Dimensioni comparative dei femori di Riano e di S. etruscus (S. etru.), S. hemitoechus (S. hem.), S. hundsheimensis (S. hund.) e S. kirchbergensis (S. kirch.) (¹ = dati da FORTELIUS *et al.*, 1993; ² = dati da LACOMBAT, 2005; ³ = dati da KAHLKE, 1977). DTap = diametro trasversale dell'epifisi prossimale; DAPap = spessore dell'epifisi prossimale; DTD = diametro trasversale dell'epifisi distale; DAPDM = spessore mediale dell'epifisi distale; DAPDL = spessore laterale dell'epifisi distale; DTtr = diametro trasversale della troclea distale; DTcon = diametro trasversale dei condili posteriori; DTfc = diametro trasversale della fossa intercondilea.*

distal view, are undamaged and well-developed (Fig. 2). The trochlea is clearly asymmetric and the medial lip is much larger and developed than the lateral one. The trochlear trough is broad and deep. In medial view, the surface of the bone is broad and the tuberosity is well-evident and massive. It is situated slightly higher than the lateral one. In lateral view, the surface of the bone is less broad than the medial one and the tuberosity is much rounded (Fig. 2). This morphology can be observable in the distal epiphysis of *S. kirchbergensis* from Taubach (cfr. KAHLKE, 1977) and Mosbach (cfr. FORTELIUS *et al.*, 1993) and it is different from those of the other species of the *Stephanorhinus* genre. These last have a different development and shape of the medial and lateral tuberosities and of the articular surfaces (GUÉRIN, 1980; FORTELIUS *et al.*, 1993; LACOMBAT, 2005). In posterior view, the condyles are well-developed and rounded; the intercondyloid fossa is strong, broad and deep (Fig. 2). The medial condyle is much broader than the lateral one; this last is postero-laterally inclined.

Even these characters seem to be distinctive of *S. kirchbergensis* and allow to distinguish it from the other species of the *Stephanorhinus* genre (GUÉRIN, 1980; FORTELIUS *et al.*, 1993; LACOMBAT, 2005).

At last, the dimensions of the femurs of Riano are relatively large. They are comparable with the maximal values of *S. hemitoechus* and the values of *S. kirchbergensis* (Tab. 2; Tab. 7).

3.7 Patellae (MPUR 7172; MPUR 7171)

Two patellae are preserved, one right and one left, differently damaged (Fig. 2). In posterior view, two articular surfaces are present, a medial one, broad and concave, and a lateral one, less broad and concave than the former. The two articular surfaces are well-separated by a saddle. The dimensions of the bones are relatively large if compared with those of *S. etruscus*, *S. hundsheimensis* and *S. hemitoechus* reported by FORTELIUS *et al.* (1993) and LACOMBAT (2003) (Tab. 3); in particular, the DTmax is much greater. This last character is peculiar of *S. kirchbergensis* (GUÉRIN, 1980) (Tab. 7).

3.8 Tibia (MPUR 7173)

Only one tibia is present. This last is very damaged and preserved the proximal epiphysis and a portion of the diaphysis. The tibia is massive, the anterior tuberosity is damaged and deformed, the tibial spine is quite salient and the interspine fossa is relatively broad (Fig. 2). The lateral rim of the tibial spine is higher than the medial

Patella		Lmax	La	DTmax	DTa	DAPmax
Riano	MPUR 7/71	99ca	>80	106ca	>80	>43
Riano	MPUR 7/72	>90	84ca	>91	>81	54ca
<i>S. etru.</i> ¹		99	61	83		48
<i>S. hem.</i> ¹			67	95		50
		106		94		50
<i>S. hund.</i> ¹		>91				52,5
			68			
		108	63	84		43
<i>S. hund.</i> ²	med	131,62	81,16	81,88	74,97	52,34
	min	94,7	78,75	80,01	74,22	50,02
	max	103,61	84,7	82,91	76	53,83
<i>S. kirch.</i> ³	med	111,78		81,3		
	min	100,8		76,2		
	max	122,5		90,1		

Tab. 3 - Comparative dimensions of patellae from Riano and of *S. etruscus* (*S. etru.*), *S. hemitoechus* (*S. hem*) *S. hundsheimensis* (*S. hund.*) and *S. kirchbergensis* (*S. kirch.*) (¹ = data from FORTELIUS *et al.*, 1993; ² = data from LACOMBAT, 2005; ³ = data from KAHLKE, 1977). Lmax = maximal length; La = articular length; DT max = maximal breadth; DTa = articular breadth; DAPmax = maximal depth.

Dimensioni comparative delle rotule di Riano e di S. etruscus (S. etru.), S. hemitoechus (S. hem) S. hundsheimensis (S. hund.) e S. kirchbergensis (S. kirch.) (¹ = dati da FORTELIUS *et al.*, 1993; ² = dati da LACOMBAT, 2005; ³ = dati da KAHLKE, 1977). Lmax = lunghezza massima; La = lunghezza articolare; DT max = diametro trasversale massimo; DTa = diametro trasversale articolare; DAPmax = diametro antero-posteriore massimo.

Talus		DTmax	DAPI	Htrl	HI
Riano	MPUR 7/76	>101	40ca	68ca	>83
<i>S. etru.</i> ¹	med	79,85		61,46	72,22
	min	75		58	69
	max	86		64,2	74
<i>S. hem.</i> ¹	med	87,25		69,32	75,16
	min	73,5		63	71
	max	95,5		76,8	78
<i>S. hund.</i> ¹	med	81,09		67,96	83,72
	min	80		61	75
	max	95,8		76	92
<i>S. hem.</i> ²	med	85,33	39,85		69,9
<i>S. hund.</i> ²	med	85,13	39,65	53,91	69,02
	min	75,59	37,74	50,83	66,56
	max	98,21	42,2	60,25	74,7
<i>S. kirch.</i> ³	med	104,34			92,07
	min	87,7			80,4
	max	114			100,5

Tab. 4 - Comparative dimensions of talus from Riano and of *S. etruscus* (*S. etru.*), *S. hemitoechus* (*S. hem.*) *S. hundsheimensis* (*S. hund.*) and *S. kirchbergensis* (*S. kirch.*) (¹ = data from FORTELIUS *et al.*, 1993; ² = data from LACOMBAT, 2005; ³ = data from KAHLKE, 1977). DTmax = maximal breadth; DAPI = lateral depth; Htrl = height of the lateral trochlea; HI = lateral height.

Dimensioni comparative dell'astragalo di Riano e di S. etruscus (S. etru.), S. hemitoechus (S. hem.), S. hundsheimensis (S. hund.) e S. kirchbergensis (S. kirch.) (¹ = dati da FORTELIUS *et al.*, 1993; ² = dati da LACOMBAT, 2005; ³ = dati da KAHLKE, 1977). DTmax = diametro trasversale massimo; DAPI = diametro antero-posteriore laterale; Htrl = altezza della troclea laterale; HI = altezza laterale.

one. The tibial fossa, in dorsal view, seems to be relatively wide; however, this last character may have been accentuated by the deformation. The medial articular surface of the proximal epiphysis is more antero-posteriorly elongated than the lateral one.

The state of preservation of the tibia does not allow to carry out an exhaustive morphometrical work. The relative dimension of the transversal diameter of the proximal epiphysis ($DTp = > 129$ mm) seems to be larger than *S. etruscus* and *S. hundsheimensis* (respectively $DTp = 87\div 110$ mm and $DTp = 111,5\div 119$ mm in FORTELIUS *et al.*, 1993; respectively $DTp = 102\div 115$ mm and $DTp = 103\div 123,5$ mm in GUÉRIN, 1980) and is closer to maximal values of *S. hemitoechus* ($DTp = 101\div 137,5$ mm in GUÉRIN, 1980) and to the values of *S. kirchbergensis* reported by GUÉRIN (1980) ($DTp = 136$ mm) and KAHLKE (1977) ($DTp = 122,5$).

3.9 Talus (MPUR 7/76)

The talus (Fig. 2) is relatively damaged; in anterior view, the trochlea lacks of the medial portion; in lateral view, the articular surface is relatively wide and is posteriorly limited by a slight depression. In medial view, the distal tuberosity is well-developed and is situated in the anterior-distal margin of the medial face, unlike *S. hemitoechus* (GUÉRIN, 1980; LACOMBAT, 2005). In posterior view, the proximo-lateral articular surface is well-developed, concave and sub-quadrangular in shape; it is elongated in the latero-distal side with a smaller articular facet. The mesio-distal articular surface has sub-trapezoidal shape; it is well-separated from the proximo-lateral one and is relatively damaged.

The maximal transverse diameter is greater than *S. etruscus* and *S. hundsheimensis*. The dimensions of the bone are comparable with the maximal values of *S. hemitoechus* and fall in the variation range of *S. kirchbergensis* (Tab. 4; Tab. 7).

3.10 Calcaneum (MPUR 7/75)

In lateral view, the calcaneum (Fig. 2) is slightly antero-posteriorly compressed; on the whole, the bone is massive and dimensionally large. The *tuber calcanei* is relatively large and high; it has an antero-posterior development similar to the beak. This last character allow to distinguish this bone from those of *S. etruscus* and *S. hundsheimensis* (GUÉRIN, 1973; 1980; LACOMBAT, 2005).

The *sustentaculum talii* is about perpendicular to the axis of the bone and it is slightly damaged in the medial portion. In antero-distal view, the articular surfaces are well-evident. The upper lateral articular surface has rounded shape; the articular surface on the *sustentaculum talii* has a clear outline and has sub-circular shape. These last articular surfaces are clearly well-separated between them. The lower articular surface is slightly damaged and more higher than long. The articular surface with the cuboid is flat and antero-posteriorly elon-

gated. All these morphological characters are comparable with *S. kirchbergensis* and allow to distinguish from *S. hemitoechus*. In this last species the articular surfaces with the talus are not well-separated between them and the lower articular surface is more longer than high (cfr. GUÉRIN, 1973; 1980; KAHLKE, 1977).

Also, the dimensions of the calcaneum are relatively great and are comparable with the values of *S. kirchbergensis* (Tab. 5; Tab. 7).

3.11 Cuboids (MPUR s.n.)

The cuboids, one right and one left, are incomplete and differently damaged. The anterior face of the bone is sub-trapezoidal in shape and the lateral side is more higher than the medial one. The lower margin of the anterior face is about straight, while the upper margin is clearly oblique. In proximal view, the articular surface seems to be flat in the anterior-lateral side and oblique in the medial side. No other morphological character is observable and the few characters present do not allow to distinguish among the species (cfr. FORTELIUS *et al.*, 1993; LACOMBAT, 2005).

The dimensions of the cuboids from Riano are comparable with the values of *S. kirchbergensis* and the maximal values of *S. hemitoechus* (Tab. 6).

3.12 Great cuneiform (MPUR s.n.)

Only one cuneiform is preserved. It is very damaged and deformed. In lateral view, two articular surfaces are visible. The proximo-medial articular surface has sub-triangular shape, while the distal one is elongated. Due to the deformation of the bone, no other morphological or morphometrical character is recognizable.

Calcaneum		Hmax	DTs	DAPs	DTmp	DTst	DAPb
Riano	MPUR 7/75	135	56,5	67	42	>63	67ca
<i>S. etru.</i> ¹	med	118	43,57	63,78	31,55	72,15	59,6
	min	109	41	52,5	30	68	54,6
	max	122	46	70	34	76	64
<i>S. hem.</i> ¹		128	56	65	45		74
		125	55,5	60	45	81	61
<i>S. hund.</i> ¹	med	124,08	48,86	69,4	39,85	77,3	65,4
	min	117	44,3	62	34,2	69	59
	max	132	52	77	47	88	72
<i>S. hem. Mars</i> ²	MAS005	124,88	56,1	60,83	43,14	80,62	63,69
<i>S. hund.</i> ²	med	119,86	52,28	68,07	40,21	74,94	59,66
	min	111,68	46,98	62,75	34,1	62,69	53,06
	max	133,26	58,48	72	47,7	85,5	66,7
<i>S. kirch.</i> ³	med	139,3	56,54	71,55	44,88	85,36	
	min	131,8	48,9	62,3	43	68,6	
	max	146,7	61,2	78,8	47,3	97	

Tab. 5 - Comparative dimensions of calcaneum from Riano and of *S. etruscus* (*S. etru.*), *S. hemitoechus* (*S. hem.*), *S. hundsheimensis* (*S. hund.*) and *S. kirchbergensis* (*S. kirch.*) (¹ = data from FORTELIUS *et al.*, 1993; ² = data from LACOMBAT, 2005; ³ = data from KAHLKE, 1975; 1977). Hmax = maximal height; DTs = breadth of the *tuber calcanei*; DAPs = depth of the *tuber calcanei*; DTmp = minimum posterior breadth; DTst = breadth of the *sustentaculum talii*; DAPb = depth of the beak.

Dimensioni comparative del calcagno di Riano e di S. etruscus (S. etru.), S. hemitoechus (S. hem.), S. hundsheimensis (S. hund.) e S. kirchbergensis (S. kirch.) (¹ = dati da FORTELIUS *et al.*, 1993; ² = dati da LACOMBAT, 2005; ³ = dati da KAHLKE, 1975; 1977). Hmax = altezza massima; DTs = diametro trasversale del *tuber calcanei*; DAPs = diametro antero-posteriore del *tuber calcanei*; DTmp = diametro trasversale minimo posteriore; DTst = diametro trasversale del *sustentaculum talii*; DAPb = diametro antero posteriore del becco.

Cuboid		H ant.	l
Riano	MPUR s.n.	44	48
<i>S. hem.</i> ⁰	med	42,25	45,35
	min	39	37,7
	max	45,5	53
<i>S. hund.</i> ⁰	med	40,15	42
	min	36	37
	max	44,3	47
<i>S. kirch.</i> ⁰	med	46,25	51,5
	min	39	43
	max	53,5	60
<i>S. etru.</i> ¹	med	38,8	41,4
	min	36	36
	max	42	47
<i>S. hem.</i> ¹		45,5	43,3
<i>S. hund.</i> ¹	med	42,7	43,12
	min	39,5	39,5
	max	44,3	47
<i>S. kirch.</i> ¹	med	44,75	51,07
	min	39	47,5
	max	50	57
<i>S. hem.</i> ²	med	41,97	39,12
	min	40,67	37,7
	max	43,5	42,54
<i>S. hund.</i> ²	med	40,41	40,63
	min	37	36,31
	max	42,37	44,5

Tab. 6 - Comparative dimensions of cuboids from Riano and of *S. etruscus* (*S. etru.*), *S. hemitoechus* (*S. hem.*), *S. hundsheimensis* (*S. hund.*) and *S. kirchbergensis* (*S. kirch.*) (⁰ = data from GUÉRIN, 1980; ¹ = data from FORTÉLIUS *et al.*, 1993; ² = data from LACOMBAT, 2005). H ant. = anterior height; l = breadth.

Dimensioni comparative dei cuboidi di Riano e di S. etruscus (*S. etru.*), *S. hemitoechus* (*S. hem.*), *S. hundsheimensis* (*S. hund.*) e *S. kirchbergensis* (*S. kirch.*) (⁰ = dati da GUÉRIN, 1980; ¹ = dati da FORTÉLIUS *et al.*, 1993; ² = dati da LACOMBAT, 2005). H ant. = altezza anteriore; l = larghezza.

3.13 Metapodial bone (MPUR s.n.)

Very fragmentary metapodial bone is preserved. It consists of a distal epiphysis articulated with the first and second phalanges (Fig. 2). No morphological or morphometrical character are recognizable.

4. DISCUSSION AND CONCLUSIONS

Even if partially damaged, the rhinoceros remains from Riano preserve some characters, such as the articular surfaces, which allow an accurate analysis. In particular, the shape and size of the articular surfaces and tuberosities of the femurs, the characters of the os coxae and the morphology of the calcaneum of the rhinoceros from Riano are comparable with *S. kirchbergensis* (cfr. GUÉRIN, 1973; 1980; FORTÉLIUS *et al.*, 1993).

Moreover, the size of the remains fall into the variation range know for *S. kirchbergensis* (cfr. KAHLKE, 1977; GUÉRIN, 1980; FORTÉLIUS *et al.*, 1993).

S. kirchbergensis seems to be a relatively rare species, although it is reported in most of Europe and Asia (GUÉRIN, 1980; TONG, 2001; LACOMBAT, 2005; BILLIA, 2008; BILLIA & PETRONIO, 2009). This rarity could be related with the ethology of the species; probably, it was present in the area with groups of few individuals. However, it can be assumed that the species living in ecological niche unfavourable for its fossilization (LOOSE, 1975). In this regards, the species seems to be typical of forest environments; this hypothesis is supported by the brachydont teeth of the species and by the remains of flora and fauna that have been discovered with this species (GUÉRIN, 1980). Recently, *S. kirchbergensis* has been found in sites of southern China, 2000 m above sea level, that correspond to temperate deciduous and coniferous forest (TONG & WU, 2009). The fossil flora of Riano, discovered with the rhinoceros remains, bear out the hypothesis that species could be typical of forest environments. This fact could be explain the relatively absence or rarity of the species in southern Italy, in the Iberian Peninsula and in North Africa, unlike to the coeval European species *S. hemitoechus* (GUÉRIN, 1980; CERDEÑO, 1990; BILLIA & PETRONIO, 2009).

The phylogenetics of *S. kirchbergensis* is still unresolved. This species is directly connected to *Larterotherium megarhinus* (DE CHRISTOL) by WÜRST (1922), STAESCHE (1941) and GUÉRIN (1980), even if the evolutionary connections between the two species are not clear much. However, *S. kirchbergensis* seems to has origin in central Asia. In fact, it is reported in Early Pleistocene sites of China and Kazakhstan (KHISAROVA, 1963; DONG *et al.* 2000; TONG & MOIGNE, 2000; TONG, 2001; BILLIA & PETRONIO, 2009; TONG & WU, 2009). Later *S. kirchbergensis* is present in the Middle Pleistocene deposits of Russia and Eastern Europe (CZYŻEWSKA, 1962; BORSUK-BIALYŃICKA & JAKUBOWSKI, 1972; BILLIA & SHPANSKY, 2005; BILLIA, 2008). The species may be evolved in central Asia from a common ancestor of the evolutionary lineage that led to *S. hemitoechus* in Europe. Later, it would spread westward during the Middle Pleistocene. In this regards, an exhaustive analysis of Mio-Pliocene Asian rhinoceros remains would confirm this hypothesis.

In Italy, the oldest remains ascribed to *S. kirchbergensis* are those discovered in the Middle Pleistocene sites of Valdemino (NOCCHI & SALA, 1997) and Ponte Molle (CAPASSO BARBATO *et al.*, 1998; BILLIA & PETRONIO, 2009), both correlable with Isernia FU (*sensu* GLIOZZI *et al.*, 1997). Also, the species is reported in few sites of late Middle Pleistocene of northern and central Italy and it seems to be absent in the second part of Late Pleistocene (PETRONIO *et al.*, 2007). However, the most part of the remains ascribed to this species consist of isolated teeth. The remains of Riano are, instead, one of the rare record in Europe of *S. kirchbergensis* based on post-cranial elements belonging to a single individual.

Femur		DTap	DAPap	DTD	DAPDM	Patella		Lmax	DTmax	DAPmax
Riano	MPUR 7/66			144ca	>164	Riano	MPUR 7/71	99ca	106ca	>43
Riano	MPUR 7/68					Riano	MPUR 7/72	>90	>91	54ca
Riano	MPUR 7/70	82ca	85ca							
<i>S. hund.</i>	med	85	79,93	126,32	149,56	<i>S. hund.</i>	med	97,3	80,8	53,44
	min	74	72	116	139,5		min	90	72	44,5
	max	95	88	140,5	163		max	104	86	65
<i>S. hem.</i>	med	92,73	88,77	135,5	155,27	<i>S. hem.</i>	med	105,5	88,5	59
	min	83	80,5	124	121		min	98		58
	max	101	94	149	172		max	113		60
<i>S. kirch.</i>	med	98,33	90,75	153,25	180,83	<i>S. kirch.</i>	med	107,28	99,21	56,88
	min	90	85	138	162		min	99	87	48
	max	103	96,5	176	198		max	122	118,5	71
Talus		DTmax	Calcaneum		Hmax	DTs	DAPs	DTmp	DTst	DAPb
Riano	MPUR 7/76	>101	Riano	MPUR 7/75	135	56,5	67	42	>63	67ca
<i>S. hund.</i>	med	86,01	<i>S. hund.</i>	med	118,76	48,59	67,92	38,15	72,83	60,36
	min	76		min	110	43	55,5	32,5	64	54
	max	107		max	131	58	77	44	80	68
<i>S. hem.</i>	med	85,08	<i>S. hem.</i>	med	120,43	50,16	62,83	39,82	75,18	66,54
	min	72,5		min	104	42	54	36	66	56
	max	95		max	139	60	74	46,5	85	75
<i>S. kirch.</i>	med	101,66	<i>S. kirch.</i>	med	143,55	56	76,3	45,13	83,28	72,67
	min	93		min	131,5	51	69	40	72	65
	max	113		max	152,5	61	86,5	51	94	79

Tab. 7 - Comparative dimensions of femurs, patellae, talus and calcaneum from Riano and of *S. hemitoechus* (*S. hem.*), *S. hundsheimensis* (*S. hund.*) and *S. kirchbergensis* (*S. kirch.*) reported by GUÉRIN (1980).

Dimensioni comparative dei femori, delle rotule, dell'astragalo e del calcagno di Riano e di *S. hemitoechus* (*S. hem.*), *S. hundsheimensis* (*S. hund.*) e *S. kirchbergensis* (*S. kirch.*) dati da GUÉRIN (1980).

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