

Rhinocerotidae from the Turolian site of Dorn-Dürkheim 1 (Germany)

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Abstract

More than 60 rhinocerotid remains have been recovered to date from the Lower Turolian of Dorn-Dürkheim 1. The taxonomic study of this material allows us to determine the presence of three species. One of them is *Lartetotherium schleiermacheri* and the other two belong to the aceratherine group. Within this group we recognise *Alicornops alfambrense*, a species recently defined at La Roma 2 (Teruel basin) from the Upper Vallesian of Spain, and some teeth and bones are also identified as *Aceratherium incisivum*. The recognition of *A. alfambrense* at Dorn-Dürkheim 1 and Montredon (France) extends its geographic distribution from Spain through France to Germany, and its time range from the Upper Vallesian (La Roma 2 and Montredon) to the Lower Turolian (Dorn-Dürkheim 1). The same rhinoceros association is known at La Roma 2 and Montredon, and the coexistence of *L. schleiermacheri* and *A. incisivum* is common at many Vallesian and Turolian sites of Western Europe.

Keywords: Rhinocerotidae, Turolian, Dorn-Dürkheim, Germany.

Kurzfassung

Mehr als 60 Rhinocerotidenreste wurden bislang aus dem unteren Turolium von Dorn-Dürkheim 1 geborgen. Die taxonomische Analyse dieses Materials ergab drei Arten. Eine davon ist *Lartetotherium schleiermacheri*, bei den beiden anderen handelt es sich um Aceratherien. Darunter befindet sich mit *Alicornops alfambrense*, eine Art, die erst kürzlich anhand von Material aus La Roma 2 im oberen Vallesium des Beckens von Teruel (Spanien) erkannt wurde. Daneben wurden einige Zähne und Knochen als *Aceratherium incisivum* identifiziert. Der Nachweis von *A. alfambrense* in Dorn-Dürkheim 1 und Montredon erweitert die geographische Verbreitung dieser Art von Spanien über Frankreich bis nach Deutschland, während sich das zeitliche Auftreten vom oberen Vallesium (La Roma 2 und Montredon) bis in das untere Turolium von Dorn-Dürkheim 1 verlängert. Dieselbe Assoziation von Nashornarten findet sich auch in La Roma 2 und Montredon, wobei allerdings das Nebeneinander von *L. schleiermacheri* und *A. incisivum* vielen vallesischen und turolichen Lokalitäten Westeuropas gemeinsam ist.

Schlüsselworte: Rhinocerotidae, Turolium, Dorn-Dürkheim, Deutschland.

Introduction

The Turolian Dorn-Dürkheim 1 formation has been the object of many field seasons since the 1970's. The first faunal list (FRANZEN & STORCH, 1975) established the existence of three mammalian orders, rodents, carnivores and proboscideans. Later the fossil record of Dorn-Dürkheim 1 has greatly increased the variety of the association; among perissodactyls, FRANZEN (1981) included two rhinoceros forms classified as *Aceratherium* sp. and *Didemcerus* cf. *schleiermacheri*.

The rhinoceros material herein studied comprises all remains found to date. Three different species are determined: *Lartetotherium schleiermacheri*, *Alicornops alfambrense* and *Aceratherium incisivum*.

A brief comment about generic names is needed. Most authors restrict the genus *Dicerorhinus* to the living species *D. sumatrensis*, and other generic taxa have been used for fossil forms classically included in it (HEISSIG, 1973; GROVES, 1983). The species *Lartetotherium schleiermacheri* however, does not have a clear

generic ascription, so GUÉRIN (1988, 1989) continues considering it as *Dicerorhinus* while CERDEÑO (1992; 1995) assigns it to *Lartetotherium*, a genus created by GINSBURG (1974) for the Middle Miocene species *L. sansaniense* from Sansan.

Alicornops was defined as a subgenus of *Aceratherium* (GINSBURG & GUÉRIN, 1979), and later assumed generic rank (GUÉRIN, 1989; HEISSIG, 1989); the diagnosis has been recently reviewed by CERDEÑO (1989, 1992).

Within the rhinoceros association found at Dorn-Dürkheim 1 the presence of *Alicornops alfambrense* is highly interesting since up to now it was a species only partially known and from just two sites: the type locality, La Roma 2 (Spain), and Montredon (France) (CERDEÑO & ALCALÁ, 1989). Its possible presence at Montredon was based on some remains previously classified as cf. *Prosantorhinus* sp. (GUÉRIN, 1988), and will be discussed with more detail below. La

Roma 2 as well as Montredon are Upper Vallesian localities; the Lower Turolian age of Dorn-Dürkheim 2 implies a temporal extension of *A. alfambrense*. Its presence at the German site also enlarges its geographical distribution. The revision of the Vallesian *A. simorreense* (out of Spain) could lead to the recognition that it really corresponds to *A. alfambrense* as we have already suggested (CERDEÑO & ALCALÁ, 1989: 51). In any case, on the basis of GUÉRIN's (1980) data, the material is quite scarce. He determines the presence of *A. simorreense* in the Lower Vallesian of Lyon Croix-Rousse and Saint Jean de Bournay (France) and Höwenegg (Germany), and in the Upper Vallesian of Montredon and Soblay (France), but only Höwenegg

and Montredon provided a significant sample. In Spain, *A. simorreense* is present at several Lower Vallesian localities showing certain differences with respect to the Aragonian material (ALBERDI et al., 1981; CERDEÑO, 1989, 1992). *A. alfambrense* replaces that species in the Upper Vallesian. In other parts of Western Europe this replacement also occurred.

The rhinoceros association of Dorn-Dürkheim 1 is the same as that found at La Roma 2 and Montredon as will be discussed later. On the other hand the coexistence of *L. schleiermachersi* and *A. incisivum* is very common at many Vallesian and Turolian sites of Western Europe.

Abbreviations

ant. = anterior, anteriorly

APD = antero-posterior diameter

APDi = antero-posterior diameter internally

APDprox. = proximal antero-posterior diameter

D = diagonal width

DL = distance between astragalar lips

dist.art. = distal articulation

dist. ep. = distal epiphysis

Hmax. = maximum height

Hmin. = minimum height

L = length

max. = maximum

min. = minimum

post. = posterior, posteriorly

prox. art. = proximal articulation

prox. ep. = proximal epiphysis

sust. = sustentaculum tali

TD = transverse diameter

TDdist. = distal transverse diameter

TDm = maximal transverse diameter

TDmd = maximal transverse diameter distally

W = width

Systematics

Family Rhinocerotidae OWEN 1845

Subfamily Rhinocerotinae OWEN 1845

Tribu Rhinocerotini OWEN 1845

Genus *Lartetotherium* GINSBURG 1974

Lartetotherium schleiermachersi KAUP 1832-34

Plate 1, Figs. 1, 3, 9; Plate 2, Figs. 1-2

Material: left P¹ (SMF-DD 312, 5457); right P² (SMF-DD 324); right M³ (SMF-DD 4747); right P₂ (SMF-DD 321); left M₂ (SMF-DD 4746); right astragalus (SMF-DD 1089); left calcaneum (SMF-DD 1091); right McII (SMF-DD 5450, 5451); right McII, proximal fragment (SMF-DD 320).

Description:

A.- Upper dentition.

Two P¹s can be ascribed to this species. They are large teeth with high and convex ectoloph, the paracone fold hardly evident. The metaloph is well developed. The protoloph is narrower, and should be little developed in height. There are no secondary folds (crista and crochet) in DD 312, but a little crochet is present in DD 5457. The lingual cingulum closes a

small prefosette in front of the protoloph and reaches the hypocone base. The posterior cingulum projects to the labial side.

The P² has a trapezoidal outline at the base, the posterior width being greater at that level than at the occlusal one (Pl. 1, Fig. 1). The paracone fold is wide, the paracone rounded. The protocone is not fixed to the

ectoloph, but it is united with the crochet. There is no labial cingulum but a tiny posterior ridge. On the contrary, the lingual cingulum is strongly developed, V-shaped, with a point of discontinuity at the protocone level.

The M³ is a very worn, incomplete tooth. Most of a well developed posterior cingulum can be observed. The protocone has a marked posterior groove. A small lingual tubercle appears at the hypocone base. Upper teeth dimensions are given in Table 1.

	p ¹		p ²		M ³		
	L	W	L	W	L	W	D
SMF-DD 312	25.7	23.1					
SMF-DD 5457	(26.4)	(>22)					
SMF-DD 324			37.9	44.7			
SMF-DD 4747					46.0	53.8	56.5
La Roma 2			33.2	40.6			
			33.1	40.0			
M.Barbo			33.4	35.7			
Concud			35.0	38.6	49.0	57.6	58.7
					(47.7)	(53.7)	55.0
Crevillente			32.0	42.3	51.2/52.0	57.4/61.5	62.6/63.1

Table 1. Comparative dimensions of the upper teeth of *L. schleiermacheri* from Dorn-Dürkheim 1 and some Spanish localities.

B.- Lower dentition.

Among the three studied P₂s from Dorn-Dürkheim 1, DD 321 can be assigned to *L. schleiermacheri* (Pl. 1, Fig. 3). It is a large and high tooth, hardly worn. The anterior valley is smoothly marked, the posterior one is deep. On the labial side the protoconid fold is well defined by a posterior groove in the upper half of the tooth, fading distally. The basal edge is missing, and the existence of a continuous labial cingulum cannot be assured, although remains are preserved at both extremes.

The large size of the M₂ DD 4746 leads the author to assign it to *L. schleiermacheri*. It is not complete, but it seems there was a small cingular rim at the base of the labial groove. For dimensions of these teeth see Table 2.

	P ₂		M ₂	
	L	W	L	W
SMF-DD 321	35.8	20.6		
SMF-DD 4746		46.7	30.3	
Can Trullás*	29.5	22.0		
Crevillente	-	18.6		
Montredon**	34.5	22.5		

Table 2. Comparative dimensions of the lower teeth of *L. schleiermacheri* from Dorn-Dürkheim 1 and some Spanish and French localities (* after SANTAFÉ 1978; ** after GUÉRIN 1988).

C.- Postcranial skeleton.

There are two McII fragments of the same individual fitting just at a point that allows the bone length to be taken with minimal error (Pl. 1, Fig. 9; Table 3). It is a large metacarpal with a wide proximal epiphysis, the maximal dimension of which is 55 mm (TD in Table 3 is taken perpendicular to the lateral facet and so it is smaller). The medial tuberosity is well developed below the proximal articular surface. This latter is a wide, long (APD), saddle-shaped facet. At a right

face, the magnum-articulation forms an acute crest with the anterior part of the proximal facet. The magnum-facet is long, subrectangular in shape, almost flat, only smoothly concave at the middle; its proximal border draws a concave-convex line. The anterior half of this articular surface continues, with a smooth crest, in a trapezoidal McIII-facet. The diaphysis is wide and flattened. The distal epiphysis presents a rounded anterior depression just above the articulation. This

	L	prox.ep.		prox.art.		diaphysis		TDmd	dist.art.	
		TD	APD	TD	APD	TD	APD		TD	APD
SMF-DD 5451	174.5	43.0	47.5	30.8	39.3	(44.5)	21.3	51.6	42.9	46.9
La Roma 2	157.0	39.6	46.5	27.8	(40)	37.0	21.3	44.6	40.0	45.6
Concud	-	39.5	48.0	29.7	41.5	-	-	-	-	-

Table 3. Comparative dimensions of the McII of *L. schleiermacheri* from Dorn-Dürkheim 1 and some Spanish localities.

A proximal fragment of another McII (DD 320; not measured) differs from the former in having two different McIII-facets, instead of only one, and the magnum-facet is straighter.

There is a very fragmented but quite complete astragalus (Pl. 2, Fig. 1). It is a large bone with a deep trochlea; the external lip slopes smoothly, rising suddenly at the internal lip. The trochlea is well separated from the distal articulation by a large groove. The medial tubercle is little developed. It shows high antero-posterior diameters (Table 4). The posterior face presents a wide and short facet-1 (incomplete), and a large, convex, irregularly outlined facet-2, slightly narrower disto-laterally where it fuses with facet-3. Distal facets are large; the one for the navicular is quite square-shaped; both curve posteriorly.

Only one calcaneum in the sample belongs to *L. schleiermacheri*, lacking the antero-proximal zone and the sustentaculum. It is a large bone with a posteriorly enlarged tuber (Table 5). The astragalus-facets are very incomplete; facet-3 seems not to be fused with facet-2 or it would be by a very narrow connection. The distal facet is wide and concave, flattened at its most anterior zone; it forms a smooth angle with facet-3. In lateral view the distal border is only slightly oblique.

One astragalus (HLD-DIN 1922) and one calcaneum (HLD-DIN 1924) from the type locality, Eppelsheim (KAUP, 1832-34), have been included in tables and plates (Pl. 2, Figs. 2 and 6) since they have been directly studied together with the Dorn-Dürkheim 1 sample.

	TDmax.	Hmax.	TDmd	dist.art.			
				TD	APD	DL	APDi.
SMF-DD 1089	90.4	88.4	79.8	78.4	53.0	65.2	59.3
Eppelsheim	91.2	85.0	76.9	76.7	47.0	63.1	56.2
La Roma 2	98.0	85.7	85.3	81.2	54.6	71.0	61.6
	94.0	84.5	79.2	74.2	46.0	69.7	60.0
	98.8	84.3	86.3	83.0	55.0	68.0	65.0
	94.6	83.0	82.0	81.4	51.0	65.5	59.0
Casiones	92.0	(79)	-	-	(50.5)	72.0	60.0
Puente Minero	(99)	-	88.2	83.5	49.0	(60.5)	(>50)
	-	-	(82)	(77)	(46)	-	-
M.Barbo	89.5	80.3	77.5	70.6	43.0	65.0	51.5
Montredon*							
max.	92.5	92.0	79.0	72.5	48.5	68.0	64.0
min.	84.0	78.5	76.0	69.0	46.0	62.0	59.5

Table 4. Comparative dimensions of the astragalus of *L. schleiermacheri* from Dorn-Dürkheim 1 and some Spanish, German, and French localities.- * after GUÉRIN (1988).

Discussion:

Among dental remains, the most problematic teeth to be ascribed to *L. schleiermacheri* are the P² (DD 324) and the P₂ (DD 321). The isolated protocone of the P² is a character often observed in that species, i.e. several Spanish specimens from the Teruel basin (CERDEÑO, 1989: Fig. 30); however, the tooth from Dorn-Dürkheim 1 has a strong lingual cingulum which is not present on the Spanish P²s. DD 324 is wider than the compared P²s (Table 1), and exceeds the maximal

not differ very much from the other P² ascribed to the aceratheres.

Instead, the P₂ (DD 321) is clearly larger than the other two from Dorn-Dürkheim 1; the labial cingulum would be surely present which is exceptional in *L. schleiermacheri*. Its width is somewhat greater than that of the P₂ from the Turolian site of Crevillente (Table 2: CERDEÑO, 1989: Tab. 55). but it fits well with

The M³ is close in size to that from Concud and slightly smaller than the Crevillente specimen (Table 1).

In direct comparison, the postcranial elements described above are very similar to the type material from Eppelsheim and to the Spanish remains.

The McII is close to those from La Roma 2 and Concud (Spain). The maximal dimension of the proximal epiphysis is slightly greater (55 mm) than that of La Roma 2 specimen (50 mm). The two Spanish McII present just one McIII-facet in the lateral face as it is in DD 5451. Table 3 shows the German McII to be longer than the La Roma 2 specimen, but the transverse diameters are also greater and the bone is slightly stronger (gracility index: DD 5451 = 25.5; La Roma 2 = 23.5). Dimensions are also greater than those expressed by GUÉRIN (1980) for *L. schleiermacheri*.

The astragalus is comparable to the homologous ones from Eppelsheim, Montredon and the Spanish sites, these latter being somewhat wider (Table 4) which is reflected in a greater index TD x 100/H, although the difference is similar to that observed within the Montredon sample (after GUÉRIN 's data, 1988):

- DD 1089 = 102.2
- Eppelsheim = 107.2
- La Roma 2 = 114.3; 111.2; 117.2; 113.9
- Masia del Barbo = 111.4
- Montredon = 110.1; 106.6; 103.7; 100.5

Morphologically the astragalus from Eppelsheim presents a larger and more flattened facet-2 with a wider connection with the facet-3.

Concerning the calcaneum, DD 1091 has a lesser height than the La Roma 2 and Montredon specimens, closer to those from Eppelsheim and Las Casiones (Table 5). GUÉRIN (1980) gives greater dimensions than those obtained for HLD-DIN 1924 from Eppelsheim (H and TD-sustentaculum do not reach the minimal value); instead astragali and calcanei from La Roma 2 reach and even exceed the maximal dimensions (CERDEÑO, 1989: 329). The fragmentary condition of DD 1091 does not allow any more comments.

	H	TD tuber	APD tuber	TD sust.	APD beak	TD post. min
SMF-DD 1091	135.5	56.0	-	-	(66)	(41.5)
Eppelsheim	131.5	52.9	68.3	76.0	70.0	39.7
La Roma 2	143.0	59.2	73.7	92.7	76.0	46.0
	139.0	52.7	68.7	71.6	73.2	43.6
	142.0	(50)	(>65)	80.6	75.3	(39.3)
	141.5	55.0	-	79.5	73.6	43.0
Casiones	131.0	53.3	76.6	-	71.3	37.2
Montredon*	140.5	-	(>66)	77.0	70.0	(41)

Table 5. Comparative dimensions of the calcaneum of *L. schleiermacheri* from Dorn-Dürkheim 1 and other European localities.- * after GUÉRIN (1988).

Subfamily Aceratheriinae DOLLO 1885

Genus *Alicornops* GINSBURG & GUÉRIN 1979

Alicornops alfambrense CERDEÑO & ALCALÁ 1989

Plate 1, Figs. 2, 4, 6-7, 10-11; Plate 2, Figs. 3-5

Material: right P² (SMF-DD 322) ?; left M³ (SMF-DD 1114) ?; right P₂ (SMF-DD 4767) ?; P₃ and P₄ of the same individual (SMF-DD 1108, 4075) ?; M₁ fragment and M₂ of the same individual (SMF-DD 5455, 5456) ?; left humerus fragment (SMF-DD 1100); trapezoid (SMF-DD 1102); right McIV, proximal half (SMF-DD 5466); metapodial distal fragments (SMF-DD 5470); right tibia, distal fragment (SMF-DD 1095); right astragalus (SMF-DD 1097); right astragalus, fragment (SMF-DD 1096); right calcaneum (SMF-DD 1094); right calcaneum (SMF-DD 5606); three right calcaneum fragments (SMF-DD 1099, 5454, 5459); left navicular (SMF-DD 5468).

Description:

A.- Upper dentition

It is difficult to establish which teeth correspond to *A. alfambrense* taking into account that its dentition has not been previously described. Its relationship with *A. simorreense* leads to the assumption that the teeth will have comparable morphology and larger dimensions. Dental characters of *A. alfambrense* and *Aceratherium incisivum* would be quite similar and the

not present two different sizes apart from those teeth ascribed to *L. schleiermacheri*. Some morphological differences have been observed between homologous teeth, and we attempt to separate them with most caution.

The P² (DD 322; Pl. 1, Fig. 2) is slightly smaller than DD 1104 considered as *A. incisivum*. The ectoloph is better and the humerus more rounded. It is a fairly

metaloph. There is a little crochet, and a vertical cylindrical tubercle leans against it. The lingual cingulum is very strong, and there is no labial cingulum. A very small prefossette is present.

A rather small, little-worn M³ can be ascribed to *A. alfambrense* (Table 6). The parastyle and the paracone-fold are strong. There is a long crochet which closes the median valley without reaching the protoloph. The anterior cingulum is strong; the posterior one is reduced, small and long. The lingual side is broken.

	P ²		M ³		
	L	W	L	W	D
SMF-DD 322	35.7	43.2			
SMF-DD 1114			41.6	46.0	47.8

Table 6. Dimensions of the upper dentition of *A. alfambrense* from Dorn-Dürkheim 1.

B.- Lower dentition.

The P₂ (DD 4767; Pl. 1, Fig. 4) is a small tooth. It has a long and roundish paralophid without a labial fold; the labial groove between the anterior and posterior lobes is well marked instead. The posterior valley is deep. Lingual and labial cingula are not present.

There are two lower premolars (P₃-P₄) of the same individual (Pl. 1, Figs. 6-7) that are interesting due to a pronounced labial groove with a swelling at its base, but without a labial cingulum. The anterior cingulum projects lingually. These are wide teeth (Table 7).

	P ₂		P ₃		P ₄		M ₂	
	L	W	L	W	L	W	L	W
SMF-DD 4767	28.7	20.3						
SMF-DD 4075*			38.1	29.0				
SMF-DD 1108*					(40.6)	(29.0)		
SMF-DD 5453			36.5	26.7				
SMF-DD 5455							45.0	26.8

Table 7. Dimensions of the lower dentition of *A. alfambrense* from Dorn-Dürkheim 1.- * Same individual.

Another P₃ could belong to *A. alfambrense*. It is small and relatively wide. There are neither labial nor lingual cingula but the anterior cingulum projects lingually. The labial groove is less pronounced. Its length does not reach the minimum value established

for *A. incisivum* (GUÉRIN, 1980) while its width is above the mean value.

An M₂ and an M₁ fragment of the same individual are included here because of their relatively smaller size (Table 7) and the marked labial groove.

C.- Postcranial skeleton.

A distal fragment of a humerus can be ascribed to *A. alfambrense* because of its small size.

The trapezoid is a long bone, narrower than DD 251; the anterior face is distally pointed with a convex proximal border. No other carpal bones have been described before for *A. alfambrense*. The dimensions are as follows: TD = 23.0; APD = 34.3; H max. = 28.5; H min. = 20.0.

The McIV fragment (Pl. 1, Figs. 10-11) presents

a trapezoidal proximal facet and epiphysis. The anterior face displays a strong lateral tuberosity. The proximal facet is concave, with great antero-posterior diameter (Table 8), becoming convex at its posterior part, which is laterally directed. In lateral view, a large, oval McV-facet makes a right angle and a crest with the proximal facet. The anterior medial McIII-facet is wide, slightly concave, quadrangular in outline and forms an open angle with the proximal facet. Both metacarpals would be rather divergent.

	L	prox.ep.		prox.art.		diaphysis		TDmd.	dist.art.	
		TD	APD	TD	APD	TD	APD		TD	APD
SMF-DD 5466	-	41.6	43.0	28.9	38.5	34.0	18.2	-	-	-
La Roma 2	110.5	32.9	38.6	25.3	35.7	28.6	17.3	34.5	32.3	30.8

A distal metapodial fragment can be associated with this species due to its whole size.

A distal half of a tibia is small, and corresponds to the astragalus DD 1097 described below. The most distal part of the diaphysis is very triangular in cross section, with an acute lateral border which ends in a large rough fibular contact area in which there is a very small articular facet. The distal articulation displays a very concave medial facet, and the lateral facet presents a small anterior extension.

The astragalus (Pl. 2, Figs. 3-4) is much smaller than that of *L. schleiermacheri*. The trochlea is deep and relatively narrow, with a short but deep groove; the trochlea lays somewhat above this groove; the lateral lip is exceptionally long and reaches the same level as the border of the cuboid-facet, but both remain far from each other. The medial tubercle is pointed and medially projected. In anterior view, the cuboid-facet is hidden and the navicular-facet appears quite concave. In distal view, the cuboid-facet is longer than that for the navi-

cular, and it has a V-shaped contact with this second articulation. The navicular facet is roughly square. In posterior view, the facet-1 is narrow, concave, and with a short projection. The ovoid, slightly convex facet-2 stretches distally where it fuses with the long and fusi-form facet-3.

	diaphysis		dist. ep.		dist. art.	
	TD	APD	TD	APD	TD	APD
SMF-DD 1095	46.9	-	80.2	65.2	66.8	44.6
Montredon*	-	-	84.5	60.5	69.0	42.5

Table 9. Comparative dimensions of the tibial fragments of *A. alfambrense* from Dorn-Dürkheim 1 and Montredon.- * *A. simorreense* (after GUÉRIN, 1988).

Another astragalus fragment is similar to this one, although it shows the particularity of having the medial lip of the trochlea nearly in contact with the distal facet. The medial tubercle is somewhat less developed.

	TDm	Hm	TDmd.	dist.art.			
				TD	APD	DL	APDi.
SMF-DD 1097	80.0	65.7	69.9	66.3	41.6	49.5	48.6
SMF-DD 1096	-	(64.0)	-	-	-	-	52.2
La Roma 2	78.8	72.7	73.3	61.8	(37.0)	56.5	50.5
	72.6	63.0	65.4	60.0	33.6	50.7	43.0
Montredon*	88.0	>72.5	76.8	74.0	39.2	(54.0)	>50.0

Table 10. Comparative dimensions of the astragalus of *A. alfambrense* from Dorn-Dürkheim 1, La Roma 2 (Spain) and Montredon (France).- * cf. *Prosantorhinus* (after GUÉRIN, 1988).

	H	TD tuber	APD tuber	TD sust.	APD beak	TD post.m in.
SMF-DD 1904	105.0	(39.4)	59.3	-	(64.6)	30.0
SMF-DD w/n	93.0	40.7	67.7	-	54.5	34.8
SMF-DD 5459	-	36.8	66.3	-	-	31.8
SMF-DD 1099	-	39.3	63.0	-	-	30.2
SMF-DD 5454	-	43.0	59.3	-	-	33.3
	105.0	44.0	57.3	68.6	60.2	32.8
La Roma 2	101.2	43.8	64.0	67.0	65.7	36.4
	105.5	45.0	66.0	-	63.7	35.2
Montredon*	95.0	42.0	61.2	-	58.0	36.0
Montredon **	(104.0)	39.5	55.0	(63.0)	(53.0)	(28.0)

Table 11. Comparative dimensions of the calcaneum of *A. alfambrense* from Dorn-Dürkheim 1, La Roma 2 (Spain) and Montredon (France).- * cf. *Prosantorhinus*, ** *A. simorreense* (after GUÉRIN, 1988).

small to middle sized bones. They are short with a narrow and anteriorly pointed tuber. DD 5606 (Pl. 2, Fig. 5) is shorter and has a more robust tuber than DD 1094. The antero-posterior diameter at the beak level is greater than at the tuber. The facet-1 forms a strong angle (S-shaped). There is no tibial facet. Facets-2 and 3 are poorly preserved but a connection area between them can be supposed. The distal articulation is slightly transversely concave, extended over a latero-distal tuberosity. The latter makes the distal border of the bone quite horizontal.

Among the proximal fragments, DD 5454 can be differentiated because of its greater development of the lateral rugosity that makes it larger than the other specimens (Table 11).

A nearly complete navicular is quite square in outline. The proximal articular surface is somewhat concave, becoming convex posteriorly. Medially, a narrow proximal articular band expands into a large posterior facet. The distal border of this face is open-V-

	TD	APD	Hmax.	Hmin.
SMF-DD 5468	35.8	>44.5	(21.6)	-
La Roma 2	41.4	51.0	27.0	17.7
Montredon*	44.0	62.0	25.0	-

Discussion:

As said before the ascription of some teeth to *A. alfambrense* is quite tentative, and does not deserve further comments. Postcranial skeletal similarities with the type material from La Roma 2 (Teruel, Spain) are evident, both morphologically and metrically, and this is also true with some acerathere remains from Montredon (France).

The size of the McIV exceeds that of the La Roma 2 specimen, but the difference is not very marked (Table 8).

The tibial fragment is similar in size to that from Montredon assigned to *A. simorrense* (GUÉRIN, 1988), with greater transversal diameters in the French specimen (Table 9) which is here considered as *A. alfambrense* as well.

The astragalus DD 1097 differs from La Roma 2 specimens (CERDEÑO & ALCALÁ, 1989) by the calcaneum-facet-1, the prolongation of which is narrower and shorter, and facets-2 and 3 are united. In any case the two astragali from La Roma 2 are also somewhat different from each other. The ratio DT x 100 / H varies among these specimens:

- SMF-DD 1097: 121.7
- La Roma 2: 108.3; 115.2

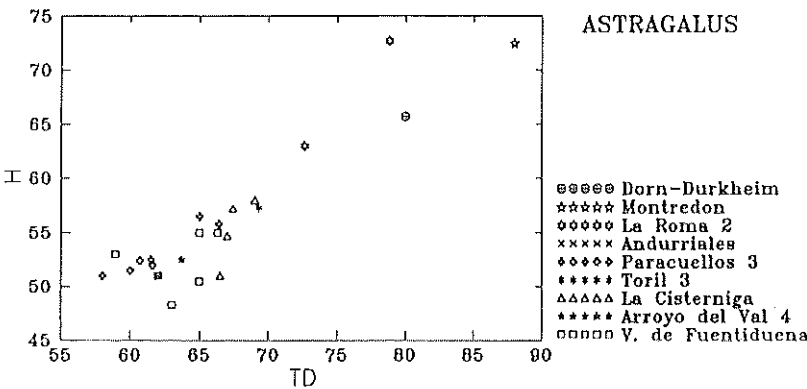
← Table 12. Comparative dimensions of the navicular of *A. alfambrense* from Dorn-Dürkheim 1, La Roma 2 (Spain) and Montredon (France).- * cf. *Prosantorhinus* (after GUÉRIN, 1988).

Tables 8-12 show the postcranial dimensions of *A. alfambrense* from Dorn-Dürkheim 1 compared with material from other localities.

The ratio of the astragalus from Montredon, classified as *Prosantorhinus* sp. (GUÉRIN, 1988), is very close to DD 1097 (121.3 vs. 121.7); it differs from the others by its greater transverse diameters (Table 10), mainly due to the medial development of the distal portion. It is tentatively included in *A. alfambrense*, keeping in mind the high variability within rhinoceroses. Its ascription to another species, however, is also difficult, because this would require the presence of a fourth rhinoceros species (represented by that bone) at Montredon, which seems improbable.

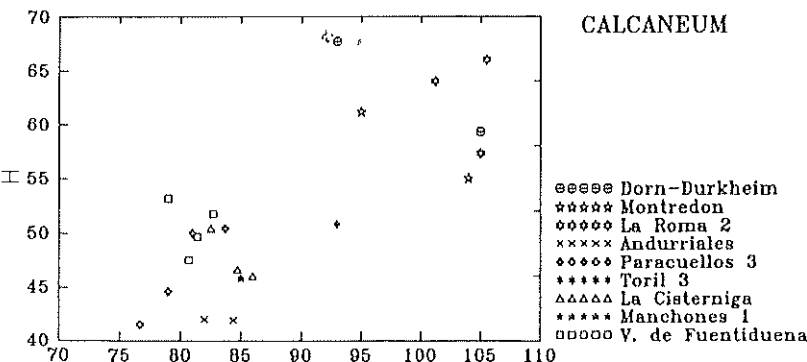
Another astragalus from Montredon ascribed to *A. simorrense* (GUÉRIN, 1988) is only a fragment which also can be considered as *A. alfambrense*. Comparative dimensions of these bones are in Table 10.

Two nearly complete calcanei from Dorn-Dürkheim 1 show differences between them as it is also the case at La Roma 2; these include the total height and the robustness of the tuber (Table 11). The calcaneum of *Prosantorhinus* sp. from Montredon (GUÉRIN, 1988) is absolutely comparable to these others, and the same can be stated for *A. simorrense* from this site.



ASTRAGALUS

Figure 1. Scatter diagram of the astragali of *A. alfambrense* (La Roma 2; Dorn-Dürkheim 1; Montredon) and *A. simorrense* from several Spanish localities.



CALCANEUM

Figure 2. Scatter diagram of the calcanei of *A. alfambrense* (La Roma 2; Dorn-Dürkheim 1; Montredon) and *A. simorrense* from several Spanish lo-

Figures 1 and 2 are scatter diagrams for the astragali and calcanei of *A. alfambrense* with respect to the related species *A. simorreense* from the Aragonian and Lower Vallesian Spanish localities. It is evident that the bones from Dorn-Dürkheim 1 and Montredon correspond closely with the type material of *A. alfambrense* from La Roma 2.

The navicular DD 5468 is much smaller than the Spanish ones from Concul and La Roma 2 of *A. incisivum*. It is closer to that from La Roma 2 (RO 80) ascribed to *A. alfambrense* (Table 12). This latter is also somewhat larger, and its lateral facet is shorter. DD 5468 is also smaller than that of cf. *Prosanctorhinus* from Montredon (France).

Genus *Aceratherium* KAUP 1832

***Aceratherium incisivum* KAUP 1832**

Plate 1, Figs. 5, 8; Plate 2, Figs. 6-8

The presence of a third rhinoceros species at Dorn-Dürkheim 1 is based on a few bones that clearly differ from those previously described. Some teeth can also be added to these postcranial elements, although separating them from those of *A. alfambrense* is rather difficult.

Material: right D⁴ fragment (SMF-DD 5460); right P¹ (SMF-DD 4051); right P² (SMF-DD 1104); right I₂ fragment (SMF-DD 325); right P₂ (SMF-DD 1110); right pyramidal (SMF-DD 5471); right trapezoid (SMF-DD 251); distal articulation of a lateral metapodial (SMF-DD 5458); right astragalus fragment (SMF-DD 318); left and right calcaneum fragments (SMF-DD 319, SMF-DD 1098); first central phalange (SMF-DD 1101); first lateral phalanges (SMF-DD 4451, 1092); second lateral phalange (SMF-DD 1093).

Description:

A.- Upper dentition.

The P¹ is clearly smaller than those ascribed to *L. schleiermacheri*. The ectoloph is less convex and shorter. A small postfossette is present. From the parastyle to the hypocone there is an open W-shaped and short cingulum. Secondary folds are well developed (a crista and two crochets), two of which reach the cingulum at their base. Increasing wear would result in the formation of several small fossettes.

The P² DD 1104 differs from those of the two other species mainly by its high labial cingulum. It is more trapezoidal in outline than DD 322, but the ectoloph is also quite regular with a smooth paracone fold. There seems to be a union of crista and crochet (the area is incomplete). The hypocone points lingually. The postfossette is deep and more rounded than in DD 324.

B.- Lower dentition.

DD 325 is a large I₂ crown fragment rather flattened antero-posteriorly (Pl. 1, Fig. 8), which can be assumed to belong to a male individual. It is ascribed to *A. incisivum* because the presence of large tusks (I₂) is well known in this species. However, the I₂s are also very well developed in *Alicornops simorreense*, and taking into account that *A. alfambrense* is very close to this species it can be assumed that this latter shows large I₂s as well. Remember that no dental remains had been previously ascribed to *A. alfambrense*.

Table 13 shows the comparative dimensions of the upper and lower premolars of *A. incisivum*.

DD 1110 is a rather worn P₂ which differs from DD 4767 of *A. alfambrense* in having a well developed labial cingulum, discontinuous at the protoconid base (Pl. 1, Fig. 5).

	p ¹		p ²		P ₂	
	L	W	L	W	L	W
SMF-DD 4051	23.0	21.2				
SMF-DD 1104			(37.4)	44.4		
SMF-DD 1110					31.4	21.7
M. Barbo					27.7	16.8
Montredon*	25.0	22.5	35.0	42.5	29.5	18.5
	25.0	22.0	35.5	42.5	30.0	18.5
					28.0	21.5
				33.0	21.5	

Table 13. Comparative dimensions of the dentition of *A. incisivum* from Dorn-Dürkheim 1, Masía del Barbo (Spain) and Montredon (France). * after GUÉRIN (1988).

C.- Postcranial skeleton.

The pyramidal (Pl. 2, Fig. 8) is a medium-sized bone with well developed antero-lateral and posterior tuberosities. The proximal facet is wide and slightly concave. The medial facets are well separated from each other, both semilunate in shape. The distal facet is short in antero-posterior diameter, being sub-trapezoidal in outline. The medial border of the anterior face

The trapezoid considered to be *A. incisivum* is shorter and wider than that of *A. alfambrense*, which is of similar size. The anterior face is higher laterally than medially due to the obliquity of the distal border; the proximal face is slightly convex.

The third type of rhinoceros astragalus found at

specimen and smaller than that of *L. schleiermachi*. It is fragmentary but displays a comparatively narrow trochlea and a wide but short distal complex. The medial tubercle is strongly antero-posteriorly developed. The lateral lip of the trochlea extends above the distal articulation. The distal facets form an undulating upper border. They are clearly separated by a crest only at their most proximal portion. The navicular-facet is slightly concave, and the cuboid-facet presents a lateral swelling. On the posterior face, the facet-1 is incomplete but shows a wide prolongation; the facet-2 is small, higher than wide and well separated from the short, fusiform facet-3 by a shallow but wide groove.

Discussion:

As stated before, distinction between the teeth ascribed to *A. alfambrense* and *A. incisivum* is rather difficult. Dimensionally, the P¹ is slightly smaller than that from Montredon, while the P² is larger. The P₂ fits well within the French sample and it is larger than the P₂ from Masía del Barbo (Table 13).

The pyramidal presents quite different dimensions with regard to the Montredon sample (Table 14), but this is surely due to the different way measurements are taken due to the irregular shape of the bone.

The trapezoid is similar to the Montredon specimens of *A. incisivum*, but relatively shorter (Table 14).

The astragalus DD 318 differs in morphology from HLD-DIN 1325 of Eppelsheim (Germany), as well as from the Concud specimen (Spain) (CERDEÑO, 1989). It resembles the astragalus from Can Llobateres (Spain) figured by SANTAFÉ (1978). The strong development of the medial tubercle is common to both specimens. On the other hand, the dimensions of DD

DD 319 and DD 1098 are two calcaneal proximal fragments with less robustness than that of *L. schleiermachi* and larger size than those of *A. alfambrense*. The tuber is relatively higher than in the latter. A tibial facet is present only in DD 1098.

The size of the lateral phalanges does not fit with that of the *L. schleiermachi* McII. Dimensions (Table 17) are, however, close to some specimens of this species from the Spanish sites of Puente Minero and El Arquillo (CERDEÑO, 1989: 340), although they are not so high. They are tentatively ascribed to *A. incisivum*.

Tables 14-17 give the dimensions of these post-cranial elements.

318 are close to those of *A. incisivum* from Eppelsheim, Concud and the largest specimens from the Vallés-Penedés basin (Can Ponsic and Can Llobateres; Spain) (Table 15).

Pyramidal	TD	APD	H	APDprox.
SMF-DD 5471	39.0	50.2	48.6	31.3
Montredon*	51.5	41.0	(48.0)	
	52.0	34.0	53.0	

Trapezoid	TD	APD	Hmax.	Hmin.
SMF-DD 251	28.7	33.5	30.2	21.1
Montredon*	28.0	38.0	34.0	
	26.5	36.0	30.0	

Table 14. Comparative dimensions of the carpal bones of *A. incisivum* from Dorn-Dürkheim I and Montredon (France).- * after GUÉRIN (1988).

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	TD	H	Tddist.max.	TD	APD	DL	APDi
SMF-DD 318	(91.2)	-	81.7	75.6	41.5	(58.5)	>57.0
Eppelsheim	87.9	78.5	80.1	77.8	45.1	59.0	55.0
Concud	82.7	76.0	78.9	71.0	(41.6)	59.0	(47.0)
Vallés-P.*	83.5	70.0	76.7	72.0	37.0	47.0	49.0
	77.0	70.0	68.0	66.0	37.0	46.0	49.0
	77.0	67.0	67.0	63.0	38.0	53.0	52.0
	77.0	67.0	71.0	66.0	37.0	46.0	46.0
	79.0	66.0	72.0	67.0	39.0	47.0	50.0
	77.0	63.0	70.0	66.0	37.0	46.0	48.0
	80.5	73.0	(73.0)	66.0	-	57.0	50.0

Table 15. Comparative dimensions of the astragalus of *A. incisivum* from Dorn-Dürkheim I and other European sites. * after SANTAFÉ (1978).

Table 16 provides the dimensions of the calcaneal fragments which appear to be quite similar to those of other European remains of *A. incisivum*, including material from the Vallés-Penedés basin described by

	H	TD	APD	Td sust.	APD beak	TD post. min.
SMF-DD 319	-	47.8	67.0	-	(58.5)	33.0
SMF-DD 1098	-	(47.0)	69.4	-	(62.5)	38.7
Montredon*	(112.0)	-	-	69.0	63.0	32.0
Vallés-P.**	98.0	39.0	63.0	-	-	32.0
	101.2	42.0	-	-	-	35.0
Vallés-P.***	94.2	41.8	54.3	65.6	56.3	35.1
	106.7	45.5	62.3	-	56.1	36.7
	109.2	47.8	62.1	76.2	60.8	38.4
	105.1	47.3	60.3	73.5	59.9	38.1
	103.2	46.3	67.0	72.0	57.1	35.0
	100.5	46.0	56.0	68.0	57.0	33.5

SANTAFÉ (1978) as *Aceratherium bi-tetradactylum-incisivum*, and considered as *A. incisivum* by GUÉRIN (1980).

← Table 16. Comparative dimensions of the calcaneum of *A. incisivum* from Dorn-Dürkheim 1, Montredon (France) and Vallés-Penedés basin (Spain).- * after GUÉRIN (1988); ** *A. incisivum* (after SANTAFÉ, 1978); *** *A. bi-tetradactylum-incisivum* (after SANTAFÉ (1978).

		TD	APD	H
1st central phalange	DD 1101	48.0	(36.0)	34.0
1st lateral phalange	DD 4451	40.0	37.1	31.5
		DD 1092	43.6	38.1

↑ Table 17. Dimensions of the phalanges of *A. incisivum* from Dorn-Dürkheim 1.

Conclusions

The investigation of rhinocerotid remains from Dorn-Dürkheim 1 reveals the presence of three different species at this site. They have been mainly identified by way of their postcranial skeletons, as dental remains (mainly lower teeth) are difficult to ascribe to species. Therefore some of them have been excluded from this descriptive study. These three species are *Lartetotherium schleiermacheri* and two aceratherines, *Alicornops alfambrense* and *Aceratherium incisivum*.

L. schleiermacheri from Dorn-Dürkheim 1 shows a close relationship with the Eppelsheim and the Spanish material of this species. The McII appears to be one of the largest and strongest specimens of *L. schleiermacheri*. The astragalus is proportionally closer to Eppelsheim and Montredon than to the Spanish specimens.

The recognition of *A. alfambrense* at Dorn-Dürkheim 1 is very interesting, taking into account the

STAGE	MN UNIT	LOCALITIES		
		GERMANY	SPAIN	FRANCE
TUROLIAN	MN 12		Concud	
	MN 11	Dorn-Dürkheim 1	Puente Minero, Crevillente 2	
VALLESIAN	MN 10		La Roma 2, M. del Barbo	Soblay, Montredon, Lyon-C.-Rousse
	MN 9	Höwenegg, Eppelsheim	Can Llobateres, Can Ponsic	St. J. Bournay

Figure 3. Biostratigraphic distribution of some European Upper Miocene localities with rhinoceros species.

scarce material assigned to this species which is still only partially known. As suggested before (CERDEÑO & ALCALÁ, 1989) some bones from the French site of Montredon (GUÉRIN, 1988) are definitely classified as

sibly all the elements described as *A. simorrense*, which are larger than the abundant material from the Aragonian and Lower Vallesian of Spain (Figs. 1, 2; CERDEÑO, 1989). The replacement of *A. simorrense* by *A. alfambrense* previously established in Spain, is now

probably originated from Lower Vallesian populations of *A. simorreense*. The presence of *A. alfambrense* at Dorn-Dürkheim 1 also extends the temporal distribution of this species from the Upper Vallesian to the Lower Turolian (Fig. 3). The third rhinoceros, *A. incisivum*, is represented by a few bones which are clearly different from the other two groups. The astragalus fragment presents, however, certain differences with respect to other homologous bones of *A. incisivum* from Germany and Spain, being closer in morphology to the

Spanish one from Can Llobateres (SANTAFÉ, 1978); metrically its transverse diameter is larger than all other compared astragali.

The rhinoceros association found at Dorn-Dürkheim 1 reflects a continuity from Upper Vallesian to Lower Turolian, implying a geographical and temporal extension of *A. alfambrense*. Both *A. incisivum* and *L. schleiermacheri* have been frequently recorded from Vallesian and Turolian sites of Western Europe.

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PLATE 1

- Fig. 1. *Lartetotherium schleiermacheri*.- Right P² (SMF-DD 324), occlusal view.
- Fig. 2. *Alicornops alfambrense*.- Right P² (SMF-DD 322), occlusal view.
- Fig. 3. *Lartetotherium schleiermacheri*.- Right P₂ (SMF-DD 321), occlusal view.
- Fig. 4. *Alicornops alfambrense*.- Right P₂ (SMF-DD 4767), occlusal view.
- Fig. 5. *Aceratherium incisivum*.- Right P₂ (SMF-DD 1110), occlusal view.
- Fig. 6. *Alicornops alfambrense*.- Left P₃ + P₄ (SMF-DD 1108 + 4075), labial view (same individual).
- Fig. 7. *Alicornops alfambrense*.- Left P₃ + P₄ (SMF-DD 1108 + 4075), occlusal view (same individual).
- Fig. 8. *Aceratherium incisivum*.- Right I₂ fragment (SMF-DD 325), labial view.
- Fig. 9. *Lartetotherium schleiermacheri*.- Right McII (SMF-DD 5451), anterior view.
- Fig. 10. *Alicornops alfambrense*.- Right McIV fragment (SMF-DD 5466), lateral view.
- Fig. 11. *Alicornops alfambrense*.- Right McIV fragment (SMF-DD 5466), medial view.

All specimens coated with Ammoniumchloride (NH₄Cl); all photos by Forschungsinstitut Senckenberg, Elke Pantak-Wein.

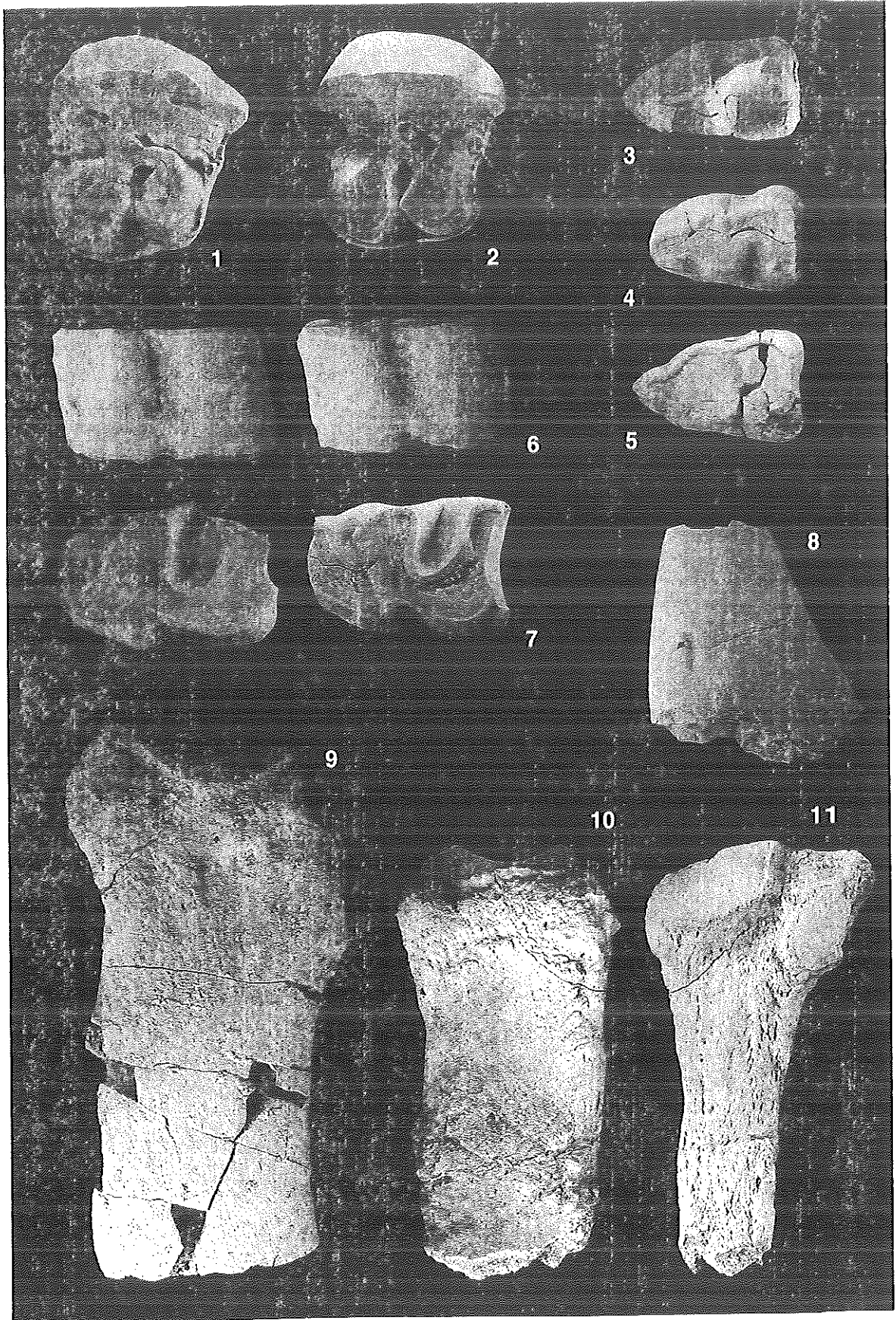


PLATE 2

- Fig. 1. *Lartetotherium schleiermacheri*. - Right astragalus (SMF-DD 1089), posterior view.
- Fig. 2. *Lartetotherium schleiermacheri*. - Right astragalus (HLD-DIN 1922), posterior view. Eppelsheim.
- Fig. 3. *Alicornops alfambrense*. - Right astragalus (SMF-DD 1097), anterior view.
- Fig. 4. *Alicornops alfambrense*. - Right astragalus (SMF-DD 1097), posterior view.
- Fig. 5. *Alicornops alfambrense*. - Right calcaneum (SMF-DD 5606), lateral view.
- Fig. 6. *Aceratherium incisivum*. - Right astragalus (HLD-DIN 1325), anterior view. Eppelsheim.
- Fig. 7. *Aceratherium incisivum*. - Left astragalus (SMF-DD 318), anterior view.
- Fig. 8. *Aceratherium incisivum*. - Right pyramidal (SMF-DD 5471), medial view.

All specimens coated with Ammoniumchloride (NH_4Cl); all photos by Forschungsinstitut Senckenberg, Elke Pantak-Wein.

