

New data on carnivores from the Middle Miocene (Upper Aragonian, MN 6) of Arroyo del Val area (Villafeliche, Zaragoza Province, Spain)

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ABSTRACT

Several new fossil remains of Carnivora from the aragonian (MN 6, local zone G2) localities of Arroyo del Val and La Barranca (near the village of Villafeliche, Zaragoza province) are studied in the present paper. These fossil sites are very closely located, and probably belonging to the same level. The faunal list of Carnivora of both sites includes the following taxa: *Hemicyon* sp. aff. *H. sansaniensis*, *Plithocyon armagnacensis*, *Amphicyon giganteus*, *Plioviverrops* sp., *Martes* sp., *Pseudaelurus lorteti*, *Pseudaelurus quadridentatus*, and *Protictitherium* sp. aff. *P. crassum*.

Key words: Carnivora, La Barranca, Arroyo del Val, Aragonian.

RESUMEN

En el presente trabajo se estudian los restos fósiles de Carnivora procedentes de los yacimientos aragoneses (MN 6, Zona local G2) de Arroyo del Val y La Barranca, ambas situadas en las proximidades de Villafeliche (Zaragoza). Estos yacimientos se encuentran situados muy cerca uno del otro, y es más que probable que se correspondan con los mismos niveles. La lista faunística de carnívoros está compuesta de los siguientes taxa: *Hemicyon* sp. aff. *H. sansaniensis*, *Plithocyon armagnacensis*, *Amphicyon giganteus*, *Plioviverrops* sp., *Martes* sp., *Pseudaelurus lorteti*, *Pseudaelurus quadridentatus* y *Protictitherium* sp. aff. *P. crassum*.

Palabras clave: Carnivora, La Barranca, Arroyo del Val, Aragoniense.

Introduction

The localities of Arroyo del Val and La Barranca, placed in the same geological levels and separated by no more than 100 m, are located within the fossiliferous area of Arroyo del Val, near the villages of Villafeliche and Daroca (province of Zaragoza, Spain) (fig. 1). This zone is known since 1980 for its remarkable richness in mammal fossil sites, aging from the Aragonian to the early Vallesian. The two mentioned localities yielded a nice sample of fossil carnivores, but it has been never deeply studied. Both sites has been dated as Middle Aragonian, local zone G2 of Daams & Freudenthal (1988), MN 6 of Mein (1975) (Bruijn *et al.*, 1992; Azanza, 2000) and are located in a wider area formed as shallow

channel deposits corresponding to the proximal or middle area of an alluvial fan (Olmo *et al.*, 1986).

Material and methods

All the material from La Barranca and Arroyo del Val is currently in the Departamento de Paleobiología of the Museo Nacional de Ciencias Naturales-CSIC (Madrid).

Abbreviations

AV and AR, material from Arroyo del Val, stored at the MNCN during the study; LB, material from La Barranca stored at the MNCN during the study; MNCN, Museo Nacional de Ciencias Naturales-CSIC; MNHN, Muséum nationale d'Histoire naturelle, Paris; UZ, Universidad de Zaragoza.

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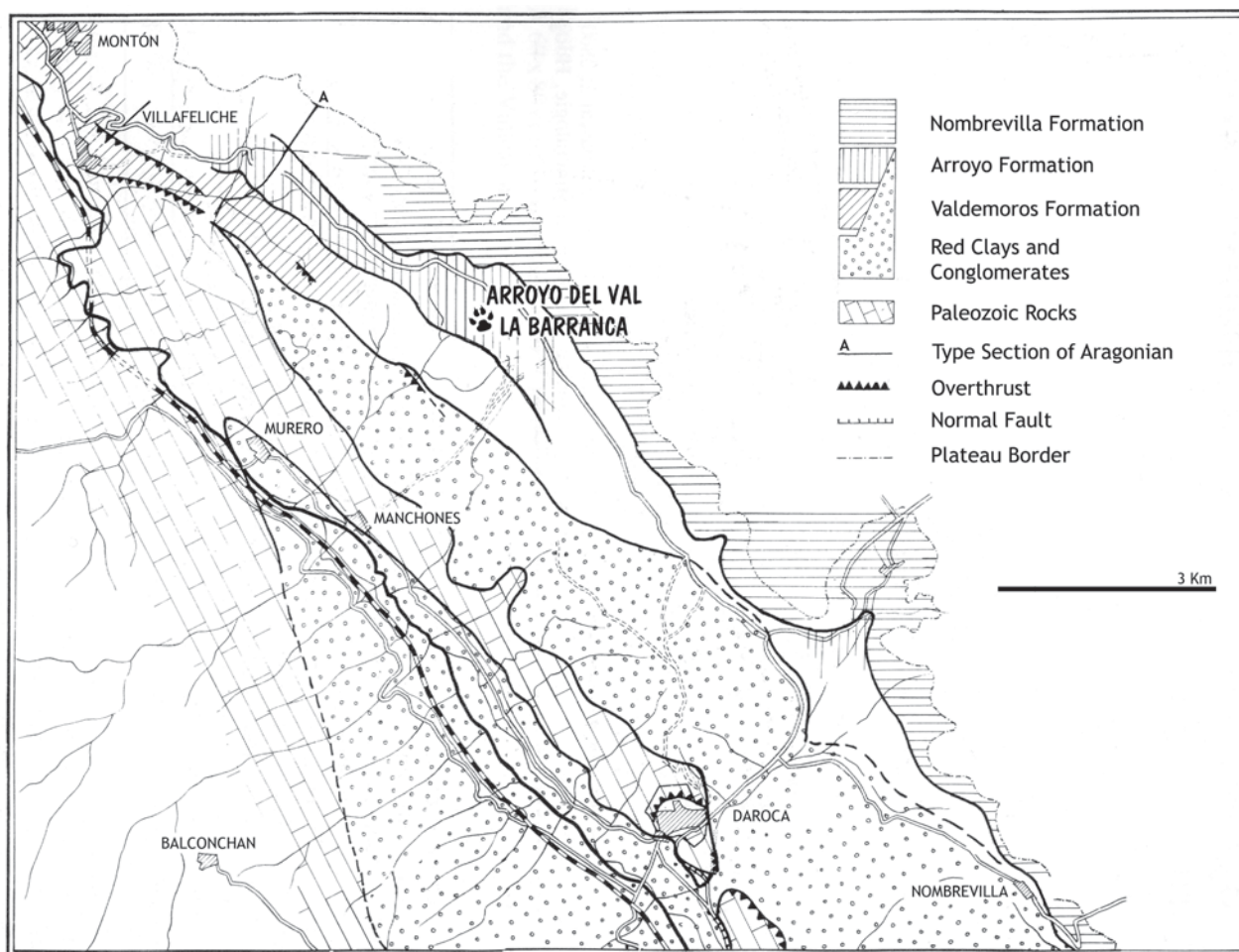


Fig. 1.—Geological map of the Villafeliche-Daroca area showing the localization of the fossil sites Arroyo del Val and La Barranca (modified from Daams & Freudenthal, 1988).

Systematic paleontology

Order Carnivora Bodwich, 1821
 Superfamily Arctoidea Flower, 1869
 Family Ursidae Fischer, 1817
 Subfamily Phoberocyoninae Ginsburg & Morales, 1995
 Genus *Plithocyon* Ginsburg, 1955
Plithocyon armagnacensis Ginsburg, 1955
 1998 - *Plithocyon armagnacensis*. Ginsburg & Morales, p. 79, fig. 8.

Material

Arroyo del Val
 AV-500 (fragment of left hemimandible with p4-m2; figured in Ginsburg & Morales, 1998, fig. 8), AV-501

(subcomplete right hemimandible with c, p2-m2) (figs. 2 and 3). These specimens probably belong to the same individual.

Description

The mandibular corpus is tall, especially posteriorly, but it is relatively thin. The premasseteric fossa is large, deep and anteroposteriorly elongated; its anterior border reaches the level of the distal border of the m1. The masseteric fossa is larger. The two fossae are clearly separated. The angular process is short and mediolaterally compressed; its tip is oriented dorsomedially and develops a smooth medial concavity; its lateral surface is rough. The condyle and coronoid processes are mostly broken. At least three mental foramina are present, the largest one

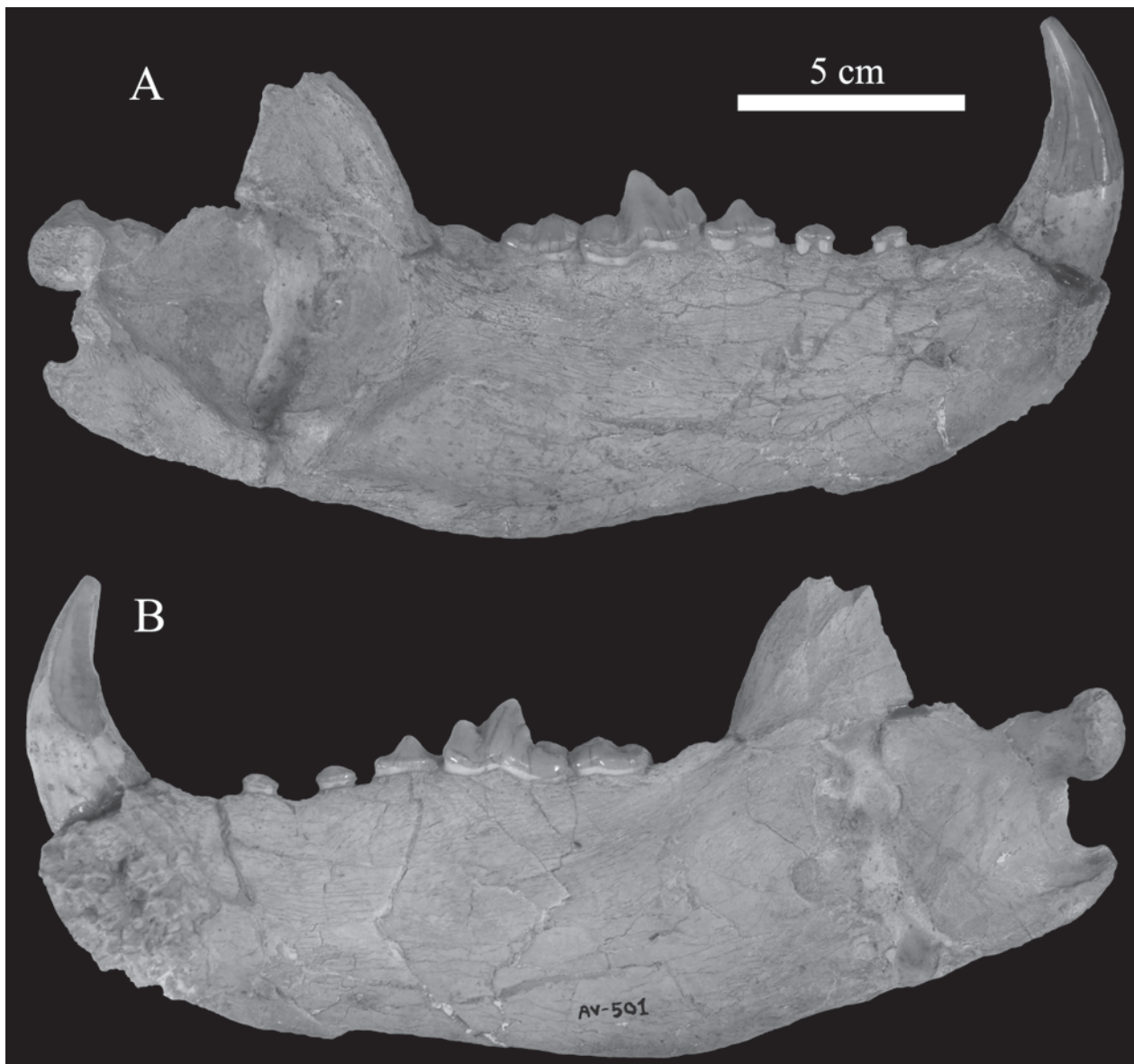


Fig. 2.—AV-501, subcomplete right hemimandible with c, p2-m2 of *Plithocyon armagnacensis* from Arroyo del Val (Zaragoza): A, lateral view; B, medial view.

being below the postcanine diastema. The mandibular symphysis is softly curved upwards, its medial surface being very rough (fig. 2).

The canine is large and slightly transversely compressed. The p1 is absent. The p2 and p3 are double-rooted, their crown being very small, elongated and low; p3 is slightly larger than p2, its mesial, distal, and distolingual faces being slightly ridged. The p4 is much larger than p3 and it is triangle shaped in occlusal view. There are no accessory cusps; as on p3 there are mesial, distal and distolingual ridges. The lingual cingulum is moderately developed along its

mesial half but marked along the distal one. The main cuspid is lower than the paraconid of m1. The carnassial is slender; the protoconid is much taller than the paraconid; the carnassial notch is shallow. The metaconid is reduced and applied against the distolingual face of the protoconid. The talonid is about the width of the trigonid; the hypoconid is slightly displaced labially. On the lingual crest, only a small entoconid is visible and very closely located to the metaconid. The m2 is narrower than m1; the protoconid and metaconid are poorly preserved but the latter is probably more reduced than the former; the metaconid and

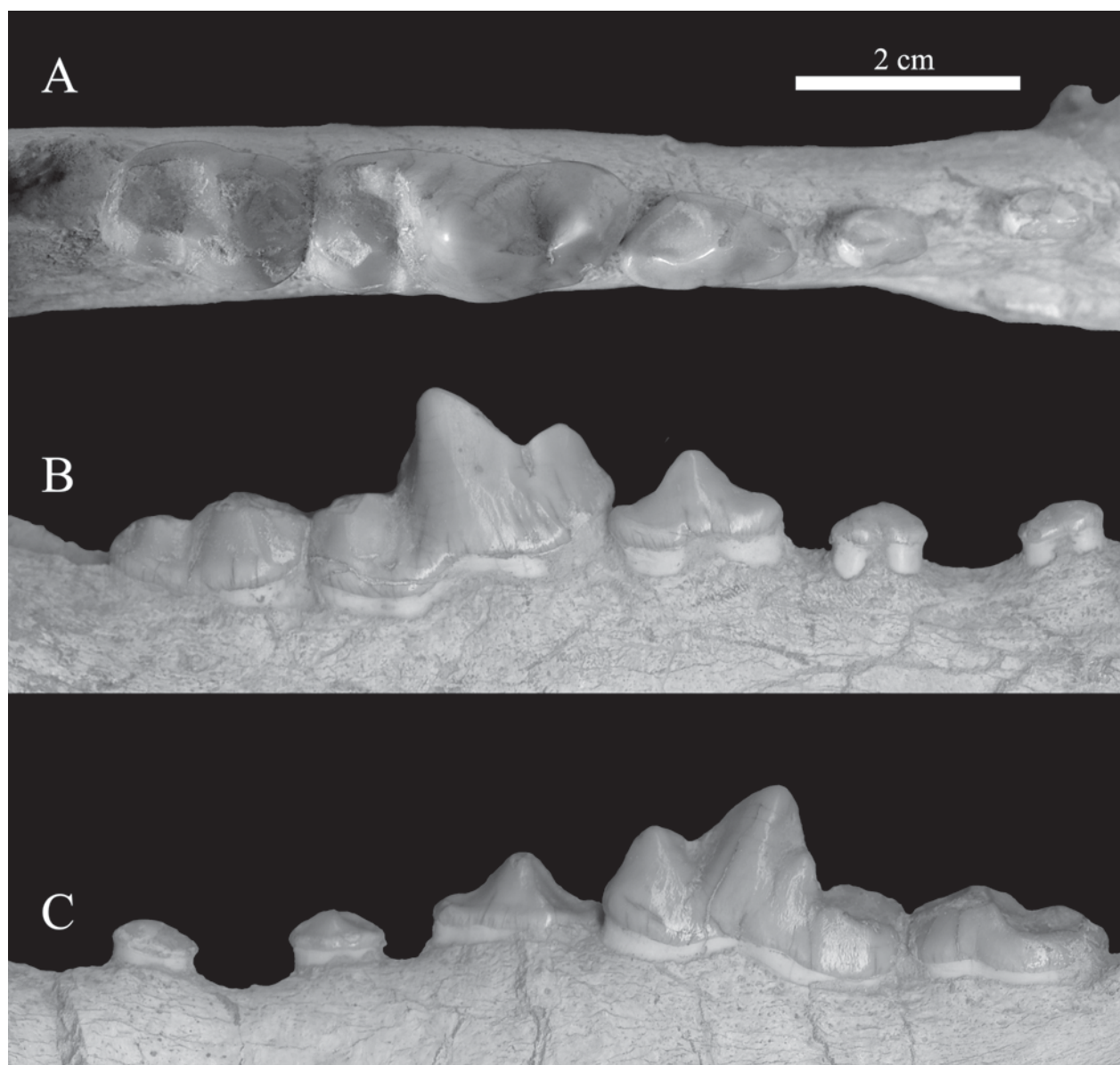


Fig. 3.—AV-501, detail of the dentition: A, occlusal view; B, labial view; C, lingual view.

protoconid mesial crest are roughly parallel; there is a visible crest on the distal face of the protoconid; the paraconid is a low transversal crest that occupies the mesial rim. The talonid slightly curves distolabially; the hypoconid is small and located labially; there is no distinct cuspid on the lingual crest (fig. 3).

Discussion

The fragmentary mandible AV-500 has been figured by Ginsburg & Morales (1998, fig. 8) and

assigned to *Plithocyon armagnacensis*. The subcomplete mandible AV-501 comes from the same locality and displays a wearing pattern, a morphology and measurements that are similar to AV-500, which suggests these specimens probably belong to the same individual. *Plithocyon armagnacensis* is not a common species in the fauna communities of the Middle Miocene, the sample from Sansan being the most complete (Ginsburg & Morales, 1998). The most striking difference between the material from Arroyo del Val and that from Sansan is the height of the mandibular corpus, which is much greater (especially

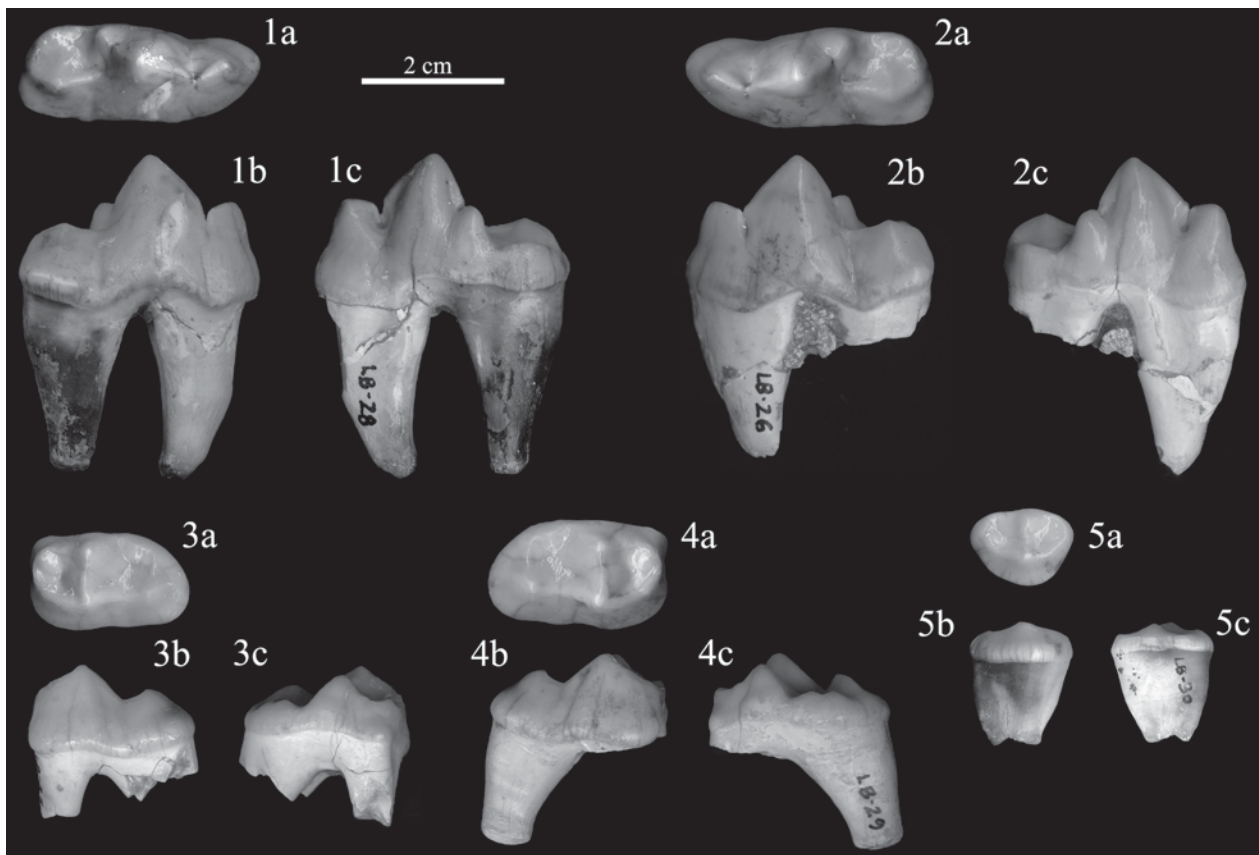


Plate 1.—Dentition of *Hemicyon* sp. aff. *H. sansaniensis* from La Barranca (Zaragoza). Fig. 1.—LB-28, right m1: a, occlusal view; b, labial view; c, lingual view. Fig. 2.—LB-26, left m1: a, occlusal view; b, labial view; c, lingual view. Fig. 3.—LB-27, left m2: a, occlusal view; b, labial view; c, lingual view. Fig. 4.—LB-29, right m2: a, occlusal view; b, labial view; c, lingual view. Fig. 5.—LB-30, right m3: a, occlusal view; b, labial view; c, lingual view.

posteriorly) in the Spanish specimens. Otherwise, the individual from Arroyo del Val differs from the type material mainly by the absence of p1 and the vestigial entoconulid on m1 (fig. 3). The differences between our material and the type sample from Sansan are probably not significant enough to indicate a specific distinction. Then the material from Arroyo del Val illustrates how great can the individual variation of the mandibular height be in this hemicyonine.

Subfamily Hemicyoninae Frick, 1926

Genus *Hemicyon* Lartet, 1851

Hemicyon sp. aff. *H. sansaniensis* Lartet, 1851

Material

La Barranca

Several lower teeth probably belonging to the same individual: right m1, m2 and m3 (LB-28, LB-29

and LB-30, respectively) and left m1 and m2 (LB-26 and LB-27) (Plate 1).

Description

The m1 (Plate 1, fig. 1 and 2) is mesiodistally elongated, with the mesial border pointed and lingually curved; there is no cingulum. LB-28 is complete, whereas LB-26 has the distal root broken; both roots, of similar size, are straight and slightly laterally compressed. In occlusal view the crown is elongated. The paraconid is much lower and shorter than the protoconid, and has its mesial border very inclined backwards. The protoconid is tall and is separated from the paraconid by a well-developed notch, which is more evident in lingual view. The metaconid is lower than the paraconid; it is placed on the distolingual face of the protoconid. The talonid is long and its distolabial corner is more distally projected than the distolingual one. The hypoconid is

low and has ridged mesial and distal faces. There is no hypoconulid. The lingual border of the talonid shows a ridged entoconid, which is clearly separated from the metaconid by a wide notch; it is slightly distal relatively to the hypoconid. The talonid basin is wide, with a shallow talonid groove. The m2 (Plate 1, figs. 3 and 4) is robust and slightly wider than m1; the mesial root has a mesiodistally compressed, whereas the distal one is laterally compressed. There is no cingulum. The paraconid is poorly prominent, crest-like, and occupies the mesiolingual corner. It is connected to metaconid and protoconid by two well-developed ridges. The protoconid is tall and triangle shaped; it is situated at the same level of metaconid, which is more reduced; a central notch separates the two cuspids. The trigonid basin is extended. The talonid is slightly shorter than the trigonid, it has a distal border slightly labially curved and distolabially projected. The entoconid and entoconulid are small and separated by a shallow groove. The hypoconid is much taller; there is no hypoconulid; the crest that closes the talonid distally is vestigial. The m3 (Plate 1, fig. 5) has two nearly completely fused roots. The crown is very low, with an inflated labial border. On the trigonid, only the protoconid and the metaconid are visible, the former being larger. The talonid displays a vestigial hypoconid.

Comparisons and discussion

Four species of *Hemicyon* are known from the Middle Miocene of Europe (Ginsburg & Morales, 1998; Astibia *et al.*, 2000): *H. mayoralii* (MN 4-5), *H. stehlini* (MN 4-5), *H. sansaniensis* (MN 5-6), and *H. goeriachensis* (MN 6-8). The material from La Barranca differs from *H. stehlini* in being larger and in having a much shorter talonid with more reduced cuspids on m1; from *H. goeriachensis* in having a less developed entoconid and entoconulid on m1 and a metaconid lower than the protoconid on m2. La Barranca material is about the size of *H. mayoralii* and *H. sansaniensis*. The distinction between these species is mainly based on the upper dentition (see Astibia *et al.*, 2000). A comparison with the lower dentition of *H. mayoralii* from Torrijos and of *H. sansaniensis* from Sansan does not allow us to assign the material from La Barranca to either of these species. The m2s from the latter locality are morphologically close to that of *H. mayoralii* in having a distally opened talonid; however, the metaconid is more reduced, the lingual crest of the talonid is mesiodis-

tally shorter and the trigonid basin is narrower in LB-27 and LB-29 than on the single known m2 assigned to *H. mayoralii*. Except for a distally opened talonid, the m2s from La Barranca are similar to those of *H. sansaniensis*. The lower carnassials from La Barranca are hardly distinguishable from those of *H. mayoralii* and *H. sansaniensis*. Nevertheless, it must be noticed that one of the m1s from Torrijos (UZ T2-101) assigned to *H. mayoralii* (Astibia *et al.*, 2000) is markedly different from La Barranca material in being much smaller and more slender and in having a distally widened talonid and a constriction across the trigonid/talonid boundary. Therefore, the observed differences support an assignment of La Barranca material to a form close to *Hemicyon sansaniensis* but differing by some details on the m2 talonid.

Family Amphicyonidae Haeckel, 1866

Subfamily Amphicyoninae Haeckel, 1866

Genus *Amphicyon* Lartet, 1836

Amphicyon giganteus (Schinz, 1825)

Material

La Barranca

Specimens mainly consist of isolated teeth (Plate 2, figs. 1-11 and 13-15). From the size it is possible to distinguish two individuals. The first one is represented by: LB-4 (right I1), LB-5 (right I2), LB-7 (right I3), LB-2 (right C), LB-9 (right P1), LB-10 (right P2), LB-11 (fragment of right maxillae with P3), LB-12 (right P4), LB-13 (small fragment of maxillae with right M1), LB-14 (right M2), LB-3 (left I1), LB-6 (left I2), LB-8 (left I3), LB-1 (left C), LB-15 (small fragment of maxillae with left P4), LB-16 (left M1), LB-17 (left M2) most probably belonging to the same individual. The second individual consists of LB-25 (left C), LB-21 (small fragment of maxillae with left P4), LB-24 (left M1), LB-22 (right M1), LB-23 (subcomplete right M2). The specimens LB-18 (right M3), LB-19 (fragment of maxillae with left M3), and LB-20 (right m3) may belong to either of these individuals.

Arroyo del Val

AR-001 (subcomplete left P4) (Plate 2, fig. 12).

Description

Incisors are caniniforms, especially I3, and lack accessory cusps. The I1 and I2 are transversal

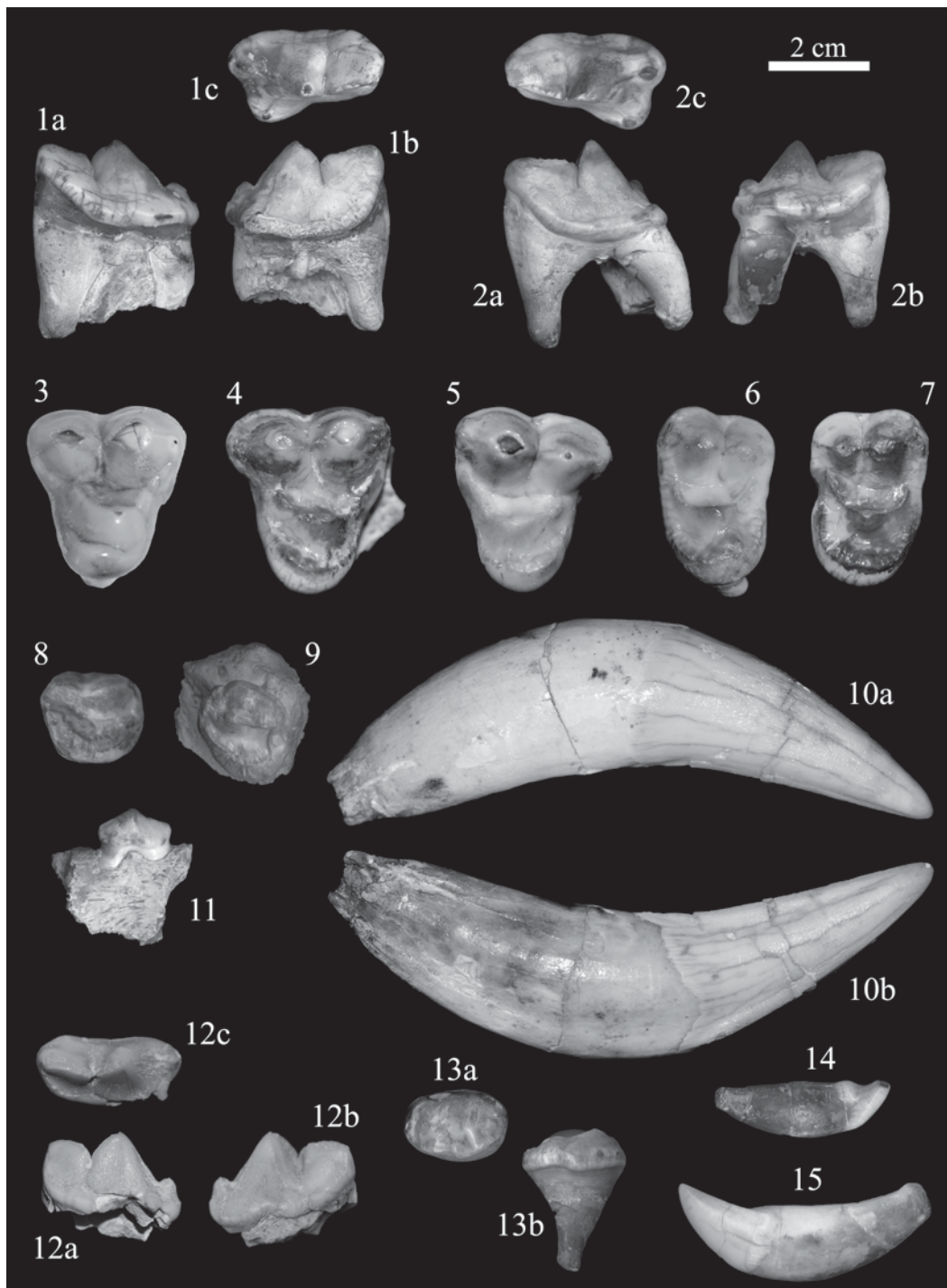


Plate 2.—Dentition of *Amphicyon giganteus* from La Barranca and Arroyo del Val (Zaragoza). Fig. 1.—LB-15, left P4 from La Barranca: a, labial view; b, lingual view; c, occlusal view. Fig. 2.—LB-12, right P4 from La Barranca: a, lingual view; b, labial view; c, occlusal view. Fig. 3.—LB-22, right M1 from La Barranca, occlusal view. Fig. 4.—LB-13, right M1 from La Barranca, occlusal view. Fig. 5.—LB-16, left M1 from La Barranca, occlusal view. Fig. 6.—LB-17, left M2 from La Barranca, occlusal view. Fig. 7.—LB-14, right M2 from La Barranca, occlusal view. Fig. 8.—LB-18, right M3 from La Barranca, occlusal view. Fig. 9.—LB-19, fragment of maxillae with left M3 from La Barranca, occlusal view. Fig. 10.—LB-2, right upper canine from La Barranca: a, labial view; b, lingual view. Fig. 11.—LB-11, fragment of maxillae with right P3 from La Barranca, labial view. Fig. 12.—AR-001, right P4 from Arroyo del Val: a, lingual view; b, labial view; c, occlusal view. Fig. 13.—LB-20, right m3 from La Barranca: a, occlusal view; b, labial view. Fig. 14.—LB-6, left I2 from La Barranca, labial view. Fig. 15.—LB-7, right I3 from La Barranca, labial view.

compressed and have an elongated, roughly rectilinear root more than twice the height of the crown. The I1 crown is symmetrical and has a well-curved labial face and strongly concave lingual face. The I2 is morphologically very similar to I1, being slightly larger and more asymmetrical. Compared to these teeth, I3 is an extremely larger, more caniniform and asymmetrical tooth, with a flattened mesial face and a relatively oblique distal face. Also, I3 has a well-curved lingual face and a distal face marked by a prominent rectilinear crest. The canine crown is strong and short; it displays a plissed enamel and two crests, a distal one and a particularly prominent mesiolingual one. In lateral view, the distal rim of the crown is mostly rectilinear yet slightly curved in the basal part near the enamel-dentine junction. The canine root is longer than the crown and particularly inflated. The P1-P3 are unworn and preserve well-trenchant mesial and distal ridges on their main and single cusp. The P1 is a small, slightly asymmetrical tooth with two fused roots and a sharp single cusp. The P2 is only slightly longer than P1 but of about the same height; the crown is symmetrical in labial view and the maximum width is across the main cusp. The P3 is associated with a fragment of maxillae which documents diastemata of ca. 6 mm length between P3 and P2, and ca. 3 mm length between P3 and P4. The P3 is distinctly larger and has a main cusp with a more concave distal rim than P2. A poorly developed basal bulge is present distolingually on the crown, across which the tooth has its maximum width. The carnassial is a large and basally wide tooth. There are marked differences between the carnassials of the two individuals from La Barranca but such a morphological variability is rather common in Amphicyonidae. Thus, on LB-12 and LB-15, P4 has a well-developed, trenchant parastyle and a reduced protocone that is composed of a tiny cusp distally shifted relatively to the parastyle. The second individual, which is represented by LB-21, has no parastyle and a mesially less inflated and more distally located protocone. The paracone is only slightly taller than the metastyle. The lingual face of the paracone and metastyle is vertical while the labial face is relatively inflated. Both are separated by a shallow notch about a quarter of the crown height. On LB-21, the cingulum is distinct only on the lingual face; it is even less marked and solely on the lingual face of the metastyle on LB-12 and LB-15. A fragment of right P4 from Arroyo del Val (AR-001) is also referred to this species. The

specimen does not preserve the protocone. This tooth is most similar to LB-12 and LB-15 but it is markedly smaller in size (see Table) and its parastyle is more prominent. The M1 is a large tooth, forming roughly an isosceles triangle. LB-13 and LB-16, which are poorly worn, have a paracone much taller than the metacone and having more steepened labial and lingual faces. The mesial and distal borders of the labial cusps are ridged, especially the mesial border of the paracone. In LB-13 and LB-16, the metacone is distally more extended than in LB-22 and LB-24, which results in a more concave distal face of M1 in the formers. The pre- and postprotocristae are low and the protocone is poorly prominent and slightly mesially located. The conules are poorly and unequally developed in a same individual. Thus LB-24 has a small metaconule but no paraconule while LB-22 has a small paraconule but no evidence of a metaconule. Only the metaconule is distinct, although it is poorly developed, on LB-13 and LB-16. All specimens display a gently curved postprotocrista; the trigon cristae form a right angle. The lingual cingulum is poorly developed and located in the distolingual corner of M1. It is bounded mesially by a low transversal crest in one individual (LB-13 and LB-16) but not in the other one (LB-22 and LB-24). The labial face displays a gentle curvature, which is interrupted by a shallow concavity labially to the notch separating the paracone and metacone. The M2 is large and rectangular in shape; it is the most transversely elongated in LB-14 and LB-17 where it nearly reaches the transverse width of M1. Cusps are much lower and the difference of size between the paracone and metacone is less pronounced than on M1. The pre- and postprotocristae are well developed and form a right angle; the preprotocrista is regularly curved. The protocone is prominent and located in a more central position than on M1. There are no distinct conules except a tiny metaconule on LB-23. The lingual cingulum is more developed than on M1, being roughly mesially and distally similarly extended. A transverse crest is present lingually and slightly distally to the protocone, separating the lingual and mesial portion of the cingulum from the distal one. The enamel on the border of the lingual cingulum is markedly plissed in LB-14 and LB-17. Like on M1, the labial face is convex except across the notch between the metacone and paracone. The mesial and lingual faces are gently convex and the distal face is rectilinear to slightly concave, especially on LB-14. The

Table 1.—Measurements in mm of the dentition of the fossil Carnivora from La Barranca and Arroyo del Val (Zaragoza)

Number	Piece	L	B	H	TrigL	IL	Species
LB-34	p2	5.3	2.3	3.3			<i>Plioviverrops</i> sp.
	p3	7.3	2.8	3.8			
	p4	8.5	3.7	—			
LB-35	p4	4.2	1.9	2.8			<i>Martes</i> sp.
	m1	6.0	2.3	—	4.2		
LB-33	P4	16.2	—	8.0			<i>Pseudaelurus lorteti</i>
LB-32	P4	—	—	8.0			<i>Pseudaelurus lorteti</i>
LB-31	m1	—	6.8				<i>Pseudaelurus quadridentatus</i>
AV-502	p2	6.7	2.8	3.8			<i>Protictitherium</i> sp. aff. <i>P. crassum</i>
	p3	9.1	3.5	—			
	p4	9.4	4.3	—			L p1-m2: 45
	m1	11.9	5.5	6.6	8.9		
LB-28	m1	36.4	15.7	20.1	27.2		<i>Hemicyon</i> sp. aff. <i>H. sansaniensis</i>
LB-26	m1	35.8	15.2	19.5	27.4		
LB-29	m2	24.4	15.9	12.7			
LB-27	m2	24.4	15.5	12.8			
LB-30	m3	14.7	11.2	6.5			
AV-501	c	20.6	15.0	—			<i>Plithocyon armagnacensis</i>
	p2	8.0	4.7	—			
	p3	9.0	5.4	—			L p2-m3: 102.3 Hmd p4-m1: 60 Tmd m1: 16.4
	p4	16.0	8.8	8.5			
	m1	29.0	13.1	16.7	20.5		
	m2	18.4	12.2	—			
AR-001	P4	29.4	—	16.0			<i>Amphicyon giganteus</i>
LB-3	left I1	8.5	5	—			<i>Amphicyon giganteus</i>
LB-4	right I1	9	6	—			
LB-6	left I2	10.0	6.2	—			
LB-5	right I2	10.3	6	—			
LB-8	left I3	15.1	11.7	24.3			
LB-7	right I3	15.3	11.6	24.3			
LB-1	left C	29.0	20.3	55.0			
LB-25	left C	27.0	18.7	—			
LB-2	right C	29.6	21.5	53.0			
LB-9	right P1	9.2	5.2	6.7			
LB-10	right P2	12.2	6.9	6.8			
LB-11	right P3	14.3	8.4	7.2			
LB-15	left P4	33.2	19.2	19.2		31.8	
LB-12	right P4	33.4	19.4	19.7		32.4	
LB-21	left P4	32.4	18.4	—		29.3	
LB-16	left M1	30.4	36.6	—			
LB-13	right M1	30.5	37.0	—			
LB-24	left M1	29.0	33.4	—			
LB-22	right M1	30.4	35.7	—			
LB-14	right M2	23.1	35.7	—			
LB-23	right M2	31.4	—	—			
LB-17	left M2	23.7	36.0	—			
LB-19	left M3	18.6	20.6	—			
LB-18	right M3	21.0	18.7	—			
LB-20	right m3	21.3	15.9	—			

L, mesiodistal length; B, labiolingual breadth; H, height; TrigL, length of the trigonid; IL, internal length; L p2-m3, length of the dental series from p2 to m3; Hmd p4-m1, mandibular height at the level of p4-m1 contact; Tmd m1, mandibular thickness at the level of m1; Approximate measurements are in italics.

two M3 described here display a markedly different morphology and may belong to two different individuals. Both are large but single-rooted. LB-19 is a fragment of left maxillae with M3; the tooth is roughly rounded, being slightly wider than long, however. The labial part consists of a low longitudinal crest on which the paracone and metacone are distinct, the former being taller than the latter. The labial cingulum is developed. Lingually to the paracone-metacone crest, a shallow basin is present, bounded lingually by a prominent curved crest. The lingual face of the tooth is inflated. LB-18 has a similar morphology. However, it is larger, longer than wide and it has a narrower labial cingulum than in LB-19.

The lower dentition is represented by a right m3 (LB-20), which is single-rooted and somewhat elongated. The crown is low and consists mainly of a pyramidal protoconid, from which extend some crests. The lingual crest is the most prominent one and reaches a tiny metaconid. The mesial crest reaches the paraconid, which is vestigial and reduced to a low crest at the mesialmost border of the tooth. The distal crest of the protoconid is less distinct than others. The talonid is short and slightly tapers distally. Its surface is irregular but roughly flat, displaying only a low labial hypoconid ridge.

Comparisons and discussion

The wide morphological variation between the individuals from La Barranca is also well documented within amphicyonids such as *Amphicyon major* from Sansan (Ginsburg, 1961). The canine morphology (transverse compression, presence of strong crests), the inflated teeth, the enlargement of molars, especially of M2 that nearly reach the width of M1, and the large flattened M3 observed in La Barranca material are diagnostic for the genus *Amphicyon*. Our material well compares with the two major, widely recognized European species known from the Middle Miocene, *A. major* (MN 4-8) and *A. giganteus* (MN 4-5) (Ginsburg, 1999). The record of the latter species from Henares-1 (Fraile *et al.*, 1997) is not confirmed here after re-examination of the material; therefore, *A. giganteus* is not recorded from post-MN 5 strata so far. The best sample of *A. major* is known from Sansan (MN 6), which composes here our major comparative database for this species. The material from this

locality is very useful in illustrating the complete dental, cranial, and postcranial anatomy and the morphological and biometrical intraspecific variation of an amphicyonine. The material assigned to *A. giganteus* consists mainly of isolated teeth; therefore, some proportional and morphological features are as well known as in *A. major*. The studied upper dentition of *A. giganteus* includes specimens from French localities (e.g., Avaray, Tavers, Pontigné, Noyant, Chilleurs).

Given the great morphological similarity of the incisors, upper canines and anterior premolars (P1-P3) of *A. major* and *A. giganteus*, these teeth cannot help us to assign the material from La Barranca. In this respect the morphology of P4 is much more useful. As pointed out in the description, the sample from La Barranca shows a great morphological variation for that tooth (Plate 2, figs. 1 and 2); thus the parastyle is well developed in one individual but completely absent in the other, the protocone is reduced and distally located in both individuals but its mesial border is more inflated in the individual represented by LB-12 and LB-15. On the P4 from Arroyo del Val, the parastyle is relatively larger than in LB-12 and LB-15 whereas the protocone was similarly located. Despite a somewhat great degree of variation, in the sample of P4s of *A. major* from Sansan, the protocone is always mesially placed, with its mesial border at the same level than the mesial border of the paracone; in addition, only one individual (MNHN-Sa 2) from Sansan displays a small parastyle, the cusp being replaced in all other specimens by a more or less prominent ridge. In the studied sample of *A. giganteus*, upper carnassials generally possess a parastyle and the protocone is reduced and located distally relatively to the mesiolabial border of the tooth. The upper carnassials from La Barranca and Arroyo del Val thus resemble that of *A. giganteus*. The upper molars of *A. major* and *A. giganteus* are similar in morphology, which also shows a wide range of variation within both species (variation in the development of the conules, of the protocone, in the position of the latter cusp, in the degree of transversal elongation, etc.). Although the upper molars from La Barranca show a more distally projected metacone on M1, we consider that these differences are not significant. *Amphicyon giganteus* from the locality of Arroyo del Val (late MN 6, Spain), which is probably slightly geologically younger than La Barranca (Fraile *et al.*, 1997), constitutes the last record of the species in Europe.

Family Mustelidae Fischer, 1817

Genus *Martes* Pinel, 1792

Martes sp.

Material

La Barranca

LB 35 (fragment of right hemimandible with p4-m1) (Plate 3, fig. 5)

Description

The anterior part of the masseteric fossa does not surpass the anterior border of the coronoid process. The main cuspid of p4 is very tall, sharp, and laterally slightly compressed. The mesial extremity is partly broken and thus does not completely preserved the mesial accessory cuspid; the distal one is fairly developed and very highly placed, with a vertically oriented distal face. The distal cingulum is low and elongated. The carnassial is poorly preserved; the metaconid and the distal basis of the protoconid are broken out. The protoconid is much taller and longer than the paraconid. The talonid is short and poorly but distinctly basined; it has a rounded outline, a labial crest on which the hypoconid is distinct, and a slightly prominent lingual border that is much lower than the labial crest; the occlusal surface is lingually inclined.

Comparisons and discussion

Many species have been assigned to the genus *Martes* in the Middle Miocene of Europe (see, e.g., Ginsburg, 1999, tabl. 1): *Martes burdigaliensis*, *M. cadeoti*, *M. delphinensis*, *M. munki*, *M. sansaniensis*, and *M. filholi*. Although the state of preservation of our material does not allow a specific assignment, there are differences that distinguish the specimen from La Barranca from certain of these Middle Miocene species. Thus, LB-35 differs from *M. munki*, *M. sansaniensis*, and *M. filholi* by its lesser size; from *M. munki*, *M. sansaniensis*, *M. cadeoti*, and *M. delphinensis* by its shorter talonid; and from *M. burdigaliensis* in having a narrower and shallower talonid. Additional material is necessary for a precise assignment of the species from La Barranca.

Superfamily Aeluroidea Flower, 1869

Family Felidae Fischer, 1817

Genus *Pseudaelurus* Gervais, 1850

Pseudaelurus quadridentatus (Blainville, 1843)

Material

La Barranca

LB 31 (fragment of right m1) (Plate 3, fig. 1)

Description

The piece consists of the mesial root, most of the paraconid and the mesial portion of the protoconid, which is taller than the former. Both cuspid are trenchant and transversely compressed. The mesial root is compressed either and its tip is rounded.

Discussion

The assignment to *P. quadridentatus* is based on the morphology and the size of this fragmentary tooth. Although no precise measurements are available, the breadth is distinctly greater than 6.8 mm, which fits into the sample of *P. quadridentatus* used in comparison here (see Ginsburg, 1983, fig. 3).

Pseudaelurus lorteti Gaillard, 1899

Material

La Barranca

LB-32 (subcomplete right P4) (Plate 3, fig. 3), LB-33 (subcomplete right P4) (Plate 3, fig. 2).

Description

The protocone is not preserved in both specimens and the parastyle is broken in LB-32. In both teeth the crown is laterally compressed, the paracone has a trenchant mesial crest, and the metastyle is about the length of the paracone; the carnassial notch is more open in LB-33. In this specimen, the parastyle is well developed and distolabially located relatively to the paracone; there is also a small ectostyle in the distolabial corner.

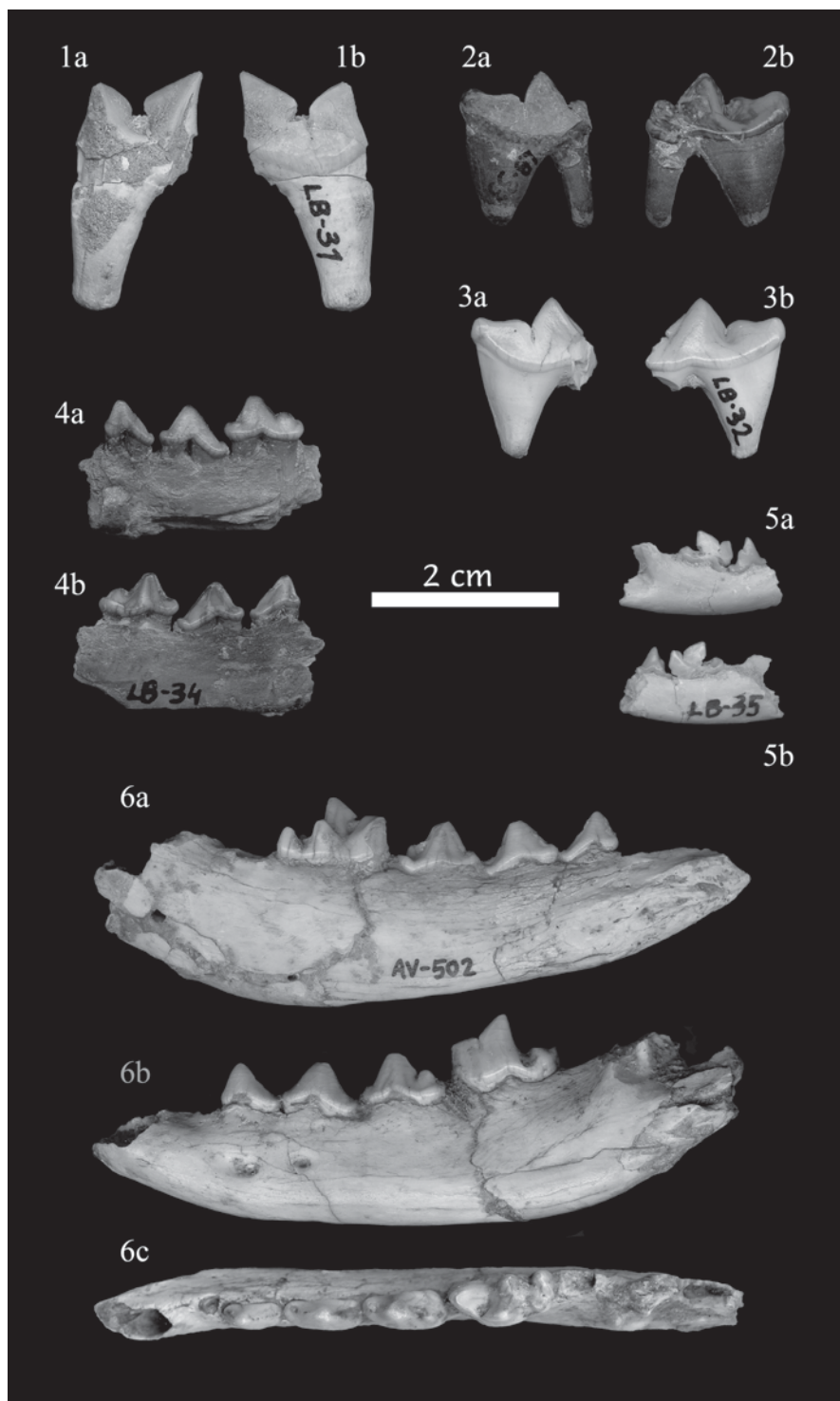


Plate 3.—Dentition of the small-sized carnivores from La Barranca and Arroyo del Val (Zaragoza). Fig. 1.—LB-31, right m1 of *Pseudaelurus quadridentatus* from La Barranca: a, lingual view; b, labial view. Fig. 2.—LB-33, right P4 of *Pseudaelurus lorteti* from La Barranca: a, lingual view; b, labial view. Fig. 3.—LB-32, right P4 of *Pseudaelurus lorteti* from La Barranca: a, lingual view; b, labial view. Fig. 4.—LB-34, fragment of left hemimandible of *Plioverrops* sp. from La Barranca, with p2, p3 and p4: a, labial view; b, lingual view. Fig. 5.—LB-35, fragment of right hemimandible of *Martes* sp. from La Barranca, with p4 and m1: a, labial view; b, lingual view. Fig. 6.—AV-502, fragment of left hemimandible of *Protictitherium* sp. aff. *P. crassum* from Arroyo del Val, with p2, p3, p4 and m1: a, lingual view; b, labial view; c, occlusal view.

Discussion

Felid features are obvious on these fragmentary teeth (well developed parastyle, highly trenchant paracone and metastyle). The assignment to *Pseudaelurus lorteti* is based on the stratigraphy and the size of the material. The association of these two felids, one being the size of *Lynx pardina* and one being the size of a large *Lynx lynx*, also occurs in, e.g., Sansan (MN 6, France; Ginsburg, 1983), Antonios (MN 4-5, Greece; Bonis & Koufos, 1999), Paracuellos-3 (MN 6, Spain; Fraile *et al.*, 1997), Hostalets de Pierola inferior (MN 7-8, Spain; Fraile *et al.*, 1997).

Family Hyaenidae Gray, 1821

Genus *Protictitherium* Kretzoi, 1938

Protictitherium sp. aff. *P. crassum* (Depéret, 1892) 1997 – *Protictitherium crassum*. Fraile *et al.*, p. 79, tabl. 1.

Material

Arroyo del Val

AV-502 (fragment of left hemimandible with p2-m1) (Plate 3, fig. 6).

Description

The posterior part of the mandible is not preserved. The mandibular corpus is slender and its height increases backwards. There are two mental foramina, the anterior one being larger and placed below p2, whereas the posterior one is placed below p3. The ventral border of the symphysis is softly curved upwards. Only the single alveolus of p1 is preserved, which is separated from the canine by a 4-mm diastema. Premolars are relatively slender and elongated. There are no accessory cuspids on p2 and p3, the former being smaller and more asymmetrical than the latter. The cingulum is distinct mesially and distally on p3. The p4 is slightly longer but markedly wider, especially distally, than p3; the mesial accessory cuspid is broken out but was likely small; the distal accessory cuspid is developed, transversely compressed and labially located; the cingulum poorly extends distally but it is developed distolingually. The paraconid is longer and much lower than the protoconid; the carnassial

notch is shallow. The metaconid is slightly lower than the paraconid; it is clearly separated from the protoconid and placed slightly distally to it. The talonid is short and wide. The hypoconid is worn; it is separated from the protoconid by a shallow notch; it is mesially located relatively to the entoconid and hypoconulid. The entoconid is well developed and prominent, slightly lower than the metaconid; these two cuspids are separated by a deep notch. A low crest-like hypoconulid is developed at the distal border.

Comparisons and discussion

In a more general study of the Neogene Carnivora from Spain, Fraile *et al.* (1997) cited this material under the name *P. crassum*. However, our study shows that AV-502 differs from *P. crassum* in some details. In comparison with the syntype material of La Grive, our material differs in having more slender premolars, no accessory cuspids on p2 and p3, a lesser developed mesial accessory cuspid and no prominent distolingual crest on the cingulum on p4, and a more mesially placed hypoconid on m1. The structure of m1, with a reduced metaconid that is much lower than the paraconid, shows that this specimen morphologically fits into the *Protictitherium* grade.

Genus *Plioviverrops* Kretzoi, 1938

Plioviverrops sp.

Material

La Barranca

LB-34 (fragment of left hemimandible with p2-p4) (Plate 3, fig. 4).

Description

The ventral part of the mandible is broken out. Two mental foramina are visible, a large one below the mesial root of p2 and a second one below the mesial root of p3. Both p2 and p3 are slender and tall, and they lack a distal accessory cuspid; p2 is asymmetrical and the distal cingulum is poorly developed; p3 is slightly taller and more elongated than p2; the cingulum is present mesially and distal-

ly but it does not develop cuspids; the distal cingulum is more marked than that of p2. The p4 is larger than p3; it has its maximum breadth distally. There are a mesial and a distal accessory cuspids, the latter of which is the largest; the distal cingulum is more developed than that of p3 and extends lingually.

Discussion

The fossil record of Aragonian hyaenids in Spain is relatively scarce, with *Proctictitherium* being the earliest recorded and only known hyaenid in MN 6 (Paracuellos-3, Paracuellos-5, Arroyo del Val; Fraile *et al.*, 1997).

The material of hyaenids from La Barranca is not very abundant but the size and morphology of the premolars support a distinction from *Proctictitherium* and an assignment to the genus *Plioviverrops*. The morphological differences with *Proctictitherium* are the transversal compression of teeth, the absence of distal accessory cuspids on p2-p3, the smaller mesial cuspid and the lesser development of the distal cingulum on p4. *Plioviverrops* sp. from La Barranca is the earliest record of the genus in Spain; the available material is not diagnostic at a specific level.

Discussion

So far the only Carnivora from La Barranca previously listed (Fraile *et al.*, 1997) were *Martes burgaliensis* and *Martes* sp. The detailed study of the material of Carnivora now available from this locality provides the following more complete list: *Plithocyon armagnacensis*, *Hemicyon* sp. aff. *H. sansaniensis*, *Amphicyon giganteus*, *Martes* sp., *Pseudaelurus quadridentatus*, *Pseudaedulus lorteti*, *Plioviverrops* sp.

The new material of Carnivora from Arroyo del Val that is described here allow to review and/or to complete the previously known fauna list from this locality (see Fraile *et al.*, 1997): *Sansanosmilus jourdani*, *Proctictitherium* sp. aff. *P. crassum* (this study), *Pseudaelurus quadridentatus*, *Hemicyoninae* indet., *Plithocyon armagnacensis* (this study), *Amphicyon giganteus* (this study).

The Carnivora from Arroyo del Val area are similar to those of Sansan. The most prominent difference is the presence of *A. giganteus*, which appears as a relict species from the Orleanian. The presence

of *Proctictitherium* sp. aff. *P. crassum* and *Hemicyon* sp. aff. *H. sansaniensis* confirm the difference in the carnivore assemblage.

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