

The Late Pleistocene and Holocene chamois in central-southern Italy

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ABSTRACT: Comparisons of a morphological, eco-ethological and palaeontological nature conducted several decades ago enabled the recognition of two distinct species of chamois: the Alpine chamois, *Rupicapra rupicapra*, and that of the Pyrenees, *Rupicapra pyrenaica*, which has survived up to the present in Italy only within the boundaries of the Abruzzo National Park in the variety of the subspecies *Rupicapra pyrenaica ornata*. However, at a distance of more than twenty years, many archaeozoological and palaeontological studies conducted on osteological materials from central-southern Italy appear to ignore these results, frequently indicating the finds with a generic *Rupicapra* sp., when they do not actually make reference to the Alpine chamois.

The Apennine chamois, *R. pyrenaica ornata*, therefore has to be considered as a subspecies exclusive to the Italian peninsula, at least judging from the data available for the less recent chronologies of the Holocene, although recently-formulated hypotheses favour the non-indigenous origin of the present Abruzzi population of chamois.

KEYWORDS: *Rupicapra*, PLEISTOCENE, HOLOCENE, CENTRAL-SOUTHERN ITALY, PALAEOBIOGEOGRAPHY

RESUMEN: Comparaciones morfológicas, eco-etológicas y paleontológicas realizadas hace varias décadas, ha permitido el reconocimiento de dos especies distintas de *Rupicapra*: la gamuza de los Alpes, *Rupicapra rupicapra*, y el rebeco de los Pirineos, *Rupicapra pyrenaica*, que ha sobrevivido en Italia hasta el presente solamente dentro de los límites del Parque Nacional de Abruzzo con la subespecie *Rupicapra pyrenaica ornata*. Aunque han pasado más de veinte años de la separación entre ambas especies, muchos de los estudios arqueozoológicos y paleontológicos de los materiales osteológicos del centro y sur de Italia parecen ignorar aún estos resultados, indicando los hallazgos frecuentemente con un genérico *Rupicapra* sp., cuando no se refieren directamente a la gamuza de los Alpes.

El rebeco de los Apeninos, *R. pyrenaica ornata*, por lo tanto debe ser considerado una subespecie única de la península italiana, al menos a juzgar por los datos disponibles de la historia antigua del Holoceno, pero se han formulado teorías recientes sobre un origen no indígena de la población del rebeco de Abruzzo.

PALABRAS CLAVE: *Rupicapra*, PLEISTOCENO, HOLOCENO, CENTRO-SUR DE ITALIA, PALEOBIOGEOGRAFÍA

INTRODUCTION

The data on the distribution of the remains attributed to the chamois in the major vertebrate deposits of the Late Pleistocene and older Holocene in central-southern Italy are reported and discussed in this paper.

The chamois are Artiodactyla mammals belonging to the Bovidae family, they have reduced snout and tail, relatively long limbs and a typically contrasted face markings. Both sexes have the horns which are not covered by longitudinal hulls and have no knots, but are straight, thin and hook-shaped with several rough annular parallels (Toschi, 1965; Carpaneto, 2003).

In the 1980s, several comparisons of a morphological, biometrical, eco-ethological, biochemical and palaeontological nature (Lovari & Scala, 1980; Scala & Lovari, 1984; Masini, 1985; Nascetti *et al.*, 1985; Lovari, 1987; Masini & Lovari, 1988) enabled the recognition of two distinct species of chamois in the primary distribution from the Western Palaearctic: the Alpine chamois, *Rupicapra rupicapra* (Linnaeus, 1758), divided into various subspecies spread from Anatolia and the Caucasus to the Alps, and that of the Pyrenees, *Rupicapra pyrenaica* Bonaparte, 1845, widespread in the Iberian Peninsula, with its subspecies from the Pyrenees and the Cantabrian Mountains, which has survived up to the present in Italy only within the boundaries of the Abruzzo National Park in the form of the subspecies *Rupicapra pyrenaica ornata* (Neumann, 1899) (see Lovari & Bruno, 2003; Tosi & Pedrotti, 2003).

Previously, on the sole basis of external and cranial morphology, both Miller (1912) and Camerano (1913, 1914, 1915, 1916) had divided the genus into three species: *R. ornata*, *R. pyrenaica*, with the subspecies or variety *R. pyrenaica parva* Cabrera, 1910, and *R. rupicapra*, divided into several subspecies. Cabrera (1914) have pointed out the strong similarity of coat of *R. pyrenaica* and *R. ornata* but he considers that the gap of their ranges makes unlikely their specific identity. Lydekker (1913), Couturier (1938) followed by Dolan (1963), instead, regrouped the chamois into a single species, *R. rupicapra*, divided into nine or, possibly, ten regional subspecies, including *R. rupicapra ornata*.

Following the aforementioned work of Nascetti *et al.* (1985), other studies of molecular biology have confirmed the distinction between *R. rupi-*

capra and *R. pyrenaica*, as well as the close genetic affinity between the Apennine chamois and those of the Iberian peninsula. Among others, Hammer *et al.* (1995) estimated the divergence interval between *R. pyrenaica* and *R. rupicapra* as 280,000 years, while Mucci *et al.* (1998) confirmed the close kinship existing between the Cantabrian chamois and that of Abruzzo.

Conversely, Pérez *et al.* (2002) and Crestanello *et al.* (2009) posited the possibility that the Apennine chamois could be considered a third species. More specifically, Pérez *et al.* (2002) estimated the divergence interval between *R. pyrenaica* and *R. rupicapra* as 57,000 years and that between *R. pyrenaica pyrenaica* and *R. pyrenaica ornata* as around 40,000 years, while Crestanello *et al.* (2009) estimated the divergence between the three groups of chamois as an interval of time of between 1.4 and 1.9 Ma. Recent papers by Rodríguez *et al.* (2009, 2010), instead, claims that postglacial recolonization was accompanied by hybridization between the *pyrenaica* and *rupicapra* clades, and conclude that only one *Rupicapra* species exists divided into 3 lineages, West (*pyrenaica* and *parva*), Central (*ornata* and *cartusiana*) and East (the other *rupicapra* subspecies). More specifically, Rodríguez *et al.* (2010) underscore the discrepancies observed in the analyses conducted on microsatellites and those on the mitochondrial DNA, and moreover estimate the divergence interval between the central-western and eastern chamois as 1.69 Ma and that between the western and central chamois as 1.37 Ma.

Considering the confusion and the discrepancies of the most recent studies of molecular genetics, in the rest of the work we shall adhere to the current classification of the population of chamois in two species, *R. pyrenaica* and *R. rupicapra* (see Masini & Lovari, 1988; Grubb, 1993).

The Alpine chamois (Figure 1) has perpendicular horns, the bony bases of which are not very expanded and are separated by a relatively large area of the frontal bone; the winter coat is blackish-brown on the back, the throat patch does not reach the chest, and the anal spot is small. The Apennine chamois (Figure 2), instead, has the horns slightly tilted back, and the bony bases of the horns are greatly expanded and leave little space between them; the winter coat is paler or cream-colored on the back, the throat patch reaches the chest, and the anal spot is large (Camerano, 1913, 1914, 1915, 1916; Couturier, 1938; Toschi,

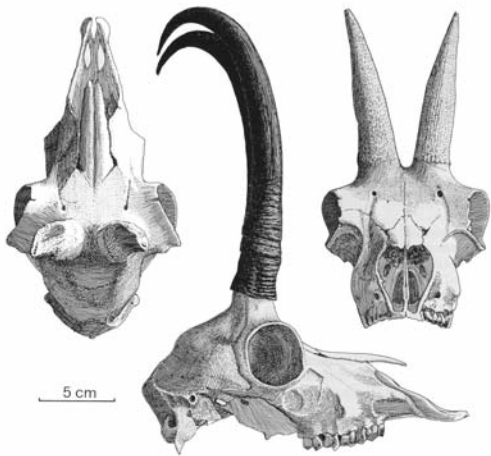


FIGURE 1

Skull of Alpine chamois, *Rupicapra rupicapra rupicapra* (from Lovari & Bruno, 2003, modified).

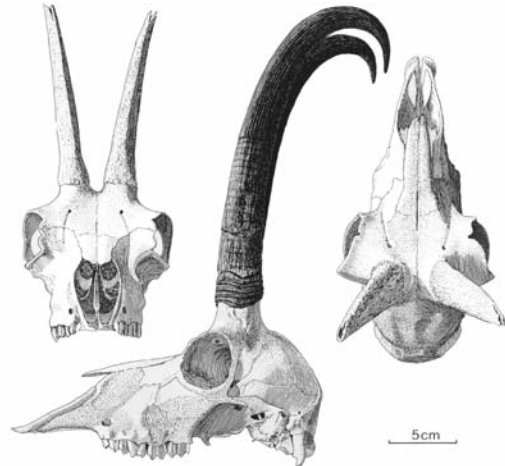


FIGURE 2

Skull of Apennine chamois, *Rupicapra pyrenaica ornata* (from Tosi & Pedrotti, 2003, modified).

1965; Carpaneto, 2003; Lovari & Bruno, 2003; Tosi & Pedrotti, 2003).

The osteological distinction between *R. rupicapra* and *R. pyrenaica* is possible for intact skulls, or at least for portion of skull containing horn-cores. Besides the insertion and inclination of the above mentioned horn-cores certain additional diagnostic characters have been identified, such as the regularity or complexity of various sutures or the obliteration of the frontomaxillary fontanelle that is variously open in the *R. rupicapra* subspecies and fully closed in *R. pyrenaica* (Camerano, 1913, 1914, 1915, 1916; Couturier, 1938; Toschi, 1965; Pratt, 1966; Altuna, 1972; Lovari & Scala, 1980; Masini, 1985; Masini & Lovari, 1988). In the vertebrate fossil deposits, however, cranial fragments are more frequently found, and in these cases the morphometric diagnostic criteria relate to the distance (at the base and apex) between the horn-cores (Altuna, 1972; Lovari & Scala, 1980; Masini, 1985), while the length and diameter of each horn-core and their ratios are not very significant (Altuna, 1972), but useful for distinguishing between *R. pyrenaica pyrenaica* and *R. pyrenaica ornata* (Couturier, 1938; Scala & Lovari, 1984; Masini, 1985); moreover the ratio between the anteroposterior diameter and the distance to the base of the horn-cores is a good method for distinguishing between *R. rupicapra* and *R. pyrenaica* (Masini, 1985). Certain distinc-

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tive morphometric features have been identified for some post-cranial bones, such as the metacarpus (Crégut-Bonnoure, 1992), and in this case too identify the degree of separation between the two species is possible if bone remains are intact, while as is well known, in the vertebrate fossil deposits, particularly those of anthropic origin, the bones are fragmented and generally in a condition that does not even allow the identification of the anatomical portion, still less the determination of the species.

METHODOLOGY

To test the past distribution of *R. rupicapra* and *R. pyrenaica* in the Italian peninsula, we performed a literature search, identifying in the scientific literature the main vertebrate deposits in central-southern Italy referred to the Late Pleistocene and older Holocene. We noted the presence of chamois remains giving priority (as far as possible) to the publications with descriptions and/or images and/or measurements of the fossil remains.

We also saw various skeletal elements of chamois from certain Pleistocene sites, such as the Grotta del Romito di Papisidero (northern Calabria), the Grotta di Monte Cucco (Umbria), the Grotta Rutina and several caves in the Fucino

basin (Abruzzo), but it was not possible to attribute these with any certainty to one or the other species, based on the morphometric criteria mentioned above, especially in view of the fragmentary nature of the remains.

RESULTS AND DISCUSSION

The genus *Rupicapra* is relatively common in the Late Pleistocene, occurring in western Europe since the Middle Pleistocene. The earliest fossil records come from «F» layer of the Caune de l'Arago (Tautavel, Pyrénées-Orientales, France), dated about 440000 years BP (Marine Isotope Stage 12 = MIS 12), with some remains referred to *Rupicapra* cf. *pyrenaica* (Crégut, 1979; Moigne *et al.*, 2006). The same taxon was also recorded from the site of Orgnac 3 (Ardèche, France) in layers dated between 339 and 298000 years BP (MIS 9) (Rivals, 2002). The finds then become slightly more numerous in the final stages of Middle Pleistocene (MIS 6) and among these we can mention the remains from the Grotte du Cap de la Bielle (Nestier, Hautes-Pyrénées, France) referred to *Rupicapra* cf. *pyrenaica* (Clot & Marsan, 1986; Masini & Lovari, 1988), those from the Grotte des Cèdres (Le Plan d'Aups, Var, France) attributed to *R. rupicapra* (Defleur *et al.*, 1989; Crégut-Bonnoure, 1992), those from the Grotte de la Niche (Montmaurin, Haute-Garonne, France) attributed to *R. pyrenaica* (Tavoso *et al.*, 1990; Crégut-Bonnoure, 1992) and those from Romain-la-Roche (Doubs, France) referred to *Rupicapra* cf. *rupicapra* (Vercoutère & Guérin, 2010).

Fossil remains attributed to *Rupicapra* in Italy are relatively numerous during the Late Pleistocene, especially from sites referred to the Last Glacial, but the taxon probably reached the peninsula during the final stages of the Middle Pleistocene (MIS 6) (Masini, 1985; Petronio *et al.*, 2007; Palombo *et al.*, 2011).

Figure 3 illustrates the assumed Italian distribution of the Alpine chamois and the Apennine chamois between the final Pleistocene and the beginning of the Holocene: *R. rupicapra* is widespread in the Alpine arch, between the Eastern Alps and the Maritime Alps, as well as in the northern Apennines, instead *R. pyrenaica* is confined to a portion of peninsula between the Sibillini Mountains (southern Umbria-Marche Apennines) and northern Calabria. This assumed distribution, already suggested by Lovari & Scala (1980), was then developed and made more specific by Masini (1985) and Masini & Lovari (1988) primarily on the basis of the study of: 4 horn-cores, two very incomplete, from the Grotta del Broion (Berici Hills, Veneto - Late Pleistocene), 32 horn-cores, including several with a portion of the frontal bone, of both male and female individuals and of different ages, from the Grotta di Equi (Apuan Alps, Tuscany - Late Pleistocene), 3 adult male skulls, one very well preserved, from Monte Sumbra (Apuan Alps, Tuscany - Holocene), 2 sub-intact skulls, one juvenile, from Ripa Grande (Sibillini Mountains, Marche - Holocene), and 2 horn-cores, one juvenile, from the Grotta del Romito di Papisidero (southern Apennines, northern Calabria - Lateglacial/Holocene).

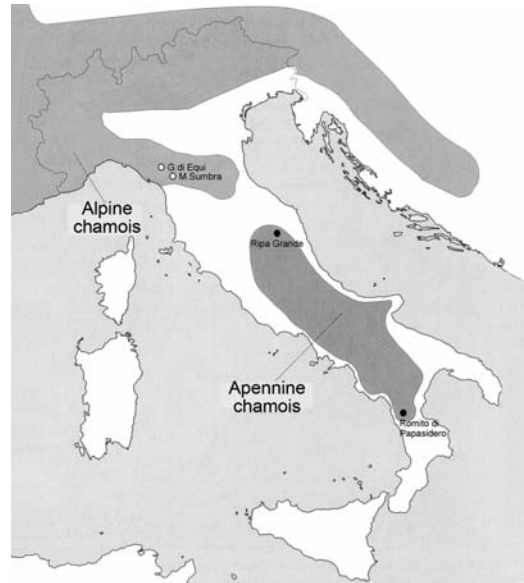


FIGURE 3

Assumed Italian distribution of *Rupicapra rupicapra* and *Rupicapra pyrenaica* between the end of the Pleistocene and the beginning of the Holocene (from Masini & Lovari, 1988, modified).

nines) and northern Calabria. This assumed distribution, already suggested by Lovari & Scala (1980), was then developed and made more specific by Masini (1985) and Masini & Lovari (1988) primarily on the basis of the study of: 4 horn-cores, two very incomplete, from the Grotta del Broion (Berici Hills, Veneto - Late Pleistocene), 32 horn-cores, including several with a portion of the frontal bone, of both male and female individuals and of different ages, from the Grotta di Equi (Apuan Alps, Tuscany - Late Pleistocene), 3 adult male skulls, one very well preserved, from Monte Sumbra (Apuan Alps, Tuscany - Holocene), 2 sub-intact skulls, one juvenile, from Ripa Grande (Sibillini Mountains, Marche - Holocene), and 2 horn-cores, one juvenile, from the Grotta del Romito di Papisidero (southern Apennines, northern Calabria - Lateglacial/Holocene).

Data obtained from 57 works following the publication of Masini & Lovari (1988), which consists of 43 sites from central-southern Italy attributed to the Late Pleistocene and older Holocene, instead, shows the situation summarised in Table 1 and illustrated in Figure 4. It should be noted that the fossil faunas of some sites are described or

Taxon	Pleistocene		Holocene	
	n° works	n° sites	n° works	n° sites
<i>R. pyrenaica ornata</i>			1	1
<i>R. pyrenaica</i>	4	3		
<i>R. cf. pyrenaica</i>	3	3		
<i>Rupicapra</i> sp.	21	13	1	1
<i>R. rupicapra</i>	26	27	6	7

TABLE 1

Number of works and sites that reported the *Rupicapra* remains referred to the Late Pleistocene and the older Holocene in central-southern Italy, according to scientific literature after the year 1988.

reported in several works; on the other hand, some publications relate or describe the faunal remains from multiple sites. In particular:

1. *Rupicapra pyrenaica ornata*: even in the presence of two horn-cores with the frontal bone portions which would allow specific attribution for the Holocene chamois from Grotta delle Balze near Gualdo Tadino, central Umbria-Marche Apennines (Loreti & Salerno, 1989), the attribution is not disputed, let alone the subspecific attribution;
2. *Rupicapra pyrenaica*: the Pleistocene chamois from the Grotta Paglicci near Rignano Garganico, Apulia (Abbazzi *et al.*, 1996), from the Grotta di Castelcivita, Campania (Masini & Abbazzi, 1997), and from the Grotta Grande di Scario near San Giovanni a Piro, Campania (Ronchitelli *et al.*, 1998, 2011) could have been coherently attributed to the species *R. pyrenaica* solely on palaeobiogeographic grounds;
3. *Rupicapra* cf. *pyrenaica*: the doubtful specific attribution, caused by the fragmentation and the small number of finds (Benini *et al.*, 1997, Boscato *et al.*, 1998), would be supported by the presence of a horn-core with frontal bone portion only in the case of the Mousterian chamois from Grotta Rutina at Guardiagrele, Abruzzo (Saccà, 2006);
4. *Rupicapra* sp.: the generic attributions are numerous (Boscato, 1994, 2000, 2007; Alhaique *et al.*, 1996, 1998a; Petronio *et al.*, 1996; Boscato *et al.*, 1997, 2005, 2009; Boscato & Palma di Cesnola, 2000; Arobba *et al.*, 2004; Boscato & Crezzini, 2005, 2009; Govoni, 2006; Martini *et al.*, 2007; Tagliacozzo & Fiore, 2007; Vacca, 2007; Collina *et al.*, 2008; Mussi *et al.*, 2008; Elevelt & Tagliacozzo, 2010; Ruiu *et al.*, 2010; Salari *et al.*, 2011) and these are sometimes defen-

ded through the lack of diagnostic osteological materials enabling attributions of the chamois remains with any certainty to one or the other species;

5. *Rupicapra rupicapra*: generally the numerous attributions to the Alpine chamois (Capasso Barbato *et al.*, 1989; Boscato *et al.*, 1991; Wilkens, 1991a, 1991b, 2003; Alessio *et al.*, 1993; Castelletti *et al.*, 1994; Alhaique *et al.*, 1998b, 2007; Mirri, 1999; Alhaique & Tagliacozzo, 2000; Cilli *et al.*, 2000; Alhaique & Recchi, 2001, 2003; Agostini *et al.*, 2003; Alhaique, 2003, 2005; Fiore *et al.*, 2004; Guerreschi *et al.*, 2005; Esu *et al.*, 2006; Alhaique & Di Camillo, 2007; Martini *et al.*, 2007; Tozzi & Dini, 2007; Dini *et al.*, 2008; Farina, 2009; Marra, 2009; Molaro, 2009) are not debated, and where there is photographic documentation, the diagnostic osteological findings at specific level are not included, with the exception of Farina (2009 - table 9, fig. 4); in this work there is an intact right metacarpal from the Late Pleistocene sediments of the Grotta di Cucigliana (Monte Pisano, Tuscany) attributed to *R. rupicapra* according to the criteria established by Crégut-Bonnoure (1992). In a recent paper by regional synthesis, moreover, several previous attributions to *Rupicapra* sp. and/or *Rupicapra* cf. *pyrenaica* are rectified to *R. rupicapra* (Sala, 2007).

The above discussion shows that in most archaeozoological and paleontological studies conducted on osteological materials from central-southern Italy, the chamois remains are referred to *R. rupicapra* or to *Rupicapra* sp., and (except for the northern Apennines sites) apparently did not wish to take into account the above-mentioned 1890s results. Sometimes, moreover, the fossil remains from the same site are referred to different taxa: e.g., the chamois from the Grotta Paglicci (Apulia) was attributed to *Rupicapra* sp. (Boscato, 1994; and subsequent works), to *R. pyrenaica* (Abbazzi *et al.*, 1996) and to *R. rupicapra* (Sala, 2007); the chamois from the Grotta del Romito di Papisidero (northern Calabria) was attributed to *Rupicapra* cf. *pyrenaica* (Boscato *et al.*, 1998), to *Rupicapra* sp. (Govoni, 2006; Vacca, 2007) and to *R. rupicapra* (Martini *et al.*, 2007). Finally it should be noted that the Abruzzo region, where *R. pyrenaica ornata* is now found, has the largest number of attributions to *R. rupicapra*.

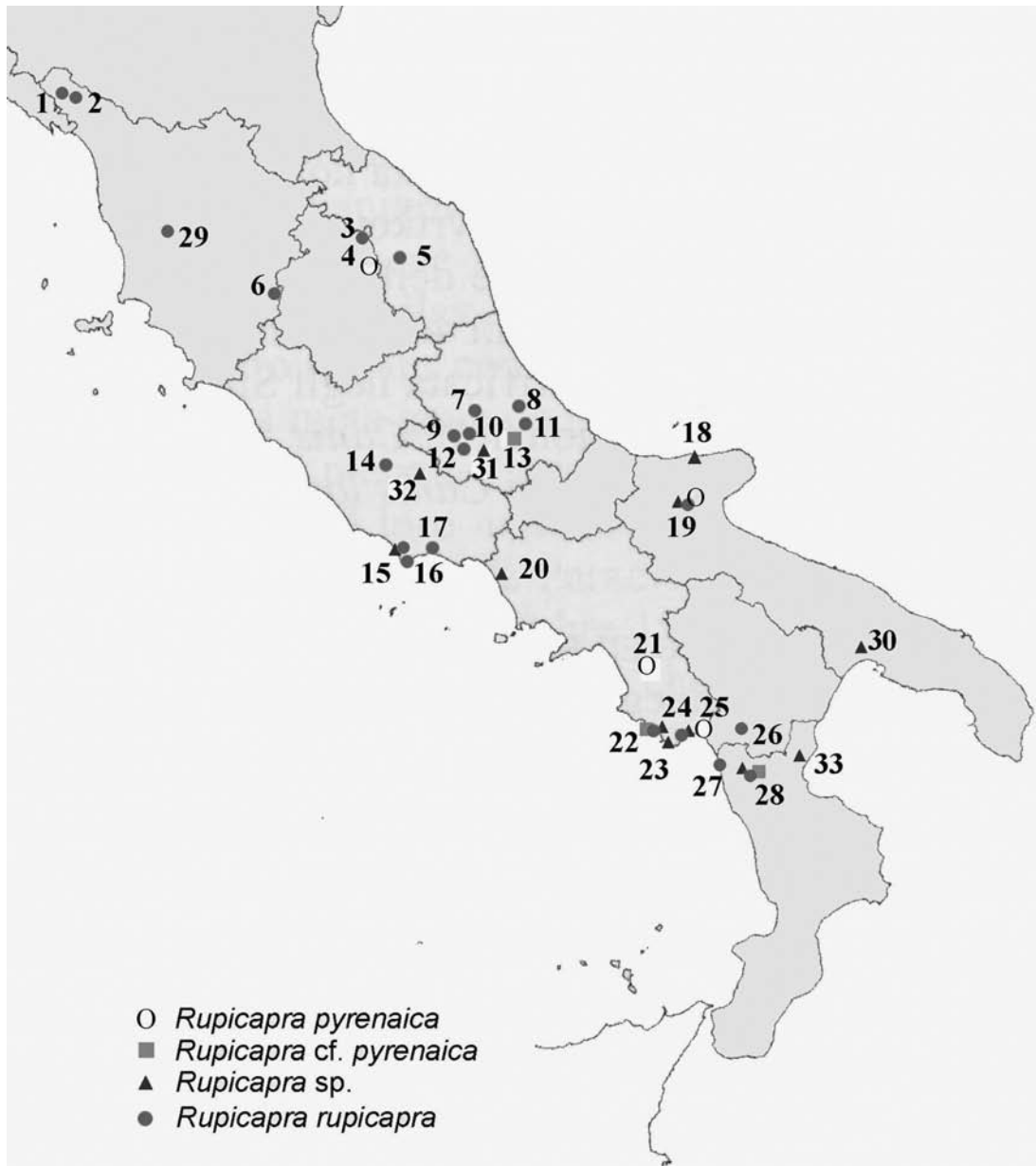


FIGURE 4

Distribution of chamois finds referred to the Late Pleistocene and the older Holocene in central-southern Italy, according to scientific literature after 1988: 1) Grotta all'Onda, Riparo Fredian and Riparo Piastricoli; 2) Grotta delle Campane; 3) Grotta di Monte Cucco; 4) Grotta delle Balze; 5) Cava Romita; 6) Grotta S. Francesco; 7) Riparo Camarda and Riparo S. Maria; 8) Catignano; 9) Grotta Ciccio Felice and Grotta Maritza; 10) Grotta Tronci and Riparo Maurizio; 11) Grotta dei Piccioni di Bolognano; 12) Grotta di Ortucchio, Grotta S. Stefano and Grotta Continenza; 13) Grotta Rutina; 14) Grotta Polesini; 15) Grotta Breuil; 16) Grotta del Fossellone; 17) Riparo Salvini; 18) Ingarano; 19) Grotta Paglicci; 20) Roccia S. Sebastiano; 21) Grotta di Castelcivita; 22) Grotta La Cala; 23) Grotta della Serratura and Riparo del Poggio; 24) Grotta S. Maria Infreschi and Riparo del Molare; 25) Grotta Grande di Scario; 26) Latronico 3; 27) Grotta del Santuario della Madonna and Grotta di Torre Nave; 28) Grotta-riparo del Romito di Papisidero; 29) Grotta di Cucigliana and Grotta di Parignana; 30) Riparo l'Oscuruscuito; 31) Grotta di Pozzo; 32) Grotta Mora Cavorso; 33) Broglio di Trebisacce.

A similar situation seems to emerge for the chamois remains from the Iberian peninsula. A quick glance at more than 70 publications subsequent to 1988 shows that many Spanish paleontologists and archaeozoologists, but also some French and Portuguese, while referring to the form unquestionably as *pyrenaica* (also using the local vernacular names as *sarrío* and/or *isard*) prefer to refer to taxa as *R. rupicapra* or *R. rupicapra pyrenaica* (Cardoso & Antunes, 1989; Altuna, 1990a, 1990b, 1992a, 1992b; Guadelli, 1990; Mariezkurrena, 1990; Álvarez *et al.*, 1992; Arrizaballaga *et al.*, 1992; Pérez Legido & Cerdeño, 1992; Castaños, 1993, 2001, 2005; Maroto, 1993; Sacchi *et al.*, 1994; Altuna & Mariezkurrena, 1995, 2000, 2001; Blasco Rancho, 1996; Geraads, 1997; Surmely *et al.*, 1997; Dari, 1999; Gardeisen, 1999; Mateos Cachorro, 1999, 2002; Quam *et al.*, 2001; Yravedra, 2001, 2006, 2007; Altuna *et al.*, 2002; Maroto *et al.*, 2002; Cacho Quesada *et al.*, 2003, 2004; MNHN, 2003/10; Marin, 2004; Valente, 2004; Michel, 2005; Sánchez *et al.*, 2005; Aura Tortosa *et al.*, 2006; Castaños *et al.*, 2006; Brugal & Valente 2007; Marín Arroyo & González Morales, 2007; Costamagno *et al.* 2008; Díez *et al.*, 2008; Murelaga *et al.*, 2008; Ríos Garaizar *et al.*, 2008; Marín Arroyo *et al.*, 2009).

CONCLUDING REMARKS

More than twenty years since the recognition of two distinct species of chamois from the Western Palearctic, the Alpine chamois, *R. rupicapra*, widespread from Anatolia and the Caucasus to the Alps, and that of the Pyrenees, *R. pyrenaica*, widespread in the Iberian Peninsula and in the Abruzzo Apennines, it was found that many archaeozoological and paleontological studies conducted on osteological materials from various sites in Italian peninsula appear to ignore these results, frequently indicating the finds with a generic *Rupicapra* sp., when they do not actually make reference to the Alpine chamois. It seems that the recognition of two distinct species has often been ignored, or that the strict palaeobiogeographic division outlined in Masini & Lovari (1988) is deemed not credible: while the ancient distribution of *R. rupicapra* in the northern Apennines (which should be expanded to the south at least as far as Monte Pisano, Tuscany) is well documented by the Pleistocene remains from the Grotta di Equi and the

Holocene skulls from Monte Sumbra, the recalled prehistoric presence of *R. pyrenaica* in central and southern Italy (which should be extended to the north to the central Umbria-Marche Apennines) is well supported only by Holocene osteological findings (the skulls from Ripa Grande and the horn-cores with frontal bone portions from the Grotta delle Balze).

The numerous generic attributions, moreover, are justified not only by the fragmentary remains and the deriving lack of diagnostic osteological materials providing a safe taxonomic attribution, but also by the fact that in the presence of two distinct species (and not subspecies) a coexistence of the two species in more or less extensive portions of the peninsula certainly cannot be ruled out *a priori*.

Regarding *R. pyrenaica ornata* (Figure 5), the contradictions of the recent molecular biology studies mentioned above (see Introduction) do not yet afford a clear view of the issue, while recently the hypothesis was put forward of a non-indigenous origin of the Abruzzo chamois population, that could instead have been introduced from the Iberian Peninsula (see Lovari, 2001; Masseti, 2003; Masseti & Nappi, 2007). We can recall that, in relatively recent historical periods, southern Italy (and part of central) was a Spanish kingdom for at least two centuries and subsequently, between the 17th and 19th century, was dominated by the Bourbons, intermarried with the Spanish royal family.

In support of this hypothesis it was observed that:

1. the modern zoologists who first records the presence of chamois in some parts of the Kingdom of Naples, between the end of the 18th century and the beginning of the 19th, also noted with some surprise that the species had not been reported previously (see Masseti, 2003, with references);
2. it is reported that between the 18th and 19th centuries many nuclei of animals of different origin, including pheasants, wild boars, dorcas gazelles, Sardinian deer and brown bears, were introduced into various royal Bourbon hunting reserves (Costa, 1839; Colletta, 1862; Rosati, 1871; Martucci & Margozzi, 1992; Masseti & Zava, 2002; Masseti, 2003; Breber & Masseti, 2007);
3. archival sources attest to the certain presence of chamois, between 1778 and 1805, in the Bourbon hunting reserves of Astroni and



FIGURE 5

Apennine chamois, *Rupicapra pyrenaica ornata* (photo Giuliano Cappelli).

Capodimonte and on the small island of Vivara, explicitly described as a station for the acclimatisation of the species (Masseti & Nappi, 2007, and references therein; see Caldora, 1965).

The presence of chamois in coastal localities is not surprising given that from 1994 (although some evidence can be traced back to 1985) the presence of a population of *R. rupicapra* was observed in an area close to the sea, on the Trieste Karst, in an altitudinal range between 30 and 280 m a.s.l. (Perco *et al.*, 2007; Fabio Cantagalli, *in litteris*). In Spain, Cantabrian chamois were recorded along the coast over 30 km northwards of their current range. One in the coastal cliffs of Cudillero (Asturias, northern Spain) in the 1990s and the second when a young male was caught on 29th October 2006 two miles off the coast of the same village of Cudillero, swimming off into the Cantabrian Sea (Carlos Nores, *in litteris*).

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