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Quaternary mammal fauna from "Surconis", Bolotana (Sardinia, Italy)

Daniel Zoboli & Gian Luigi Pillola

D. Zoboli, Dipartimento di Scienze Chimiche e Geologiche, Università di Cagliari, Via Trentino 51, I-09127 Cagliari; zoboli.a@tiscali.it
G.L. Pillola, Dipartimento di Scienze Chimiche e Geologiche, Università di Cagliari, Via Trentino 51, I-09127 Cagliari; pillolag@unica.it

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ABSTRACT - A mammal assemblage discovered in a small fissure filling in the Surconis area, near the village of Bolotana (Marghine mountain range, central-western Sardinia, Italy) is described herein. The association is composed of several taxa: Prolagus sardus*,* Microtus (Tyrrhenicola) henseli, Rhagamys orthodon, Cynotherium *cf.* sardous *and* Praemegaceros (Nesoleipoceros) cazioti*. The analysed assemblage infers a Late Pleistocene or Early Holocene age* ("Microtus [Tyrrhenicola]*" Faunal Complex*)*. The Surconis assemblage represents to date the richest fossil mammal site reported in the Marghine mountain range.*

RIASSUNTO - [La fauna a mammiferi quaternari di "Surconis", Bolotana (Sardegna, Italia)] *- I primi studi sulle faune plio-quaternarie a mammiferi continentali della Sardegna risalgono ai primi anni del XIX secolo. Le località fino ad oggi studiate nell'isola sono numerose e in tempi recenti, grazie alla scoperta dei ricchi riempimenti carsici del Monte Tuttavista (Sardegna centro-orientale), le conoscenze sui complessi faunistici a mammiferi plio-quaternari hanno avuto un significativo incremento. I principali depositi fossiliferi sardi sono rappresentati da brecce ossifere in anfratti carsici, depositi di grotta, depositi eolici e subordinatamente da paleosuoli e depositi fluvio-lacustri. Per quel che riguarda i depositi in cavità carsiche, questi sono ubicati principalmente nelle vaste aree carbonatiche del Sulcis-Iglesiente (Sardegna meridionale), della Nurra (Sardegna settentrionale) e della Sardegna centro-orientale. Risultano pertanto relativamente rari quelli localizzati in aree dove gli affioramenti carbonatici sono scarsamente rappresentati.*

Nel presente lavoro viene segnalata un'associazione a mammiferi individuata all'interno del riempimento di una piccola cavità carsica in località Surconis, a poca distanza dal centro abitato di Bolotana (Marghine, Sardegna centro-occidentale, Italia). I taxa segnalati sono: Prolagus sardus*,* Microtus (Tyrrhenicola) henseli*,* Rhagamys orthodon*,* Cynotherium *cf.* sardous *e* Praemegaceros (Nesoleipoceros) cazioti*. La presenza del Cricetidae esclude il Complesso Faunistico a "*Nesogoral*" a favore del Complesso Faunistico a "*Microtus (Tyrrhenicola)*" e al Sub-complesso Faunistico di Dragonara (fine Pleistocene Medio - inizio Olocene). Allo stato attuale delle conoscenze la località di Surconis rappresenta il sito a mammiferi fossili quaternari più ricco segnalato nella subregione del Marghine.*

INTRODUCTION AND GEOLOGICAL SETTING

Quaternary mammalian faunal assemblages of Sardinia have been reported since the 19th century. The fossil rich deposits of well-known localities in literature (i.e., Bonaria [Cagliari], Grotta dei Fiori [Carbonia], Funtana Morimenta [Gonnesa], Portovesme [Portoscuso], Monte San Giovanni [Iglesias], Is Oreris [Fluminimaggiore], San Giovanni di Sinis [Cabras], Carmas [Riola Sardo], Grotta della Medusa/Dragonara [Alghero], Tramariglio [Alghero], Monte Tuttavista [Orosei], Grotta Corbeddu [Oliena], Capo Figari [Olbia]; Studiati, 1857; Major, 1905; Dehaut, 1911; Comaschi Caria, 1968, 1970; Malatesta, 1970; Eisenman & Van der Geer, 1999; Abbazzi et al., 2004; Boldrini, 2008; Madurell-Malapeira et al., 2015) testify faunal turnovers characterized by the extinction of several vertebrate taxa and the appearence of new elements from the mainland (Palombo, 1985; Van der Made, 1999; Sondaar, 2000; Abbazzi et al., 2004; Palombo, 2006, 2009; Palombo et al., 2008). In addition, speciation due to insularity has been studied in more detail as well as the dwarfism processes that characterized several evolutionary lineages (Azzaroli, 1952; Comaschi Caria, 1968; Malatesta, 1970; Caloi & Malatesta, 1974; Van der Made, 1988; Lyras et al., 2006; Van der Made & Palombo, 2006; Palombo et al., 2012).

Palombo (2009) recognized two main mammalian faunal complexes (FC): the "*Nesogoral*" FC (Late Pliocene - Early Pleistocene), divided into two subcomplexes (FSC) (Mandriola and Capo Figari/Orosei 1 FSC) and the "*Microtus* (*Tyrrhenicola*)" FC (late Early Pleistocene - Early Holocene), divided into two subcomplexes (Orosei 2 and Dragonara FSC).

The bulk of fossil Sardinian mammal remains of these subcomplexes originates from cave deposits, karstic fissure fillings or pockets, aeolian sediments and, to a lesser degree from palaeosoils and fluvial-lacustrine deposits. However, it should be remarked that most of the fossiliferous sites are located along the current coastline or in correspondence of main calcareous outcrops, mostly outside the central part of the Island (Fig. 1). For this reason, the description of fossiliferous localities from the central areas of Sardinia represents an additional source of data. Very few fossil vertebrate localities from the Quaternary of the central areas of Sardinia are known, among which the Samatzai karst fillings (Dragonara FSC), Sadali (Capo Figari/Orosei 1 FSC) and Nurighe (Dragonara FSC) (Cordy et al., 1998; Palombo et al., 2003; Zoboli, 2010).

The aim of this paper is to provide the description and discussion of the mammalian fossil assemblage localized in the locality of Surconis and to propose a biochronological assignment.

The Surconis site is located in the Marghine mountain range, about 0.5 km E from the village of Bolotana (Nuoro province, central-western Sardinia, Italy; Fig. 2). The mammal remains described in this paper have been collected from the deposit of a small cavity developed

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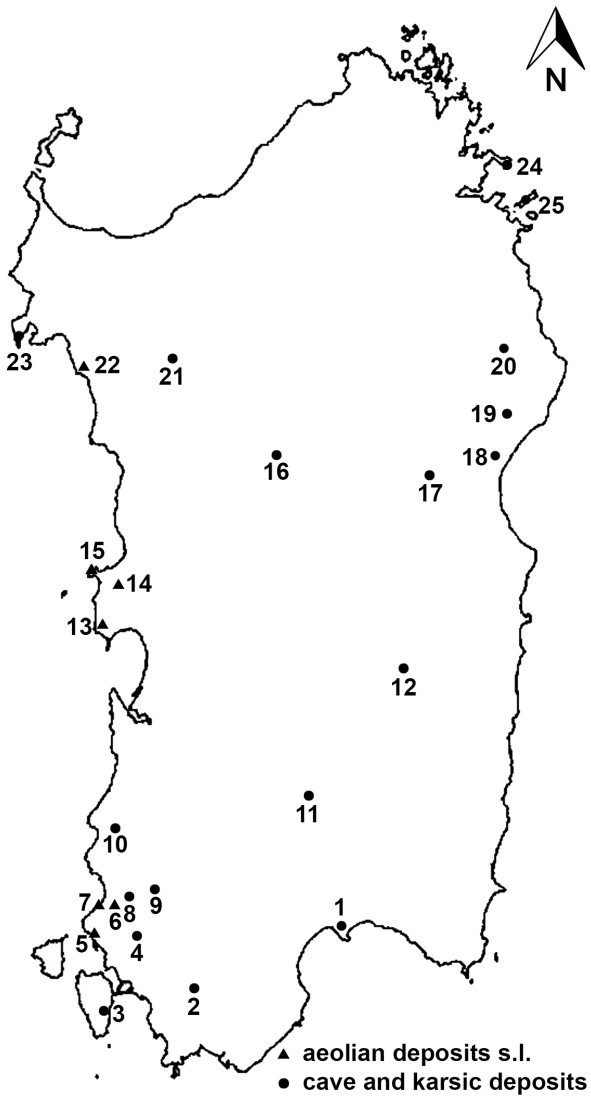


Fig. 1 - Distribution of the principal Plio-Quaternary vertebrate fossiliferous sites of Sardinia: 1) Bonaria (Cagliari), 2) Grotte di Is Zuddas (Santadi), 3) Cannisone (Sant'Antioco), 4) Grotta dei Fiori (Carbonia), 5) Portovesme (Portoscuso), 6) Funtana Morimenta (Gonnesa), 7) Porto Paglia (Gonnesa), 8) Monte S. Giovanni (Iglesias), 9) Grotta di S. Giovanni (Domusnovas), 10) Is Oreris, S. Lucia (Fluminimaggiore), 11) Su Concali (Samatzai), 12) Su Fossu de Cannas (Sadali), 13) S. Giovanni di Sinis (Cabras), 14) Carmas (Riola Sardo), 15) Mandriola, Capo Mannu (San Vero Milis), 16) Surconis (Bolotana), 17) Grotta Corbeddu (Oliena), 18) Grotta di Ispinigoli (Dorgali), 19) Monte Tuttavista (Orosei), 20) Grotta Juntu (Siniscola), 21) Grotta di Nurighe (Cheremule), 22) Il Càntaro (Alghero), 23) Grotta della Medusa/Dragonara, Tramariglio, Grotta dei Cervi (Alghero), 24) Capo Figari (Olbia), 25) Isola di Tavolara (Olbia) (data from: Studiati in Lamarmora, 1857; Major, 1905; Dehaut, 1911; Comaschi Caria, 1968, 1970; Malatesta, 1970; Mezzabotta et al., 1995; Eisenman & Van der Geer, 1999; Abbazzi et al., 2004; Van der Made & Palombo, 2006; Boldrini, 2008; Palombo, 2009; Madurell-Malapeira et al., 2015).

in Silurian-Devonian metamorphic limestones (Fig. 3). The deposit consists of loose clays and metamorphic limestone pebbles. Few other macromammal remains have been collected from cemented breccias outside the cavity; however, this poorly-preserved material does not allow an accurate taxonomic attribution.

MATERIAL AND METHODS

The material analyzed in this study was collected within a small cavity. A total of 50 kg of sampled sediment was sifted using wet sieves (2.5 to 0.5 mm) in order to remove most part of the loose clay. The dried residue has been inspected to recover vertebrate fossils. Furthermore, we employed a Leica MS5 stereomicroscope in order to isolate and study micromammal remains. We used an air engraving pen (3400BPM) to prepare the macromammal remains. Afterwards, the most fragile samples were consolidated using Paraloid B-72. Subsequently, we measured the macromammal remains with a Rupac 0-150 mm/0.01 ABS digital caliper, according to von den Driesch (1976). Comparison was made using literature data (Malatesta, 1970; Caloi & Malatesta, 1974; Salotti et al., 2000; Croitor et al., 2006; Van der Made & Palombo, 2006; Madurell-Malapeira et al., 2015) and materials stored in the Museo Sardo di Geologia e Paleontologia D. Lovisato (Cagliari). Photographs and measurements of the studied micromammal teeth were performed using a Nikon D5000 mounted on a Leica MS5 stereomicroscope. The measurements and nomenclatures of the murid cheek teeth follow the methodologies specified in Michaux (1971). Eight m1 of *Microtus* (*Tyrrhenicola*) *henseli* (Major, 1905) have been studied. Comparison was made with samples of *M*. (*Tyrrhenicola*) spp. from various Sardinian localities (data from Mezzabotta et al., 1995; Minieri et al., 1995; Marcolini et al., 2005, 2006; Boldrini, 2008; Boldrini et al., 2010). Measurements and indexes of m1 of *M*. (*Tyrrhenicola*) *henseli* were taken according to Van der Meulen (1973), Marcolini et al. (2006) methods and Boldrini's (2008) further modifications. The

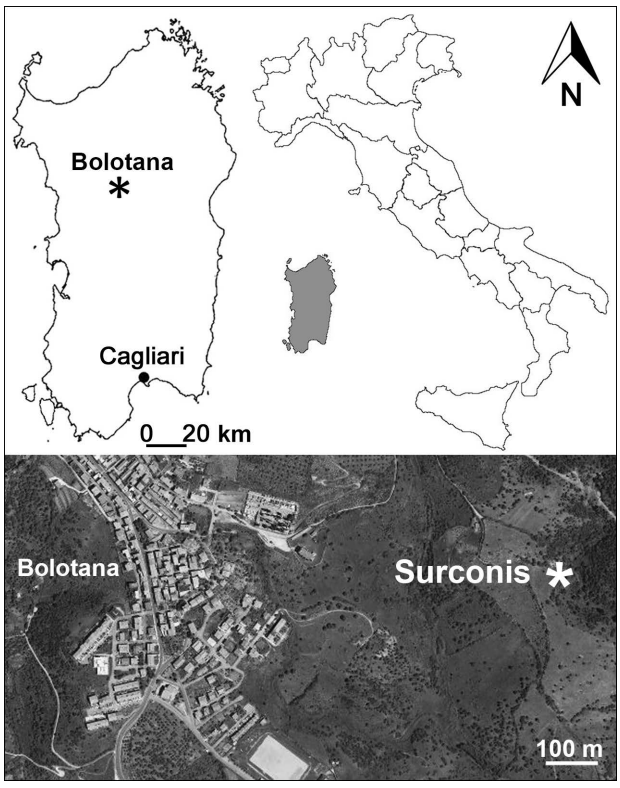


Fig. 2 - Location map of the site of Surconis.

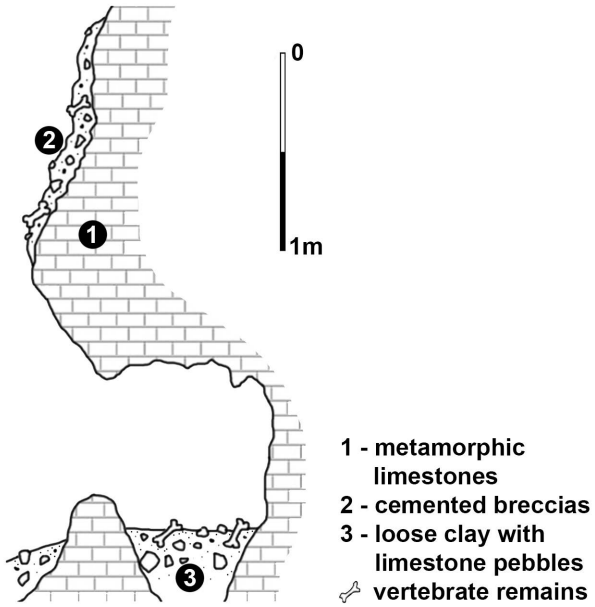


Fig. 3 - Stratigraphic sketch of the site of Surconis.

nomenclatures of lagomorph teeth follow López Martínez (1989) and Angelone (2007).

The studied material is stored at the Museo Sardo di Geologia e Paleontologia Domenico Lovisato (acronym MDLCA) of the Dipartimento di Scienze Chimiche e Geologiche of the University of Cagliari.

Abbreviations

Terminology of the m1 occlusal surface of *M.* (*Tyrrhenicola*): ACC: anteroconid complex, TTC: trigonid-talonid complex, AC: anterior cap, T: triangle, LSA: lingual salient angle, LRA: lingual reentrant angle, BSA: buccal salient angle, BRA: buccal reentrant angle, PL: posterior loop; measurements and morphological indices of the m1 of *Microtus* (*Tyrrhenicola*): V1: total length, V2: total width, V3: length of posterior part of BRA2, V4: width of the neck, A/L: length of ACC against total length, LAC: V4/V1, W/L: width against total length; measurements of macromammal bones and teeth: ph: phalanges, DAPp: proximal antero-posterior diameter, DAPd: distal antero-posterior diameter, DTp: proximal transverse diameter, DTd: distal transverse diameter, Lint: medial length, Lext: lateral length, Lm: medial length, L: total length, DTA: transverse diameter of anterior lobe of the tooth, DTM: transverse diameter of middle lobe of the tooth, DTP: transverse diameter of posterior lobe of the tooth.

SYSTEMATIC PALAEONTOLOGY

Order Lagomorpha Brandt, 1855
Family Ochotonidae Thomas, 1897

Genus *Prolagus* Pomel, 1853
Type species *Prolagus sansaniensis* (Lartet, 1851)

Prolagus sardus (Wagner, 1829)
(Pl. 1, figs 12-15)

Material - Four incomplete crania (MDLCA 23535/1-4), seven right maxillae without dental series (MDLCA 23536/1-7), three left maxillae without dental series (MDLCA 23537/1-3), 54 right hemimandibles (MDLCA 23538/1-54), 54 left hemimandibles (MDLCA 23539/1-54), 15 cervical vertebrae (MDLCA 23540/1-15), six thoracic vertebrae (MDLCA 23541/1-6), 20 lumbar vertebrae (MDLCA 23542/1-20), four sacrums (MDLCA 23543/1-4), two incomplete ribs (MDLCA 23544/1-2), two incomplete right scapulae (MDLCA 23545/1-2), two incomplete left scapulae (MDLCA 23546/1-2), 15 right humeri (MDLCA 23547/1-15), 17 left humeri (MDLCA 23548/1-17), eight right ulnas (MDLCA 23549/1-8), eight left ulnas (MDLCA 23550/1-8), two right radii (MDLCA 23551/1-2), four left radii (MDLCA 23552/1-4), 15 right innominate bones (MDLCA 23553/1-15), 19 left innominate bones (MDLCA 23554/1-19), 44 right femurs (MDLCA 23555/1-44), 49 left femurs (MDLCA 23556/1-49), 39 right tibias (MDLCA 23557/1-39), 41 left tibias (MDLCA 23558/1-41), one proximal phalanx (MDLCA 23559).

Remarks - *Prolagus sardus* is the most abundant taxon at Surconis. This species is typical of the Dragonara FSC (Angelone et al., 2008), and is the most abundant mammal in the deposits of the last part of the Middle Pleistocene - Early Holocene of Sardinia and Corsica (Vigne, 1990). The Surconis site is not an exception, since the bones of this ochotonid are the most numerous. The majority (about 90%) of the studied p3 shows a posteriorly indented and lingually elongated anteroconid (Pl. 1, fig. 12). This morphology suggests that the Surconis material is comparable with the advanced morphotypes of Monte Tuttavista fissure fillings (Angelone et al., 2008). The *Prolagus* assemblage of Surconis includes individuals with different ontogenetic stages, as demonstrated by the different degrees of ossification of the studied bones. Moreover, most of the limb bones (about 80%) lack epiphyses whereas some others can be ascribed to young or sub-adult individuals (Pl. 1, figs 13-15), thus suggesting that adult specimens represent a small portion of this assemblage.

Order Rodentia Bowditch, 1821
Family Cricetidae Fischer, 1817
Subfamily Arvicolinae Gray, 1821

Genus *Microtus* Schrank, 1798
Type species *Microtus terrestris* Schrank, 1798

Subgenus *Tyrrhenicola* Major, 1905

Microtus (*Tyrrhenicola*) *henseli* (Major, 1905)
(Pl. 1, fig. 10)

Material - Twelve right hemimandibles (MDLCA 23560/1-12), 14 left hemimandibles (MDLCA 23561/1-14), one right humerus (MDLCA 23562), two left innominate bones (MDLCA 23563/1-2), six right femurs (MDLCA 23564/1-6), seven left femurs (MDLCA 23565/1-7), two right tibias (MDLCA 23566/1-2), two left tibias (MDLCA 23567/1-2).

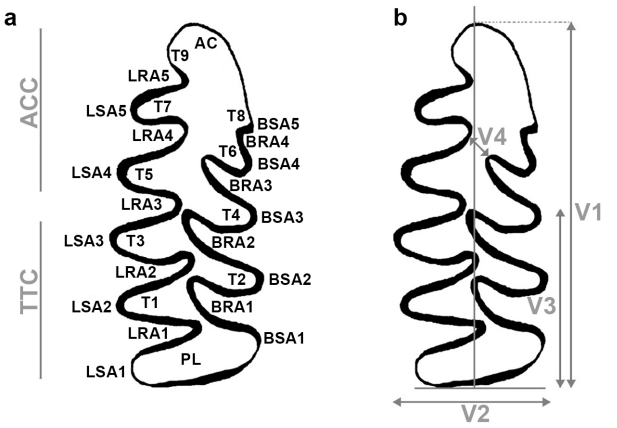


Fig. 4 - a) Terminology of the first lower molar occlusal surface of cricetids (modified from Van der Meulen, 1973). ACC: anteroconid complex, TTC: trigonid-talonid complex, AC: anterior cap, T: triangle, LSA: lingual salient angle, LRA: lingual reentrant angle, BSA: buccal salient angle, BRA: buccal reentrant angle, PL: posterior loop; b) Sketch of measurements of the first lower molar of *Microtus* (*Thyrrhenicola*). V1: total length, V2: total width, V3: length of posterior part of BRA2, V4: width of the neck.

n=8	min	average	max
V1 (total length)	3.24	3.47	3.84
V2 (total width)	1.24	1.36	1.41
V3	1.56	1.73	1.88
V4	0.06	0.09	0.14
A/L	46.95	50.03	53.02
LAC	0.02	0.02	0.04
W/L	0.36	0.39	0.42

Tab. 1 - Measurements (in mm), descriptive statistics of variables and morphological indices of m1 of *Microtus* (*Tyrrhenicola*) *henseli* from Surconis. V1: total length, V2: total width, V3: length of posterior part of BRA2, V4: width of the neck, A/L: length of ACC against total length, LAC: V4/V1, W/L: width against total length.

Remarks - The studied hemimandibles are incomplete and usually present no or heavily damaged teeth. The condyloid process is present in six hemimandibles. Only eight m1 are complete. The m1 are characterized by elongated ACC, asymmetric AC, pronounced T6 and T7, developed T9 and deep LRA5. The post cranial elements are very poorly represented. The distal femoral epiphyses are usually absent. The proximal epiphysis is absent in all tibias.

Microtus (*Tyrrhenicola*) *henseli* is the second most abundant taxon after *Prolagus*. The m1 of *M.* (*Tyrrhenicola*) spp. shows a wide morphologic variability. Mezzabotta et al. (1995) described four principal morphotypes classes of m1 of *M.* (*Tyrrhenicola*). The most primitive class includes small m1 with a simple and short AC, large neck and not well developed or absent T6, whereas the most derived class includes large m1 with long asymmetrical AC, developed T6, narrow neck and always present T7. The intermediate classes include m1 with transitional characters (Mezzabotta et al., 1995). The analysis of m1 of *M.* (*Tyrrhenicola*) from Surconis (Fig. 4, Tab. 1) confirms the presence of derived morphotypes (Pl. 1, fig. 10). The studied sample appears to be comparable with the most advanced *M.* (*Tyrrhenicola*) *henseli* populations of Sardinia (Fig. 5) and differs widely from

EXPLANATION OF PLATE 1

Bone remains of the mammal taxa found in the site of Surconis (Bolotana).

Figs 1-7 - *Praemegaceros* (*Nesoleipoceros*) *cazioti* (Depéret, 1897).

1 - Left incomplete temporal bone (MDLCA 23574) in lateral view.

2 - Incomplete m3 (MDLCA 23575) in buccal (a), lingual (b) and occlusal view (c).

3 - First anterior phalanx (MDLCA 23578/1) in dorsal (a), abaxial (b) and axial view (c).

4 - First posterior phalanx (MDLCA 23581) in dorsal (a), axial (b) and abaxial view (c).

5 - Second phalanx (MDLCA 23579/1) in dorsal (a), abaxial (b) and axial view (c).

6 - Third anterior phalanx (MDLCA 23580) in dorsal (a) and abaxial view (b).

7 - Right astragalus (MDLCA 23576) in anterior (a), posterior (b) and lateral view (c).

Figs 8-9 - *Cynotherium* cf. *sardous* Studiati, 1857.

8 - Incomplete left femur (MDLCA 23573) in anterior (a) and medial view (b).

9 - Left p4 (MDLCA 23572) in occlusal (a), lingual (b) and buccal view (c).

Fig. 10 - *Microtus* (*Tyrrhenicola*) *henseli* (Major, 1905) - left m1-m2 (MDLCA 23561/1) in occlusal view.

Fig. 11 - *Rhagamys orthodon* (Hensel, 1856) - left m1-m3 (MDLCA 23569/1) in occlusal (a) and lingual view (b).

Figs 12-15 - *Prolagus sardus* (Wagner, 1829).

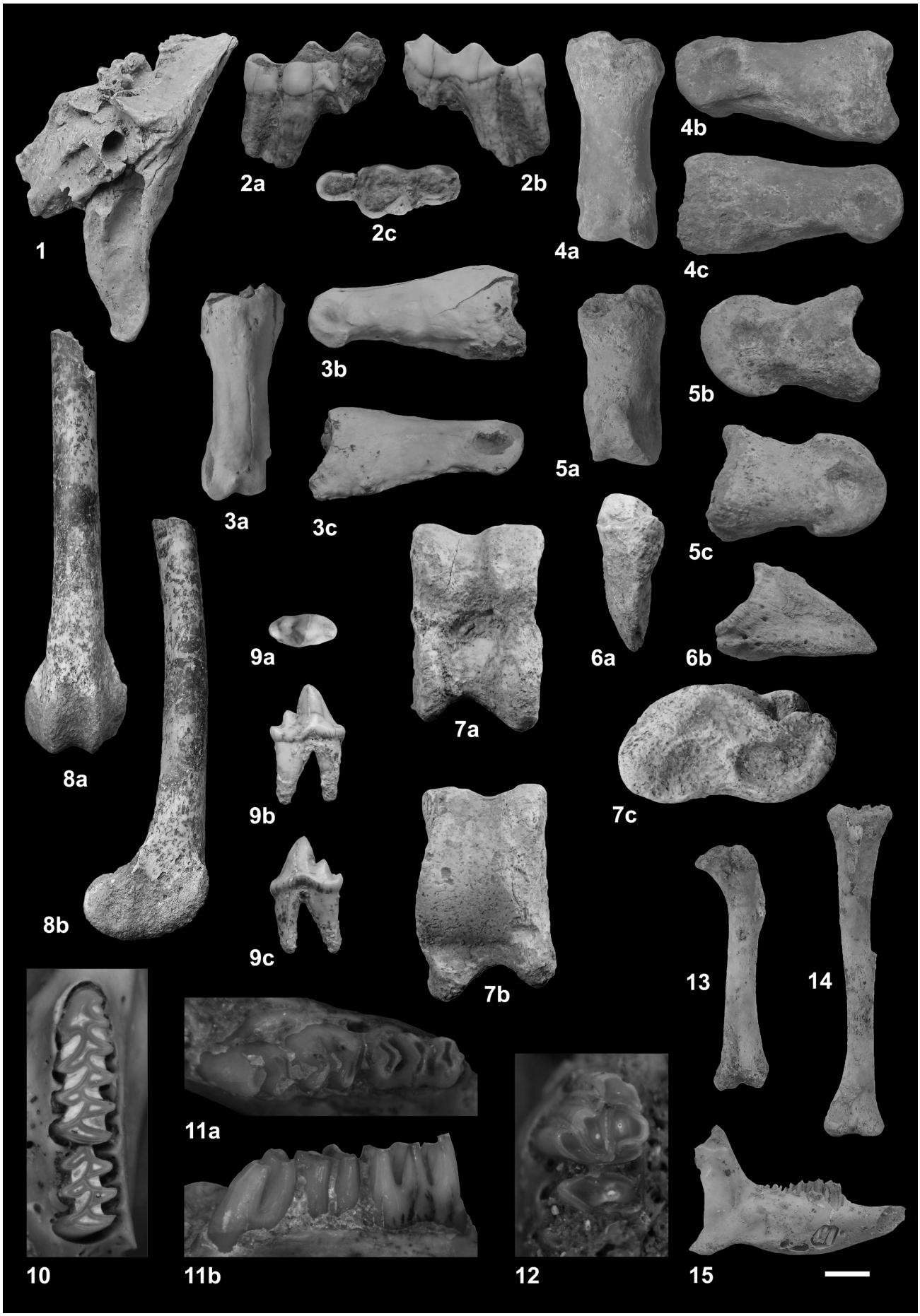
12 - Left p3 (MDLCA 23539/1) in occlusal view.

13 - Juvenile left femur (MDLCA 23556/1) in anterior view.

14 - Juvenile left tibia (MDLCA 23558/1) in anterior view.

15 - Juvenile incomplete right hemimandible (MDLCA 23538/1) in buccal view.

Scale bar: figs 1-7 = 1 cm, fig. 8 = 1.5 cm, fig. 9 = 0.7 cm, figs 10-12 = 1 mm, figs 13-15 = 0.5 cm.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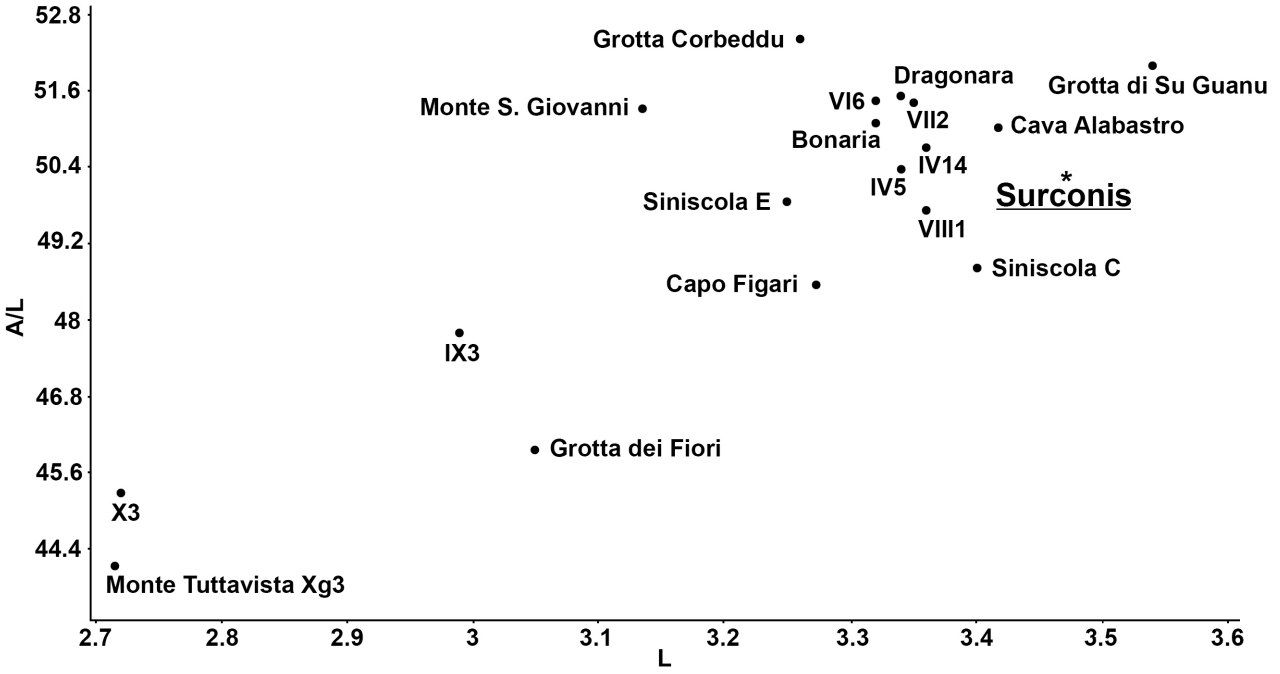

Fig. 5 - Total length (L) against the ratio of lengths of anteroconid complex (A/L = [V1-V3]/V1*100) (measurements in mm) of m1 of *Microtus* (*Tyrrhenicola*) spp. from various localities of Sardinia (data from Mezzabotta et al., 1995; Minieri et al., 1995; Marcolini et al., 2005, 2006; Boldrini, 2008).

the primitive morphotypes of *M*. (*Tyrrhenicola*) *henseli* and *M*. (*Tyrrhenicola*) *sondaari* from Monte Tuttavista (Marcolini at al., 2006).

Family Muridae Illiger, 1811

Genus *Rhagamys* Major, 1905
Type species *Rhagamys orthodon* (Hensel, 1856)

Rhagamys orthodon (Hensel, 1856)
(Pl. 1, fig. 11)

Material - One right hemimandible (MDLCA 23568), two left hemimandibles (MDLCA 23569/1-2), one left humerus (MDLCA 23570), one left tibia (MDLCA 23571).

Remarks - The coronoid process and the condyloid process are broken in all hemimandibles. The dental series is complete in two specimens and the molars are characterized by marked hypsodonty. The maximum length, width and height (in mm) of the two complete m1 are 2.40 x 1.54 x 1.95 (MDLCA 23569/1) and 2.59 x 1.57 x 1.86 (MDLCA 23569/2).

Rhagamys orthodon is rather rare in the Surconis fossil assemblage. This taxon is an endemic insular form living in Sardinia and Corsica from the Middle Pleistocene to the Early Holocene. *R. orthodon* is a very large species of murid, bearing extremely hypsodont molars, significantly different from the continental ancestor assigned to the genus *Rhagapodemus* Kretzoi, 1959 (Piras et al., 2012). The genus *Rhagapodemus* colonized the Corso-Sardinian massif during the early - late Pliocene boundary (Zanclean - Piacenzian transition), originating an insular lineage (Angelone & Kotsakis, 2001). The oldest *Rhagapodemus* species of Sardinia (*Rhagapodemus azzaroli* Angelone & Kotsakis, 2001) is reported in the Capo Mannu D1 local fauna (formerly known as "Mandriola") (Angelone & Kotsakis, 2001; Abbazzi et al., 2008; Piras et al., 2012). *Rhagapodemus minor* (Brandy, 1978), the second species of the lineage, is reported at Capo Figari (Brandy, 1978), in several fissure fillings of Monte Tuttavista (Abbazzi et al., 2004; Piras et al., 2012) and in Corsica (Pereira et al., 2005); this species is reported in the "*Nesogoral*" FC (Capo Figari/Orosei 1 FSC) and in the "*Microtus* (*Tyrrhenicola*)" FC (Orosei 2 FSC) (Palombo, 2009). *Rhagamys orthodon* is the most recent species of this lineage, reported in several localities of Sardinia and Corsica (Dragonara FSC) (Palombo, 2009). The teeth morphology of *R. minor* and *R. orthodon* does not differ (Piras et al., 2012) and the transition between the two species is characterized by an increase in size and hypsodonty (Brandy, 1978; Abbazzi et al., 2004). Based on their dimensions and features, the Surconis samples are referred to the most recent taxon of this endemic lineage.

Order Carnivora Bowditch, 1821
Family Canidae Fischer, 1817

Genus *Cynotherium* Studiati, 1857
Type species *Cynotherium sardous* Studiati, 1857

Cynotherium cf. *sardous* Studiati, 1857
(Pl. 1, figs 8-9)

Material - One complete left p4 (MDLCA 23572), one incomplete left femur (MDLCA 23573).

Remarks - The crown and the roots of the left p4 are complete (Pl. 1, fig. 9). The tooth is robust and its crest is very cutting. Two sharp pointed cusps are present. The anterior cusp is slightly bent backward and inward while the posterior cusp is relatively vertical. A very small denticle is present on the proximal base of the posterior cusp. The cingulum gives rise to two small denticles on the anterior and posterior corners of the tooth. The length and the width of the tooth are 11.41 and 5.42 mm, respectively. The only post-cranial bone of *Cynotherium* is an incomplete left femur (Pl. 1, fig. 8). This element is broken at its proximal third diaphysis. The plantar tuberosities are visible on the distal part of the shaft. The medial and the lateral condyli are complete. The distal antero-posterior diameter and the transverse diameter are 32.04 and 31 mm, respectively.

Cynotherium sardous was established by C. Studiati (in A. Lamarmora, 1857) based on the material collected from Pleistocene breccias of Monreale di Bonaria (Cagliari). This taxon is reported in Middle-Late Pleistocene localities of Sardinia: Monreale di Bonaria (Cagliari), Carreras near Monte Marganai (Iglesias), Cannisone (Sant'Antioco), Su Concali (Samatzai), Nurighe (Cheremule), Grotta dei Cervi, Tramariglio, Monte Santa Giusta, Grotta della Medusa/Dragonara (Alghero), Grotta Corbeddu (Oliena), fissure VII-2 of Monte Tuttavista (Orosei) and Corsica: Castiglione (Oletta), Grotte de la Coscia (Macinaggio/Rogliano) (Comaschi Caria, 1968; Malatesta, 1970; Ulzega et al., 1980; Antonioli et al., 1998; Bonifay et al., 1998; Cordy et al., 1998; Eisenmann & Van der Geer, 1999; Lyras et al., 2006; Salotti et al., 2000; Abbazzi et al, 2005; Zoboli, 2010). *Cynotherium* cf. *sardous* is reported in fissure VI-B6 of Monte Tuttavista (Orosei) (Abbazzi et al., 2005) while *Cynotherium* sp. in other Sardinian localities: Capo Figari (Olbia), fissure fillings

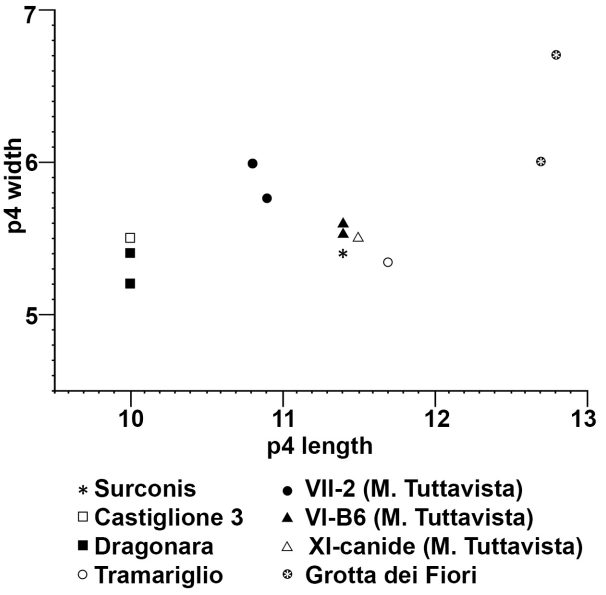

Fig. 6 - Scatter diagram of length and width of lower carnassial (p4) of *Cynotherium* spp. from Sardinia and Corsica (measurements in mm). Data from Malatesta (1970), Salotti et al. (2000), Abbazzi et al. (2005) and Madurell-Malapeira et al. (2015). Data on the Tramariglio specimen are from a mandible plaster cast stored in the Museo Sardo di Geologia e Paleontologia D. Lovisato (Cagliari).

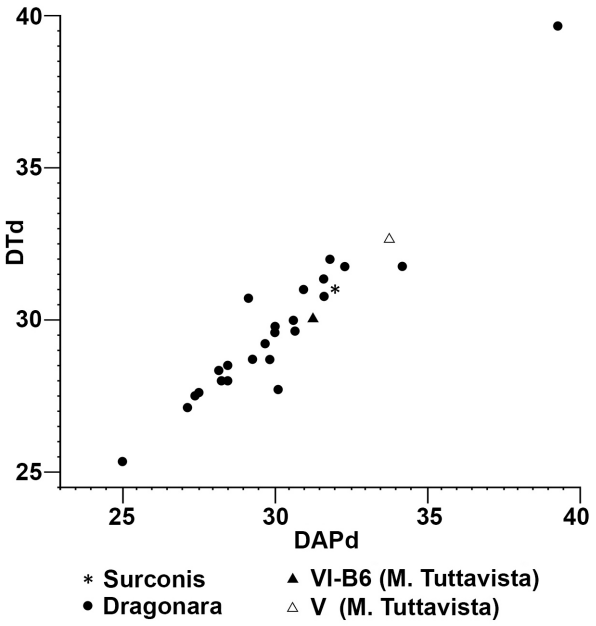

Fig. 7 - Scatter diagram of distal antero-posterior diameter (DAPd) and transverse diameter (DTd) of distal femoral epiphysis (measurements in mm) of *Cynotherium*. Data on the Dragonara specimens of *C. sardous* are from Malatesta (1970), those on M. Tuttavista samples are from Abbazzi et al. (2005).

XI canide, XI Dic2001, IV 20, IX Prolagus, IX cervo and V of Monte Tuttavista (Van der Made, 1999; Abbazzi et al., 2005). Recently, Madurell-Malapeira et al. (2015) established the new species *Cynotherium malatestai* (Madurell-Malapeira, Palombo & Sotnikova, 2015) from the ?late Early Pleistocene and/or early Middle Pleistocene of Grotta dei Fiori (Carbonia). The linear measurements of the p4 from Surconis have been compared with some *Cynotherium* spp. samples from Sardinia and Corsica (Fig. 6). The *Cynotherium* from Surconis is comparable in size with the samples of Tramariglio, fissures VI-B6 and XI-canide of Monte Tuttavista, and differs from the Dragonara, Castiglione 3 and especially Grotta dei Fiori samples. The antero-posterior and the transverse diameters of the distal epiphysis of Surconis have been compared with samples from Dragonara and Monte Tuttavista (fissures V and VI-B6) (Fig. 7). There are no significant dimensional differences among the Surconis and the other specimens. Unfortunately, the osteological material from Surconis is very poor, so we prefer to assign the remains from Bolotana to *Cynotherium* cf. *sardous*.

Order Artiodactyla Owen, 1848
Family Cervidae Goldfuss, 1820

Genus *Praemegaceros* Portis, 1920
Type species *Praemegaceros verticornis* (Dawkins, 1872)

Subgenus *Nesoleipoceros* Radulesco & Samson, 1967

Praemegaceros (*Nesoleipoceros*) *cazioti* (Depéret, 1897)
(Pl. 1, figs 1-7)

Bone	DAPp	DAPd	DTp	DTd	L
ph. 1 ant.	20.38	12.60	16.84	13.37	44.71
ph. 1 ant.	22.20				
ph. 2 ant.	24.53	21.23	18.87	16.58	35.00
ph. 2 ant.		20.00		15.51	
ph. 2 ant.		18.90			
ph. 3 ant.	24.25		14.92		36.97
ph. 1 post.	21.14	14.82	18.83	17.20	44.47
ph. 3 post.	28.11		16.65		
	Lint	**Lext**	**Lm**	**DTp**	**DTd**
Astragalus	42.10	43.96	34.50	26.48	26.67
Tooth	**DTA**	**DTM**	**DTP**	**L**	
m3		12.48	6.85		

Tab. 2 - Measurements (in mm) of the phalanges (ph.), anstragalus and m3 of *Praemegaceros* (*Nesoleipoceros*) *cazioti* from Surconis. DAPp: proximal antero-posterior diameter, DAPd: distal antero-posterior diameter, DTp: proximal transverse diameter, DTd: distal transverse diameter, Lint: medial length, Lext: lateral length, Lm: medial length, L: total length, DTA: transverse diameter of anterior lobe, DTM: transverse diameter of middle lobe, DTP: transverse diameter of posterior lobe.

Material - One left incomplete temporal bone (MDLCA 23574), one incomplete right m3 (MDLCA 23575), one right astragalus (MDLCA 23576), one incomplete metapodial (MDLCA 23577), two first anterior phalanges (MDLCA 23578/1-2), three second anterior phalanges (MDLCA 23579/1-3), one third anterior phalanx (MDLCA 23580), one first posterior phalanx (MDLCA 23581), one third posterior phalanx (MDLCA 23582).

Remarks - An incomplete left temporal bone is the only cranial fragment of *Praemegaceros*. In this fragment, the meatus acusticus externus, the meatus temporalis and the complete styloid process are still visible (Pl. 1, fig. 1). The only deer tooth found in Surconis is an incomplete right m3 (Pl. 1, fig. 2). The tooth is much worn and does not have a high crown, its anterior root and the hypoconid are broken. The limb bones are the most abundant postcranial elements. The astragalus (Pl. 1, fig. 7) is rectangular and elongated and its proximal-lateral trochlear crest is much higher than its proximal-medial trochlear crest. The first phalanges (Pl. 1, figs 3-4) appear elongated and slender, with a considerable difference between the proximal antero-posterior and the distal antero-posterior diameters (Tab. 2). The only complete second phalanx (Pl. 1, fig. 5) appears short and massive with the proximal antero-posterior diameter bigger than the proximal transverse diameter. This difference in diameters suggests the assignment of this bone at the manus. The third phalanx (Pl. 1, fig. 6) is short, high and wide, and has a large plantar surface.

Praemegaceros (*Nesoleipoceros*) *cazioti* (Depéret, 1897) represents one of the most typical taxa of the Middle Pleistocene - Early Holocene insular faunas of Sardinia and Corsica (Dragonara FSC). The ancestor of this deer has been identified in the bigger size (about 25-40%) *Praemegaceros* (*Nesoleipoceros*) *sardus* (Van der Made & Palombo, 2006) from S. Lucia quarry, Capo Figari (Olbia) and probably Su Fossu de Cannas Cave (Sadali) (Van der Made & Palombo, 2006). The origin of the endemic Sardinian deer lineage has been identified as the continental megacerine *Praemegaceros solilhacus* (Robert, 1830) (Vislobokova, 2013).

We compared the deer phalanges from Surconis with *P.* (*Nesoleipoceros*) spp. from Sardinia (Bonaria and S. Lucia) and Corsica (Castiglione 3 and Coscia) (Fig. 8). The dimensions of the Surconis specimens are comparable with the *P.* (*Nesoleipoceros*) *cazioti* samples from Coscia and differ from the samples of *P.* (*Nesoleipoceros*) *sardus* of S. Lucia and from the cervid of Bonaria. It is interesting to point out that the samples from Bonaria ("Collezione Lamarmora Vertebrati", Museo Sardo di Geologia e Paleontologia D. Lovisato, Cagliari) exceed in dimension the paratype specimens of *P.* (*Nesoleipoceros*) *sardus* from S. Lucia. The dimension of the astragalus from Surconis has been compared with samples from Dragonara and S. Lucia (Fig. 9). The astragalus of Bolotana is comparable with the larger specimens of *Praemegaceros* from Dragonara and differs from the megacerine of S. Lucia. In conclusion, the morpho-dimensional features of the deer from Surconis are comparable to the samples of Dragonara and Coscia and differ from the *P.* (*Nesoleipoceros*) *sardus* samples.

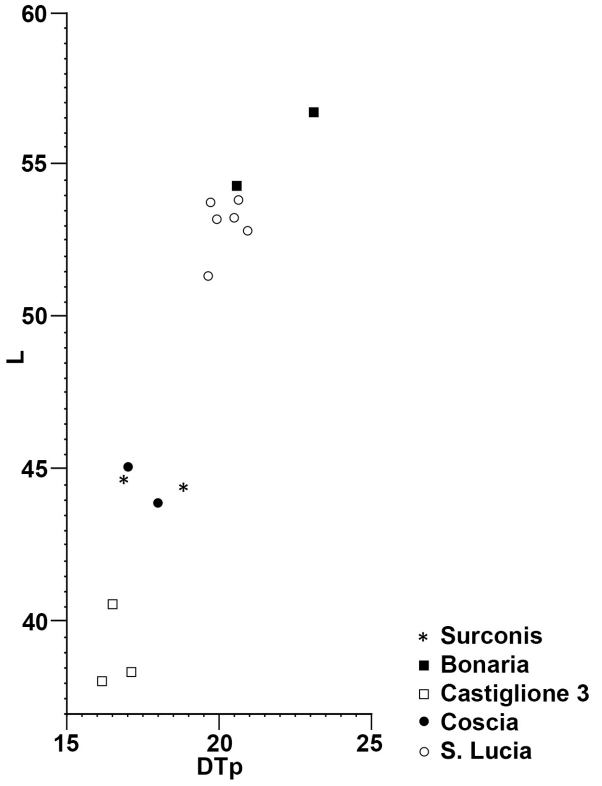

Fig. 8 - Scatter diagram of the first phalanx (L: length, DTp: proximal transverse diameter) of *Praemegaceros* (*Nesoleipoceros*) spp. from Sardinia and Corsica (measurements in mm). Data are from Salotti et al. (2000), Croitor at al. (2006) and Van der Made & Palombo (2006). Data on the Bonaria specimens of ?*P.* (*Nesoleipoceros*) *cazioti* are from material stored in the "Collezione Lamarmora Vertebrati" (Museo Sardo di Geologia e Paleontologia D. Lovisato, Cagliari).

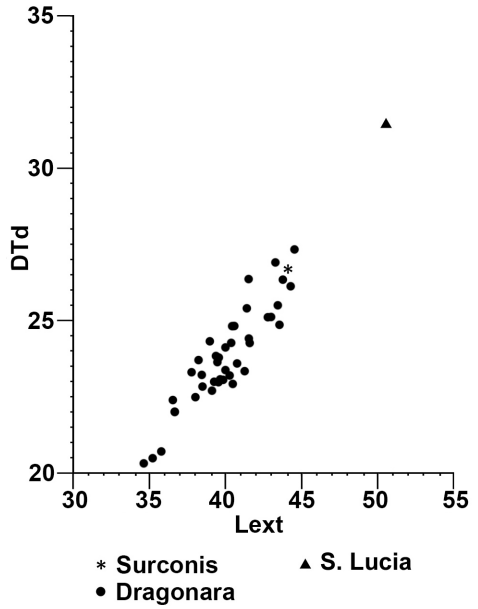

Fig. 9 - Scatter diagram of the astragalus (Lext: lateral length, DTd: distal transverse diameter) of *Praemegaceros* (*Nesoleipoceros*) *cazioti* from Surconis and Dragonara (data from Caloi & Malatesta, 1974) and *Praemegaceros* (*Nesoleipoceros*) *sardus* from S. Lucia (data from Van der Made & Palombo, 2006) (measurements in mm).

DISCUSSION AND CONCLUSIONS

Mammals reported in this study are: *Prolagus sardus* (Wagner, 1829), *Microtus* (*Tyrrhenicola*) *henseli* (Major, 1905), *Rhagamys orthodon* (Hensel, 1856), *Cynotherium* cf. *sardous* Studiati, 1857 and *Praemegaceros* (*Nesoleipoceros*) *cazioti* (Depéret, 1897).

The described taxa of the Surconis site have been previously documented in different localities of Sardinia and Corsica. *Prolagus sardus* is the most abundant taxon, wheras *Microtus* (*Tyrrhenicola*) *henseli* and *Rhagamys orthodon* are less frequent. *Talpa tyrrhenica* Bate, 1945 and *Asoriculus similis* (Hensel, 1855), other typical taxa of the Quaternary of Sardinia and Corsica, have not been identified. Large mammals are poorly represented by several isolated and incomplete bones and teeth.

The presence of Cricetidae, Cervidae and Canidae certainly excludes the "*Nesogoral*" FC in favor of the "*Microtus* (*Tyrrhenicola*)" FC; in fact, these families are not reported in the oldest faunal complex (Palombo, 2009). The preliminary morpho-dimensional analysis of the taxa seems to indicate the well-known "classic" mammal insular assemblage of the Late Pleistocene-Early Holocene of the Corso-Sardinian massif (Dragonara FSC).

The new findings of Surconis provide further contribution regarding the fossil vertebrates of the Quaternary of Sardinia. Up to now, Surconis represents the most diverse fossil vertebrate site reported in the Marghine mountain range.

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