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The Pleistocene vertebrate fauna of the Oricola-Carsoli intermontane Basin (Latium-Abruzzi, Italy): state of the art and historical review

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KEY WORDS - Quaternary, Central Apennines, large mammals, history of Geology, Alessandro Portis, Museum Collections.

ABSTRACT - A review of the abundant vertebrate fauna found in the Quaternary deposits of the Oricola-Carsoli intermontane Basin is here presented, with a brief excursus on the history of the research in this area and some biochronological considerations on these faunal assemblages. Palaeoloxodon antiquus*,* Hippopotamus *cf.* antiquus*, and* Stephanorhinus *sp. remains were found in the 19th century in the municipalities of Vallinfreda and Riofreddo and only described in pioneering studies by the Italian geologists and palaeontologists Giuseppe Ponzi and Alessandro Portis. After some accidental findings of other bones, never described, a hippopotamus was found in 1980 in Riofreddo and, subsequently, during fieldworks led by Aldo Giacomo Segre of the Italian Institute of Human Palaeontology (IsIPU), a very rich vertebrate fauna was found in the municipality of Oricola (L'Aquila). All the available bone material, most of which never studied, described, or mentioned before, is currently stored in different repositories and here has been re-evaluated and briefly described. Two distinct faunal assemblages have been detected; the older is ascribable to the late Villafranchian ELMA (European Land Mammal Age) and is characterised by* Pseudodama *cf.* nestii*,* Leptobos *aff.* furtivus*,* Equus stenonis*,* Stephanorhinus etruscus*,* Mammuthus meridionalis*, and other taxa. The younger assemblage is ascribable to the Galerian ELMA and is characterised by* Palaeoloxodon antiquus*,* Hippopotamus *cf.* antiquus *and* Stephanorhinus *sp.*

INTRODUCTION

The Quaternary sedimentary infilling of the Oricola-Carsoli intermontane Basin (hereinafter OCB) in Central Italy yielded several remains of large vertebrates since the second half of the 19th century. However, most of them have been found by chance and many have been unfortunately lost. Only few remains have been studied, especially in the past, by different Authors including Ponzi (1878), Portis (1896a), and De Angelis d'Ossat (1956). The main goal of this contribution is to provide an updated historical review of the Pleistocene vertebrate fauna collected in the OCB, in order to re-evaluate such important palaeontological findings and also to plan new upcoming fieldworks. Finally, a brief overview of the systematics of the large mammals discovered in different localities within the basin, with their biochronological and palaeoenvironmental considerations, is provided.

GEOLOGICAL SETTING

The Oricola-Carsoli intermontane Basin (OCB, also known as "Piana del Cavaliere") is a tectonic depression with an extent of about 40 km^2, belonging to the drainage basin of the Turano River, a sub-tributary of the Tiber River (Fig. 1). The OCB is westward bounded by the eastern slopes of the Sabini Mts, having at the base the Olevano-Antrodoco-Posta Line, which is the longest thrust fault of the Central Apennines (Salvini & Vittori, 1982; Damiani et al., 1991; Cosentino et al., 2010; Fabbi et al., 2014). The southern and eastern boundaries of the OCB are represented by the Simbruini Mts, whereas north-eastward and northward, the basin is bounded by the Carseolani Mts. The main tributaries of the basin are sourced from the Simbruini Mts, whereas the main emissary is the Turano River which flows northwards toward the Rieti Basin.

The Oricola-Carsoli intermontane Basin originated in the upper Pliocene when, after the main uplift phase of the Apennine Chain (Cosentino et al., 2010), a strong extensional tectonic phase caused the sinking of several portions of the orogen, producing an array of intermontane basins throughout the Apennines (Cosentino et al., 2010). Extensional faults responsible of the basin sinking have been detected through geophysical methods in the carbonate substrate of the OCB, under the thick Pliocene-Pleistocene infilling (D'Orefice et al., 2014).

Throughout the Early Pleistocene and the early Middle Pleistocene, the OCB was essentially occupied by a lacustrine and marshy environment representing the depositional site of the "silts, clay and sands of the Bosco di Oricola" (Fig. 2). This stratigraphic unit is more than 200 m-thick and represents the main infilling of the OCB (D'Orefice et al., 2010, 2014). Subordinate to the lacustrine deposits, also fluvio-lacustrine (gilbert type

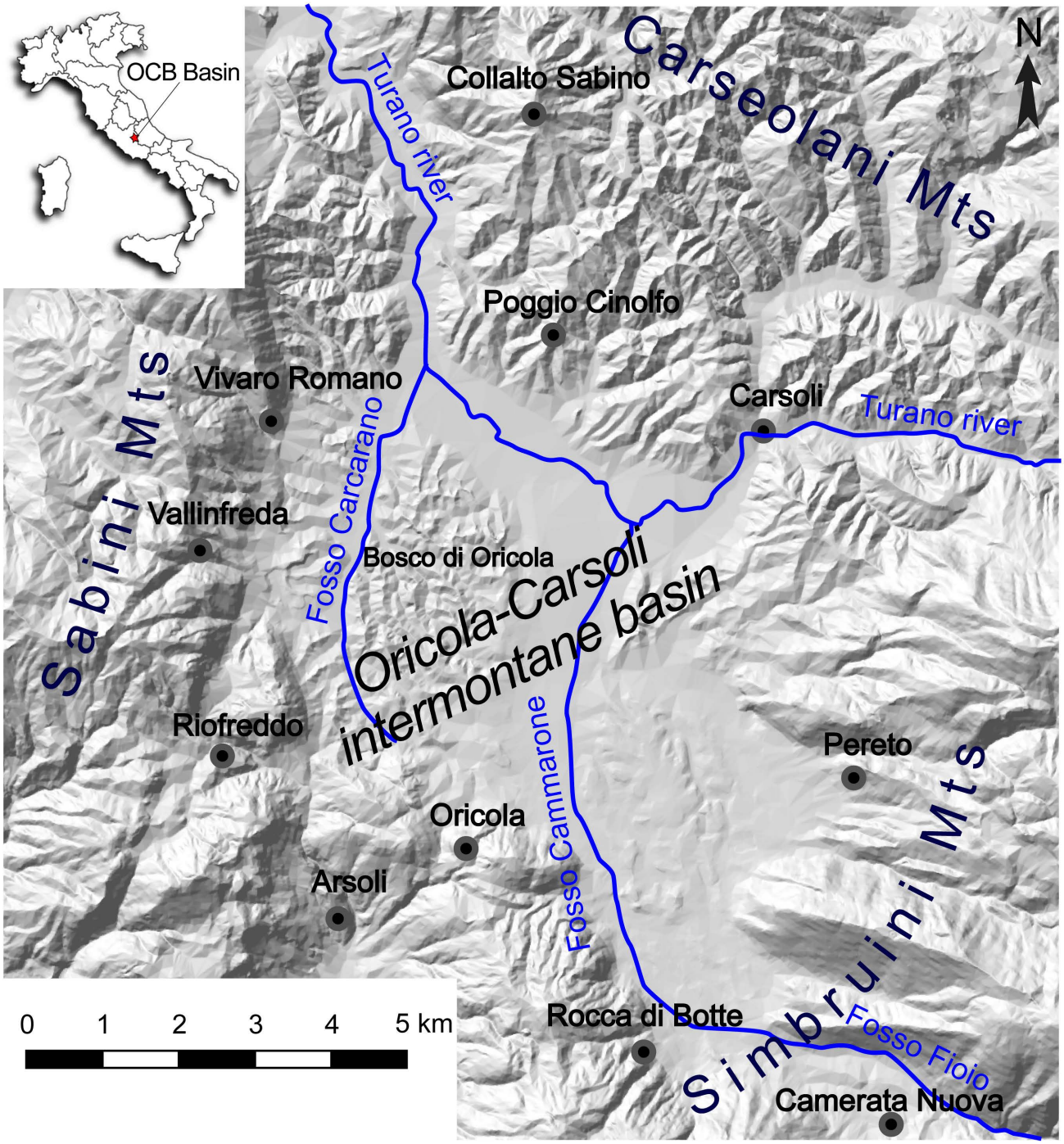

Fig. 1 - (color online) Location and geographical setting of the Oricola-Carsoli intermontane Basin (OCB). Basemap: 10 m - resolution DEM of Italy (Tarquini et al., 2007).

coarse-grained delta) and fluvial deposits s.s. characterise the Lower to Middle Pleistocene sedimentary infilling of the Basin (D'Orefice et al., 2014).

During the Middle Pleistocene (540-531 ka; D'Orefice et al., 2014), a diffuse volcanic activity occurred in the western sector of the OCB, through several monogenic centres. The most important eruptive centre is the Civita di Oricola one, already mentioned by Brocchi (1819) and Meli (1881) in pioneering papers. Volcanic products widely crop out in the area, and are mainly represented by tuffs and other pyroclastic deposits, with subordinated lava flows (Barbieri et al., 2000-2002; D'Orefice et al., 2006).

The upper Middle Pleistocene is represented by post-volcanic lacustrine and fluvio-lacustrine deposits ("gravel, sands and silts of I Prati"; D'Orefice et al., 2014), which differ from their Lower-Middle Pleistocene counterparts for the abundant occurrence of mafic volcanic minerals in the sand/silt fraction (D'Orefice et al., 2014).

In the Late Pleistocene, the OCB was close to the widely glaciated Simbruini Mts ridge (Damiani & Pannuzi, 1990), and sedimentation was dominated by coarse-grained alluvial deposits. Finally, the younger deposits that infill the OCB (uppermost Pleistocene-Holocene) are essentially represented by alluvial cones (Barbieri et al.,

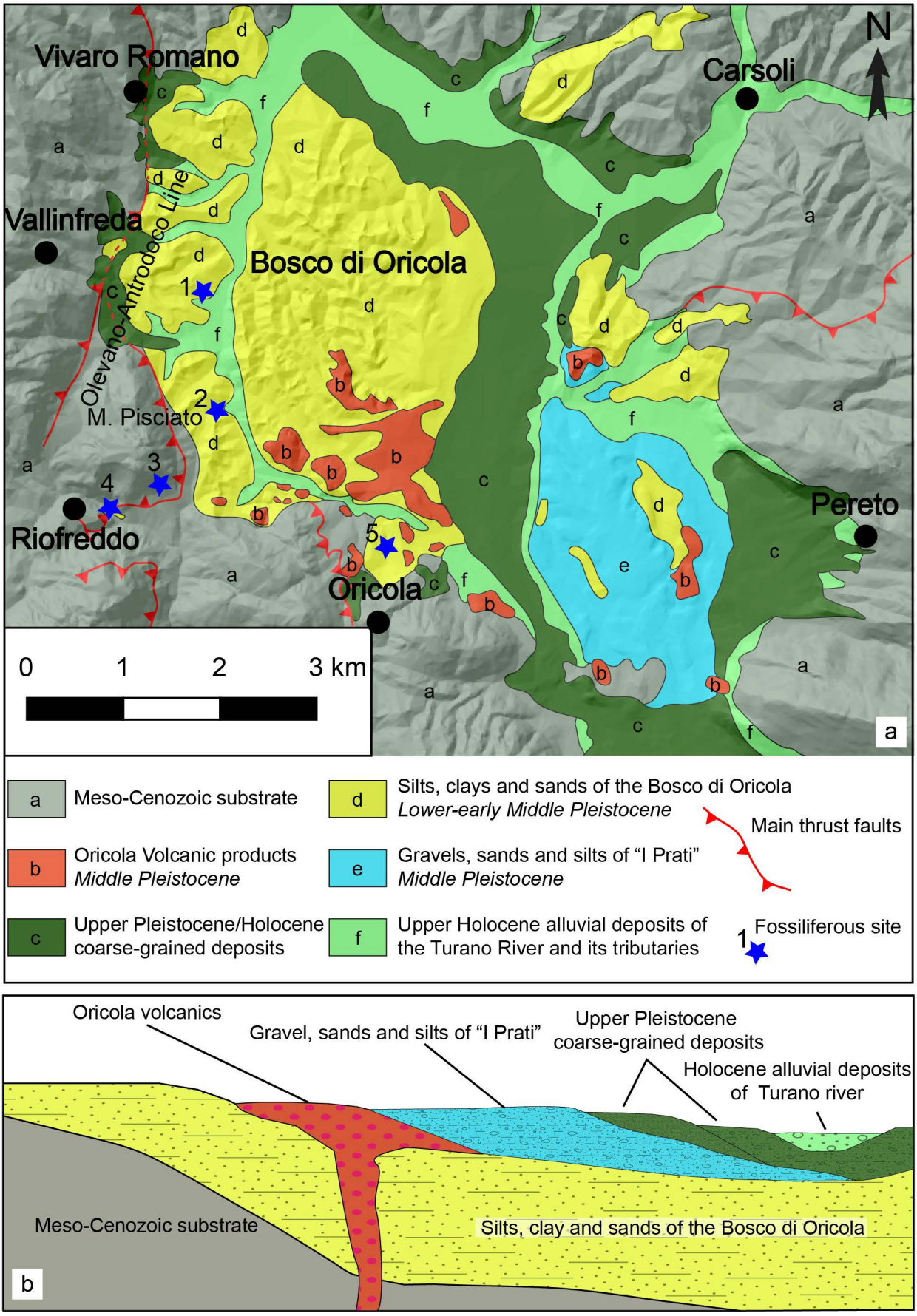

Fig. 2 - (color online) a) Geological sketch map of the OCB with location of the fossiliferous sites: 1, Vallinfreda; 2, Riofreddo-Monte Pisciato; 3, S. Giorgio Cave; 4, Riofreddo-Fonte la Ripa; 5, Piana del Cavaliere-Oricola (Basemap: 10 m - resolution DEM of Italy; Tarquini et al., 2007). b) Sketch depicting the stratigraphy of the OCB (derived from D'Orefice et al., 2014).

1998) and fluvial sediments belonging to the Turano River and its tributaries, deposited during the last late-glacial and post-glacial periods (D'Orefice et al., 2014).

HISTORICAL BACKGROUND

Although pioneering geological notes on the area were provided by Brocchi (1819), the first known report of a fossil vertebrate from the OCB refers to a hippopotamus described by Ponzi (1878), which was discovered by chance in the neighbourhoods of the village of Vallinfreda (Rome, central Italy; Fig. 1). Ponzi (1878) hypothesised that the material could originally belong to a complete skull, subsequently broken by farmers during ploughing work. The Author provided only few information about the site and its geological features, also suggesting that the hippopotamus belonged to a new species, but without any formal description.

Few years later, in 1894, an almost complete elephant skeleton was fortuitously found during ploughing work on a field near the village of Riofreddo (Fig. 1), in the province of Rome, on the western edge of the OCB (Fabbi & Romano, 2020). The authorities of Riofreddo, the Mayor and the General Ricciotti Garibaldi, the youngest son of Ana Maria de Jesus Ribeiro da Silva (better known as Anita Garibaldi) and the "Hero of the Two Worlds" Giuseppe Garibaldi, contacted the Ministry of Education to promote the study of the fossil material. Immediately after, Alessandro Portis, Professor of Geology at Sapienza Università di Roma ("Regia Università di Roma" at that time), and his assistant Gioacchino De Angelis d'Ossat reached the site, located on the easternmost slopes of Monte Pisciato, about one kilometre far from the Riofreddo railway station. They found an almost complete skeleton, about 2.50 x 1.60 m in size, of an elephant (Fig. 3): "... an elephant skeleton lying on the left side, with a somewhat arched spine […] about 60 centimetres deep from the current cultivated surface, which, being very inclined, came, at the end of the feet, to lap the bones, leaving only a few centimetres of vegetal soil to cover them…" (Portis, 1896a, p. 221). The elephant was found in association with some scanty remains of a rhinoceros and a coprolite of a carnivore (Portis, 1896a; De Angelis d'Ossat, 1956) representing, up to now, the most important finding of vertebrate remains in the OCB (Fabbi & Romano, 2020).

After the studies led by Ponzi (1878) and Portis (1896a), only few contributions have been published on the OCB vertebrate fauna, in particular the taxonomical revisions of the Riofreddo elephant by De Angelis d'Ossat (1956) and the Vallinfreda hippopotamus by Caloi et al. (1980). More recently, Segre-Naldini & Valli (2004) described the middle Villafranchian cervid remains from Carsoli-Piano del Cavaliere Basin (Piana del Cavaliere-Oricola site in this paper).

Nevertheless, several discoveries of vertebrate fossils occurred in the last century, some of them briefly described (Radmilli, 1953; Ceruleo, 1982) or just mentioned in local newspapers (Foglio di Lumen, 2007). In particular, some large fossil bones were found in 1952 during the building of a road near Pereto (Fig. 1) and stored for over two decades in a local school; subsequently their destination became unknown. At present, it is therefore not possible to determine their taxonomical attribution (Foglio di Lumen, 2007). In the same year, few poorly preserved cervid remains were found together with human artefacts near the San Giorgio Cave (Radmilli, 1953). In the spring of 1980, the skeleton of a hippopotamus was found near Fonte la Ripa, in the narrow valley facing the village of Riofreddo (Ceruleo, 1982); some bones were found by the owner of the castle of Riofreddo, Arcangelo Spaccatrosi, and subsequently the skeleton was recovered by Piero Cassoli and the Archaeological Superintendence of the Latium Region (Società Riofreddana di Storia Arte e Cultura, 1998). Since then, no further information was available, thus leading Fabbi & Romano (2020) to infer that this specimen was probably lost. However, during the preparation of the present paper, the hippopotamus of Riofreddo was found in the collections of the Italian Institute of Human Palaeontology ("Istituto Italiano di Paleontologia Umana", hereinafter IsIPU); the Superintendence in fact entrusted the specimen to the IsIPU in 1980 for its restoration but it was never described nor studied in detail.

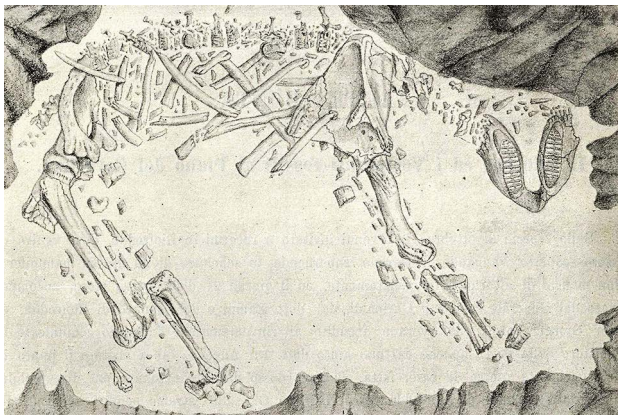

Fig. 3 - The "Elephant of Riofreddo" in its finding conditions, original drawing by A. Portis (after Portis, 1896a).

After this discovery, the IsIPU organised several surveys of the site and surrounding areas, led by A.G. Segre, P. Cassoli and I. Biddittu, and a fossiliferous outcrop was detected in the municipality of Oricola (Figs 4-5). Scientific excavation fieldworks were thus organised between 1980 and 1984, and several bones and teeth belonging to different taxa were recovered in this site, which was erroneously named "Pian del Cavaliere". "Piana del Cavaliere" is the name with which the inhabitants refer to the entire plain, so it is more precise to refer to this site as "Piana del Cavaliere-Oricola".

The photographic documentation of the field surveys and several original notes by A.G. Segre, annotated during and after the surveys, are preserved in the archive of IsIPU (Figs 4-5). Schemes of the site are reported in the notes, with significant annotations, such as the finding of two fossiliferous horizons, the upper one characterised by light-coloured bones, whereas the lower one by dark-coloured bones (Fig. 4). Segre also reported a possible ape (*Pithecos*) among the findings, but it was probably a misinterpretation of some remains, as no further information was provided on this topic (Fig. 4).

The rich fossil fauna found in these fieldworks, which includes proboscideans, bovids, cervids, equids, rhinos

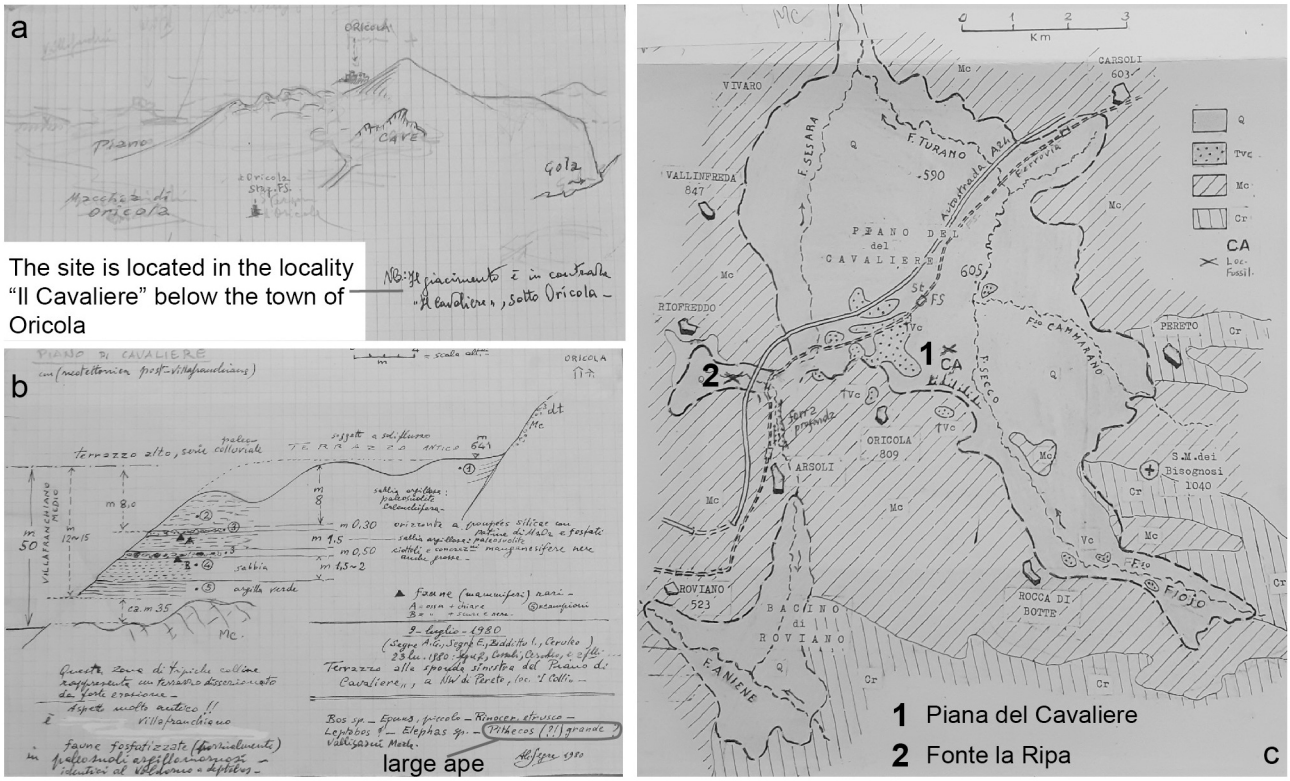

Fig. 4 - a-b) Original field sketches by A.G. Segre of the site Piana del Cavaliere-Oricola; it is reported the occurrence of a large ape (*Pithecos*). c) Sketch map of the OCB by A.G. Segre, with the location of the fossiliferous sites of Riofreddo-Fonte la Ripa and Piana del Cavaliere-Oricola (A.G. Segre Archive - IsIPU).

and tortoises is now preserved in the IsIPU collections. Among this fossil material, only the cervids (Segre-Naldini & Valli, 2004) and a single bovid (Masini, 1989; Masini et al., 2013) have been studied in detail, whereas the rest of the material is currently under study and will be presented in upcoming papers.

MATERIAL AND METHODS

All the known and available fossil material coming from the following palaeontological sites within the OCB (Fig. 2) has been reconsidered and briefly reported. The repository of the specimens is reported whenever it is known:

- Vallinfreda: 1878, the oldest known report of a large fossil vertebrate in the OCB (Ponzi, 1878). Housed at the "Museo Universitario di Scienze della Terra" (hereinafter MUST) of Sapienza Università di Roma.
- Riofreddo-Monte Pisciato: 1894, the most complete skeleton of a proboscidean known from the OCB (Portis, 1896a). Partly stored at MUST, with a bone fragment housed at Museo delle Culture of Villa Garibaldi (Riofreddo); unfortunately, it is partly lost.
- Riofreddo-S. Giorgio Cave: 1952, scarce remains of some fragmentary bones (Radmilli, 1953). No repository information is currently available.
- Pereto: 1952, large fossil bones found during the cutting of a road (unpublished data). It is unknown where they are housed, probably they are lost.
- Riofreddo-Fonte la Ripa: 1980, some remains of hippopotamus and rhinoceros (unpublished data). Currently stored at the IsIPU laboratory in Anagni (Frosinone, Latium), except for a bone fragment which is housed at Museo delle Culture of Villa Garibaldi (Riofreddo).
- Riofreddo-S. Giorgio Cave: 1980, abundant fossil bones, never studied (unpublished data). This material is now housed at the IsIPU laboratory in Anagni (Frosinone, Latium).
- Piana del Cavaliere-Oricola: 1980, 1981, 1984, when the only organised digging fieldworks were carried out in the OCB. The fossil remains are only partly studied and published (Segre-Naldini & Valli, 2004; Masini et al., 2013). This material is now housed at the IsIPU laboratory in Anagni (Frosinone, Latium).

RESULTS

In the following paragraphs we briefly report the fossil specimens found in each considered locality.

Vallinfreda

In 1878, a fragmented mandible, four mandibular fragments and other dentognathic material (Fig. 6) were recovered in yellowish sands nearby the village of Vallinfreda. This material was described by Ponzi (1878) and tentatively ascribed by the Author to a new species without any further description. These fossils are indicated in the original labels of the MUST as

Fig. 5 - Pictures captured during the fieldworks carried out in 1980/1981 in the Piana del Cavaliere-Oricola site. a) Piero Cassoli (standing), Antonio Tagliacozzo (wearing shorts) and other people during the excavations. b) Eugenia Segre-Naldini. c) Left forelimb of *Leptobos* aff. *furtivus* in its finding conditions. d) A long bone still not excavated. e-f) Field pictures showing the conditions of the site in 1981 (A.G. Segre Archive - IsIPU).

"*Hippopotamus major*, Miocenic species" (Fig. 6a). Ponzi did not provide an accurate description of the site, which was subsequently reconstructed by Portis (1896a) about 1 km from the site where the proboscidean remains were discovered by himself, and recently relocated in the map by Fabbi & Romano (2020). The skull of the hippopotamus from Vallinfreda was accidentally discovered and, at the same time, probably broken (Ponzi, 1878). Nowadays the mandible has been partially restored (Fig. 6b). The analysis of the remains collected by Ponzi allowed Portis (1896a) to rule out the attribution to a new species, and he ascribed these remains to *Hippopotamus amphibius* Linnaeus, 1758. However, the unworn conditions of the teeth led Portis to refer the material to a juvenile individual. Finally, Caloi et al. (1980) ascribed the remains of the hippopotamus from Vallinfreda to *Hippopotamus* cf. *antiquus* Desmarest, 1822.

Fig. 6 - (color online) The hippopotamus of Vallinfreda. a) Original label with the written "*Hippopotamus major*, Miocenic species, Vallinfreda" (MUST - Museo Universitario di Scienze della Terra, Sapienza Università di Roma). b) Occlusal view of the mandible (MUST SN180FS). c) Upper canine (MUST SN57). d1-d2) Left maxillary fragment (MUST SN52A). Scale bars correspond to 5 cm.

Riofreddo-Monte Pisciato

Elephantidae - Proboscidean remains from the OCB are essentially represented by the skeleton found at Riofreddo (Portis, 1896a; Fabbi & Romano, 2020) and by other scarce fragmentary fossils, preserved in the collections of IsIPU.

The elephant of Riofreddo-Monte Pisciato was almost complete (Fig. 3) but the lack of the tusks and most of the skull led Portis (1896a) to infer that it was destroyed during the ploughing work, also considering the shallow depth of the skeleton within the productive deposits. In addition, some bones were found among the stones of the surrounding dry-stone walls, such as the calcaneus and fragments of long bones referable to this specimen (Portis, 1896a); this fact confirmed the hypothesis of a partial exposure of the skeleton and of an anthropic reworking of the material.

Unfortunately, the shallow depth of the layer also caused a significant weathering of the bones by meteoric waters and plants, resulting in a bad preservation, with some bones that were almost crumbled (Portis,1896a; De Angelis d'Ossat, 1956). The bones that Portis was able to save, collect and analyse include a mandible with two well-preserved molars, a few vertebrae, a calcaneus, and some long bones fragments (Fig. 7).

The specific determination was attempted by the analysis of the molariform teeth (Fig. 7a-b), which were very well-preserved (Portis, 1896a; De Angelis d'Ossat, 1956). The two teeth are 30 × 11 × 15 cm in size and, after comparison with other known specimens (Portis, 1896a), they were originally attributed to *Elephas meridionalis.* Portis himself, however, was not satisfied with this specific attribution (Portis, 1896a), stressing that features on the atlas vertebra and the calcaneus were fully compatible with the condition observed in *Elephas antiquus*. Based on these observations, Portis inferred that the species *E. antiquus* and *E. meridionalis* were not fully distinguishable and suggested that they could be considered synonyms (Portis, 1896b). These two species are now ascribed to different genera (Palombo & Ferretti, 2005), i.e., *Palaeoloxodon antiquus* (Falconer & Cautley, 1847) and *Mammuthus meridionalis* (Nesti, 1825), but most likely the specimens that had aroused Portis' doubts really all belonged to the same species. The elephant of Riofreddo was later correctly attributed by De Angelis d'Ossat (1956) to *Elephas antiquus* and is, thus, now ascribed to *Palaeoloxodon antiquus.*

Most of the elephant bones from Riofreddo, collected by Portis, are preserved in the MUST collections (Fig. 7) but, unfortunately, the calcaneus and the mandible with the two molariform teeth were not found during our research; these remains are not currently listed in the MUST catalogue and probably they got lost.

Rhinocerothidae - In the site, besides the elephant, Portis also discovered in 1894 a left hemimandibular branch of a rhinoceros (Fig. 8b) that was ascribed to "*Rhinoceros mercki* var. *etruscus*" (Portis, 1896a). In the original label with the description of the material,

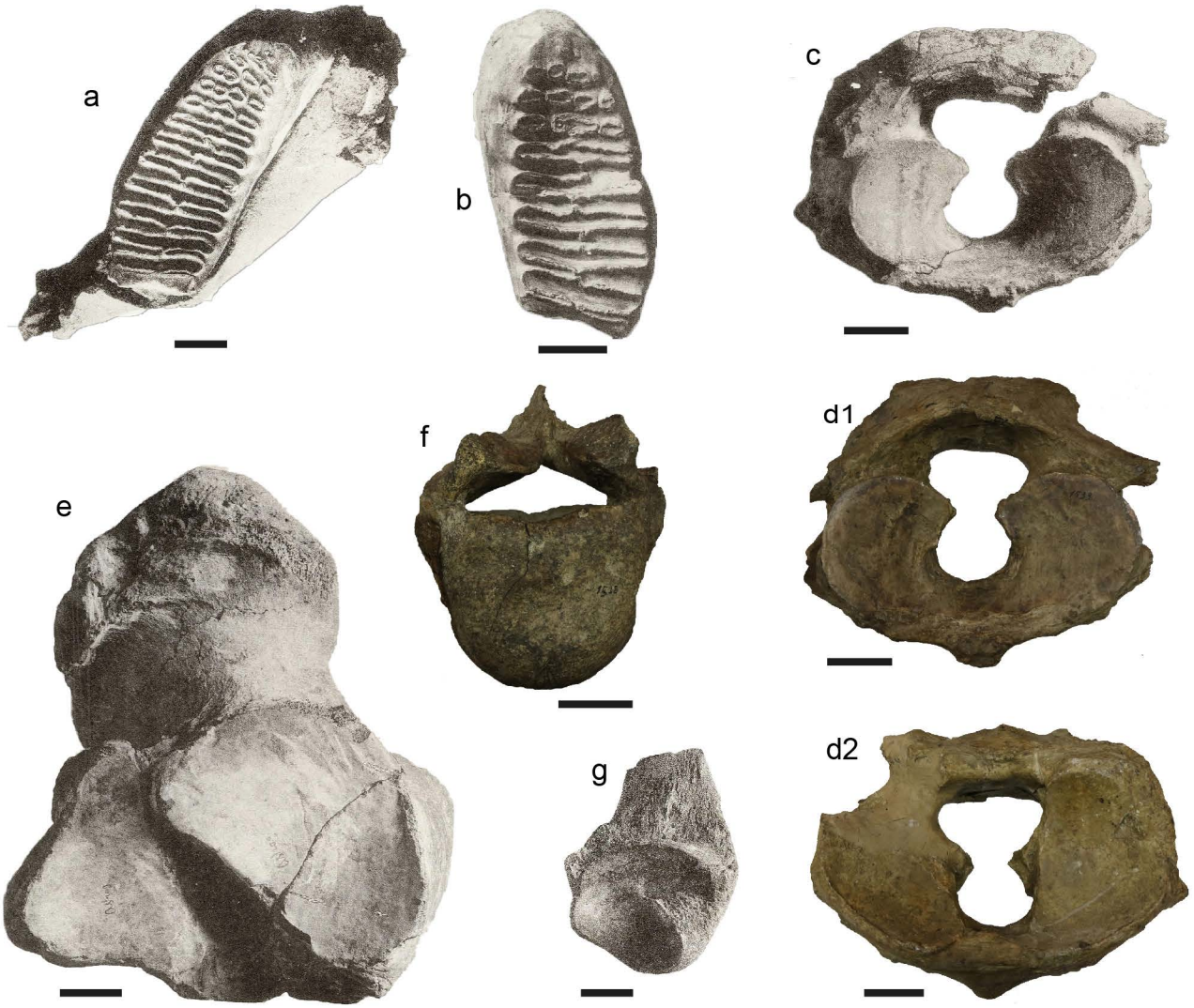

Fig. 7 - (color online) The elephant of Riofreddo. a) Lower left molar (after Portis, 1896a). b) Lower right molar (after Portis, 1896a). c) Atlas in posterior view (after Portis, 1896a). d) Atlas in posterior (d1) and anterior (d2) views, partly restored (MUST SN1539). e) Right calcaneus (after Portis, 1896a). f) Epistropheus in anterior view (MUST SN1548). g) Distal end of right fibula in internal view (after Portis, 1896a). Scale bars correspond to 5 cm.

handwritten by Portis (Fig. 8a), the mandibular branch is described as broken, bearing only two teeth, with other two teeth found not in situ; such teeth were subsequently repositioned by Portis himself on the reconstructed mandible (Portis, 1896a). The finding of this rhinoceros, in association with the elephant, suggests that they would have been probably coeval. Considering the uncertain determination, we conservatively ascribe the material to *Stephanorhinus* Kretzoi, 1942 but further analyses will better address this issue, conceivably allowing a specific determination for this specimen.

Carnivorans - A coprolite of a large carnivore was found by Portis in the site and preliminarily referred by the Author to *Leo spelaea,* now *Panthera spelaea* (Goldfuss, 1810) or *Hyaena brevirostris,* now *Pachycrocuta brevirostris* (Gervais, 1850) (Portis, 1896a). The coprolite had never been figured in any paper and it has not been found in the MUST collections. Unfortunately, we hypothesise that it got lost and any taxonomic attribution would be now purely speculative.

Riofreddo-Fonte la Ripa

Hippopotamidae - Other remains of a hippopotamus were found in the site of Riofreddo-Fonte la Ripa in 1980 (Ceruleo, 1982), and are now housed in the IsIPU collections, with a single bone fragment stored at Museo delle Culture of Villa Garibaldi (Riofreddo).

Unfortunately, no skull material has been found but several postcranial bones are preserved, belonging to a left limb (Fig. 9), a right forelimb (including the ulna, some metatarsal and other bones) and fragments of vertebrae and isolated teeth. The presence of two left calcanei suggests the occurrence of, at least, two individuals. Such material, here figured for the first time, has been very recently rediscovered and it is currently under study by the Authors.

Rhinocerotidae - A lower right molar (Fig. 8c) and fragments of metatarsal bones of a rhinoceros have been found in the site in 1980 and recovered along with the hippopotamus of Riofreddo. Such remains are now stored in the collections of IsIPU.

Fig. 8 - (color online) Rhinocerotidae. a) Original label of the mandibular remain of *Stephanorhinus* sp.; the finding conditions are here described by Portis (MUST - Museo Universitario di Scienze della Terra, Sapienza Università di Roma). b) Left mandibular portion of *Stephanorhinus* sp. found by Portis at Riofreddo-Monte Pisciato in lingual (b1) labial (b2) and occlusal (b3) views; the white area shows the partial restoration of the mandible (MUST NS1505). c) Right lower molar (m2) of *Stephanorhinus* sp. from Riofreddo-Fonte La Ripa site, in vestibular (c1) and occlusal (c2) views (IsIPU). Scale bars correspond to 5 cm.

Fig. 9 - (color online) Left femur of the hippopotamus found at Riofreddo-Fonte la Ripa (IsIPU). a) Posterior view. b) Left lateral view. c) Anterior view. Scale bar corresponds to 20 cm.

Riofreddo-S. Giorgio Cave

Fragments of unidentified bones, conceivably belonging to cervids and small mammals, were found inside the San Giorgio Cave at Riofreddo (Radmilli, 1953; Ceruleo, 1982). In addition, abundant fossil material found in 1980 inside and around the San Giorgio Cave is also available in the IsIPU collections. Such material was never studied before, and its study is planned to be carried out by the Authors.

Piana del Cavaliere-Oricola

Cervidae - The most abundant remains from this site belong to cervids, and include, in particular seven antlers, a left mandibular branch, a scapula, two distal ends of humerus, three proximal ends of radius, three metacarpal bones, three distal fragments of tibia, two astragali, a calcaneus, four metatarsal bones and other fragments, referable to at least five adults and a juvenile individual that were found in the early 1980s (Fig. 10c-d). These remains were studied in detail by Segre-Naldini &Valli (2004) and ascribed to *Pseudodama* cf. *nestii* (Azzaroli, 1947) due to some doubts on the antlers shape.

Bovidae - The most important remains of bovids found in this locality in 1980 and 1981 are the partial skull (Fig. 10a), some postcranial bones and teeth likely belonging to a single individual, now stored in the IsIPU collections. The incomplete skull is crashed and deformed but allowed Masini (1989) and Masini et al. (2013) to ascribe it to *Leptobos* aff. *furtivus* Duvernois, 1989; the postcranial bones suggest that it was a small individual (Masini et al., 2013). In addition, fragmentary remains of *Gazella* cf. *borbonica* Depéret, 1884 were also found (Segre-Naldini & Valli, 2004).

Other taxa - Scarce fragments of bones and tusks of a proboscidean were ascribed to *Mammuthus meridionalis* by Segre-Naldini & Valli (2004) even if no description has been provided. Perissodactyls are represented by scanty remains of the Etruscan rhinoceros *Stephanorhinus etruscus* (Falconer, 1868) and by the equid *Equus stenonis* Cocchi, 1867. Carnivorans are only represented by a right femur of *Vulpes* cf. *alopecoides* (Del Campana, 1913) and other fragmentary bones (Segre-Naldini & Valli, 2004). Finally, *Testudo* Linnaeus, 1758 and *Emys* Duméril, 1805 are also identified (Segre-Naldini & Valli, 2004). This material is currently under study for a thorough taxonomic revision.

DISCUSSION AND FINAL REMARKS

All the specimens briefly reported in the present paper have been found in the same stratigraphic unit, i.e., the

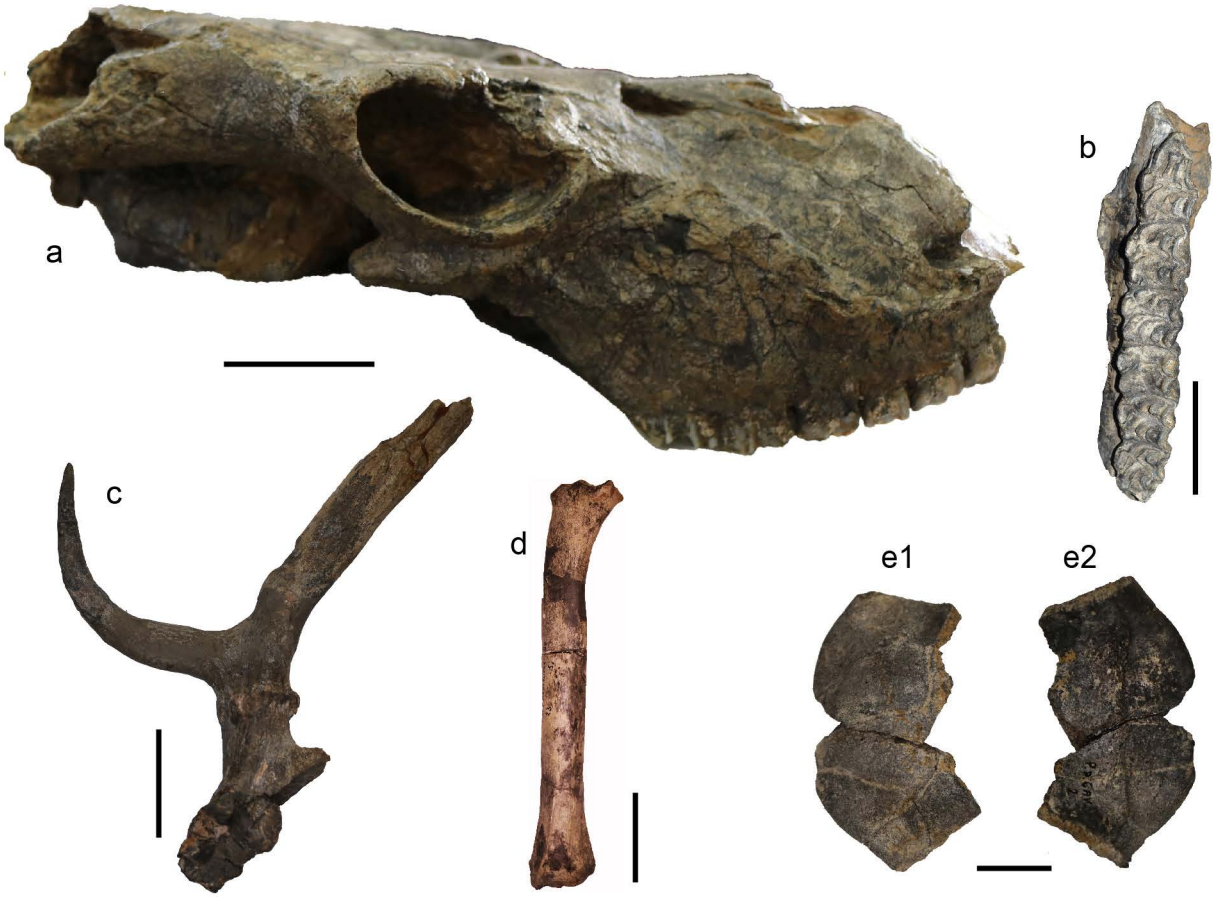

Fig. 10 - (color online) Fossil remains from Piana del Cavaliere-Oricola. a) *Leptobos* aff. *furtivus*, cranium in right lateral view (IIPU PDC1980.7). Scale bar corresponds to 5 cm. b) *Equus stenonis*, occlusal view of the left maxilla (IIPU 120801). Scale bar corresponds to 5 cm. c) *Pseudodama* cf. *nestii*, left antler (IIPU 36). Scale bar corresponds to 5 cm. d) *Pseudodama* cf. *nestii*, left radius (IIPU P.D.CAVALIERE80.23). Scale bar corresponds to 5 cm. e) Fragmentary carapace of Testudinoidea in dorsal (e1) and ventral (e2) views (IIPU P.D.CAV.2). Scale bar corresponds to 3 cm.

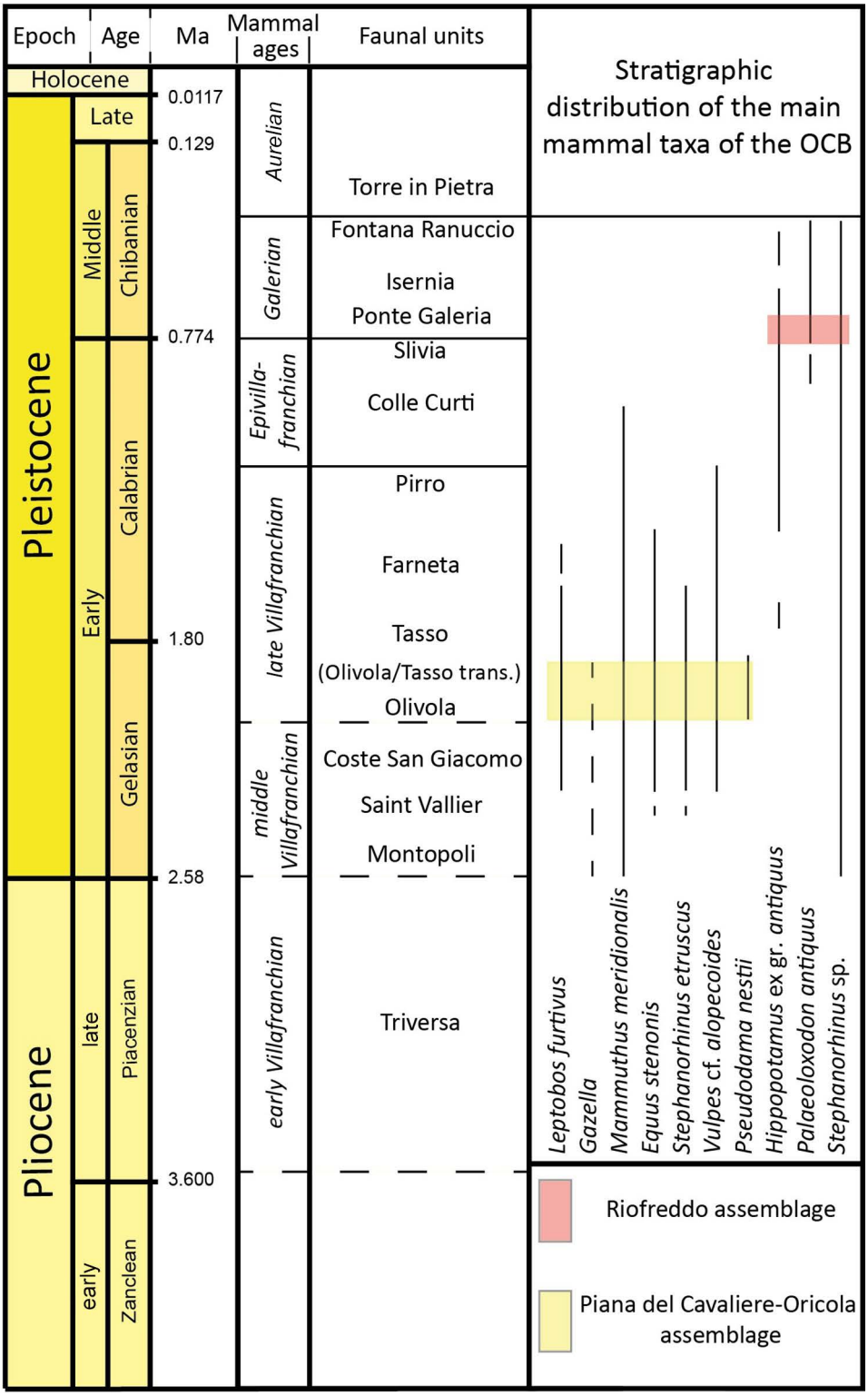

Fig. 11 - (color online) Late Pliocene-Pleistocene Faunal Units (redrawn after Masini & Sala, 2007 and Bellucci et al., 2015), and stratigraphic distribution of the taxa mentioned in the present paper; the position of the two different faunal assemblages recognised in the OCB is indicated.

"silts, clay and sands of the Bosco di Oricola", which was deposited in a long lasting marshy environment, inhabited by large mammals experiencing different climatic conditions, mostly warmer than present-day ones (Portis, 1896a; Segre-Naldini & Valli, 2004; D'Orefice et al., 2014).

This stratigraphic unit covers the Early to Middle Pleistocene (pre-volcanic, ca. 540 ka) (Fig. 2). This means a time span of about 1 Ma, which encompasses several Faunal Units (FUs) according to the Italian biochronological record (see Gliozzi et al., 1997; Petronio et al., 2011; Bellucci et al., 2015) (Fig. 11).

At least two faunal assemblages showing different age can be recognised in this area, which mirror the sites of discoveries, plus two sites whose attribution is currently not determined, i.e., Piana del Cavaliere-Oricola, Riofreddo (Riofreddo-Monte Pisciato and Vallinfreda localities), Riofreddo-Fonte la Ripa (species unknown-under study) and Riofreddo-San Giorgio Cave (new material, no data currently available).

The Piana del Cavaliere-Oricola assemblage is composed of *Mammuthus meridionalis*, *Pseudodama* cf. *nestii*, *Leptobos* aff. *furtivus*, testudinoids, and other subordinate faunal elements (see above). *Pseudodama nestii* is known from the Olivola and Tasso FUs (Petronio et al., 2011) or unique of the Olivola FU, following Masini & Sala (2007); *Leptobos furtivus* is recognised in the early late Villafranchian assemblages of Tuscany (Olivola-Tasso FUs) (Masini, 1989; Duvernois, 1990; Gentili & Masini, 2005) and finally *Mammuthus meridionalis* is reported from the middle Villafranchian Montopoli FU to the early Galerian Colle Curti FU (Petronio et al., 2011). Testudinoidea are widely known from several Pleistocene sites of Italy (Kotsakis, 1981).

This faunal assemblage is thus confidently referable to the late Villafranchian (Calabrian, Early Pleistocene), probably to the Olivola FU (Fig. 11), pending a detailed revision of this material.

The straight-tusk elephant *Palaeoloxodon antiquus*, the rhinoceros *Stephanorhinus* sp. and *Hippopotamus antiquus* were discovered in the Riofreddo site. The proboscideans of Riofreddo and the hippopotamus of Vallinfreda were found embedded in the same stratigraphic unit ("silts, clay and sands of the Bosco di Oricola") that led Portis to consider they were roughly coeval; nevertheless, in the original description handwritten by Portis of the embedding material (Fig. 12) it is mentioned the occurrence of augite, which lacks in such sediments prior to the beginning of volcanic activity in the region. This consideration allows us to consider the hippopotamus of Vallinfreda slightly younger than the elephant of Riofreddo, and possibly being encased in the uppermost layers of the "silts, clay and sands of the Bosco di Oricola", at least coeval with the initial activity of the main volcanoes of the Latium volcanic district (ca. 800 ka; Karner et al., 2001). This mammal assemblage can be referred to the Galerian ELMA (Fig. 11) according to the Italian biochronological framework proposed by different Authors (Gliozzi et al., 1997; Masini & Sala, 2007; Petronio et al., 2011) even if the hippopotamus from Vallinfreda could be slightly younger (see above). The hippopotamus and rhinoceros from the Riofreddo-Fonte la Ripa site are currently under study and their specific determination has not been defined yet, so they cannot be referred to any precise Faunal Unit.

The faunal assemblage of San Giorgio Cave has never been studied but is conceivably younger than the others, due to abundant cut marks referrable to human butchering processes.

In conclusion the OCB represents an important area for the study of the Pleistocene vertebrate associations since the second half of the 19th century as well-attested in historical documents. Multiple fossil vertebrate remains have been unearthed in the last two centuries, either accidentally found by the local population or collected during surveys and excavations carried out by eminent geologists and by IsIPU researchers. Unfortunately, it is not possible to know where some fossil remains are housed and documents recording their location may had been lost. However, a rich collection from the Piana del Cavaliere-Oricola and the Riofreddo localities is currently stored at MUST (Sapienza Università di Roma) and at the Istituto Italiano di Paleontologia Umana. The Piana del Cavaliere-Oricola assemblage is here referred to the Olivola FU (late Villafranchian; Early Pleistocene), whereas the Riofreddo assemblage to the Galerian (Middle Pleistocene).

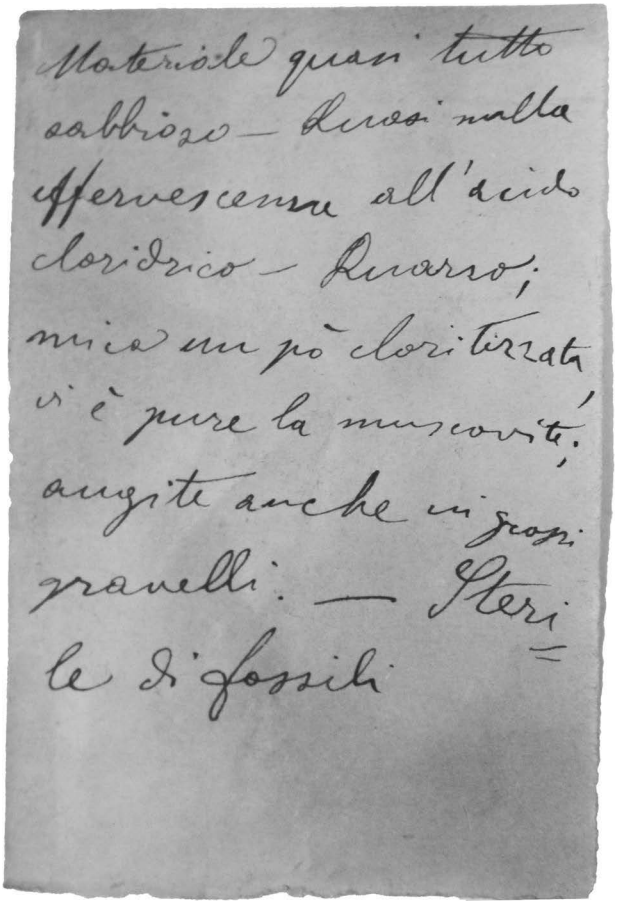
Materiale quasi tutto sabbioso — Dà poca effervescenza all'acido cloridrico — Quarzo; mica un pò cloritizzata si è pure la muscovite; augite anche in grossi granelli. — Sterile di fossili

Fig. 12 - Original label handwritten by A. Portis noticing augite crystals within the components of the sand matrix embedding the hippopotamus of Vallinfreda (MUST - Museo Universitario di Scienze della Terra, Sapienza Università di Roma).

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are warmly acknowledged for giving us the possibility to access to their collections, for fruitful discussions and for providing old local publications that allowed us to reconstruct the history of the findings. Finally, we would like to thank Fabiana Console (Ispra Library) and Marco Pantaloni (Ispra-Servizio Geologico d'Italia) for giving us the hint to focus our attention on Portis' old publications on the study area, and for providing iconographic material from Portis' monograph.

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