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Early Pleistocene fossil birds from Cava Sud, Soave (Verona, North-Eastern Italy)

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Abstract — The analysis of the fossil bird remains found in the Early Pleistocene deposits of Cava Sud, one of the localities of the so-called “Brecce di Soave”, is presented. The fossil remains have been found in some fissure fillings opened in the Eocene limestone and exploited by quarry activities. The fossil bird bones were associated with macro- and micromammals and the whole association is referred to the late Early Pleistocene MNQ 19 on the basis of the taxonomy and evolutionary degree of the micromammals. This study reveals the presence of at least 14 taxa and Cava Sud testifies the oldest occurrence of some of them, particularly *Rallus aquaticus* and *Strix nebulosa*, and the oldest Italian record of *Carduelis chloris*. The species identity of *Corvus pliocaenus* is also discussed and confirmed. Our results also support the hypothesis that the late Early Pleistocene represents the beginning of the present-day European avifauna, as the fossil associations of this age comprise mostly extant taxa. The bird taxa found at Cava Sud allow making palaeoenvironmental reconstructions of the area, suggesting the presence of dense woodlands and open grassy environment.

Key words: Birds, Early Pleistocene, Italy, paleoenvironment, *Strix nebulosa*

Introduction

The locality of Cava Sud is one of the various localities of the so-called “Brecce di Soave”. This term is used to define a karst filling complex occurring in the Eocene limestone exposed and extensively quarried near the village of Soave (Verona, NE Italy). The fissures are filled by white or reddish not cemented calcareous sands and locally contain fossil vertebrates (PASA 1947; BONA & SARDELLA 2012). The fossiliferous deposits have been described and studied since the first half of the 19th century (SCORTEGAGNA 1844).

The deposits of Cava Sud are the oldest of the entire karst network and are referable to the late Early Pleistocene, as Cava Sud is the type-locality of the Arvicolinae *Microtus (Allophaiomys) ruffoi* described by PASA (1947), a key species for the biochronology of the Italian late Early Pleis-

tocene (SALA & MASINI 2007; MARCOLINI *et al.* 2013). In particular, Cava Sud is one of the localities referred to the “Pirro Nord Faunal Unit” of the Italian biochronological scheme (GLIOZZI *et al.* 1997), corresponding to the MNQ 19, around 1.5 Ma. The complete list of mammals from Cava Sud is listed in BON *et al.* (1991).

Most of the fossil remains collected at Cava Sud are of small dimensions, resulting that the association is dominated by small-sized taxa and/or small-sized bones of bigger taxa. Most of the bird bones are presented by very fragmented long bones, so they can only be referred to small-sized Passeriformes or Aves indeterminate. In addition, the bones are not very well preserved, as they are slightly decalcified, and the complete long bones are extremely rare, except for some pedal phalanges, explaining the relatively scarce number of taxa identified at specific level.

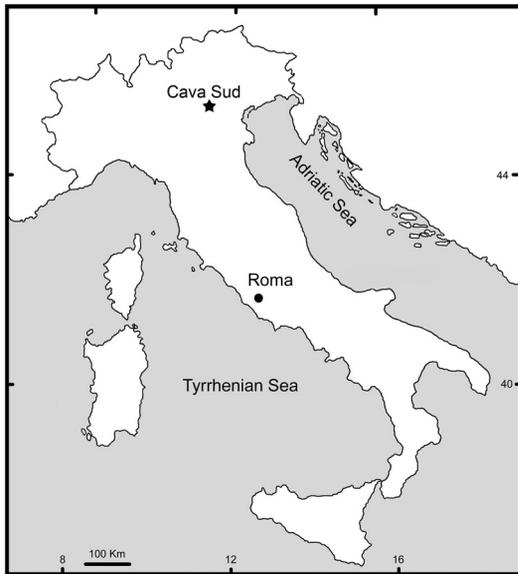


FIGURE 1. Geographic location of Cava Sud, near the village of Soave, Verona County, in the North-Eastern Italy.

MOURER-CHAUVIRÉ (1980) partially analysed the fossil birds from Cava Sud and reported the presence of *Palaeocryptonyx* sp., Alaudidae and *Corvus pliocaenus*. More recently, one of us (CB) studied the complete fossil bird assemblage and reported the presence of 16 taxa (BEDETTI 2003). Aim of this paper is the completion of the study of the fossil of birds collected by PASA during the first half of the 20th Century (PASA 1947) and stored at the Museo di Storia Naturale of Verona, Italy.

Material and Methods

The bird material collected at Cava Sud is entirely stored at the Museo Civico di Storia Naturale of Verona (MCSN V). The fossil bones were compared with recent bird skeletons stored in the Dipartimento di Scienze della Terra, University of Torino, Italy (Marco Pavia Ornithological Collection, MPOC), in the Museo Civico di Storia Naturale di Carmagnola, Torino, and in the Laboratoire de Géologie de Lyon, Université Claude Bernard Lyon 1, Villeurbanne, France. Osteological terminology used in this publication principally follows BAUMEL & WITMER (1993); measurements were taken after VON DEN DRIESCH (1976) and GÖHLICH & MOURER-

CHAUVIRÉ (2005). The systematic order and the nomenclature for the extant taxa is following DEL HOYO *et al.* (1992, 1994, 1996, 1999, 2004, 2009, 2011), including the author names of the extant bird taxa.

Systematic Paleontology

The present analysis refines the conclusions reached by BEDETTI (2003) and allows us to define the fossil bird assemblage of Cava Sud. It is constituted by 14 taxa: *Branta* sp., *Palaeocryptonyx donnezani*, cf Tetraoninae indet., *Aquila* sp., *Rallus aquaticus*, Charadriiformes indet., *Bubo bubo*, *Strix nebulosa*, Strigidae indet., *Alauda arvensis*, *Corvus pliocaenus*, *Carduelis chloris*, *Emberiza* sp., Passeriformes indet. Synonymy lists have been provided only for the fossil species.

Order Anseriformes WAGLER, 1831

Family Anatidae VIGORS, 1825

Genus *Branta* SCOPOLI, 1769

Branta sp.

Material: Cranial fragment of left scapula (MCSN V12400); distal right radius (MCSN V12420); left os carpi ulnare (MCSN V12328a).

Remarks: The three fragments are of a middle- to big-sized Anatidae thus comparable with the genera *Branta* and *Tadorna* among the Palaearctic Pleistocene taxa. The fossil can be referred to the genus *Branta* for the size, bigger than *Tadorna*, and the following characteristics, which are absent in *Tadorna*: a small fossa on the lateral surface of the scapula, just below the facies articularis humeralis; a shallow sulcus tendinosus in the distal radius and the wider incisura metacarpale in the os carpi ulnare. The dimensions of the bones are comparable with *Branta leucopsis*, the biggest European species of the genus (BACHER 1967), but their fragmentary status do not allow to better the determination above the genus level.

Order Galliformes TEMMINCK, 1820

Family Phasianidae VIGORS, 1825

Genus *Palaeocryptonyx* DEPÉRET, 1892

***Palaeocryptonyx donnezani* DEPÉRET, 1892**

(Fig. 2A–E, G–H)

- *1892 *Palaeocryptonyx donnezani* – DEPÉRET: 691.
- *pars 1897 *Palaeocryptonyx Donnezani* DEPÉRET, 1892 – DEPÉRET: 131–134; pl. 13, figs 2–10 [non pl. 13, figs 3–3a, 4–4a, 7–7a, 10–10a].
- *pars 1897 *Turdus* aff. *cyaneus* [sic *Turdus cyaneus* = *Monticola solitarius*] LINNAEUS, 1766 – DEPÉRET: 137–138, pl. 13, figs 23–23a.
- 1933 *Palaeocryptonyx donnezani* DEPÉRET, 1890 [sic] – LAMBRECHT: 438.
- 1954 ?*Palaeocryptonyx donnezani* DEPÉRET, 1892 – THENIUS: 49–50.
- 1964 *Palaeocryptonyx donnezani* DEPÉRET, 1892 – BRODKORB: 316–317.
- * 1980 *Palaeocryptonyx* sp. – MOURER-CHAUVIRÉ: 355.
- 1996 *Palaeocryptonyx donnezani* DEPÉRET, 1892 – MLÍKOVSKÝ: 188.
- 1997 *Palaeocryptonyx donnezani* DEPÉRET, 1892 – BOCHEŇSKÝ: 309.
- 1998 *Palaeocryptonyx donnezani* DEPÉRET, 1892 – MLÍKOVSKÝ: 136.
- 1998 *Palaeocryptonyx donnezani* DEPÉRET, 1892 – TYRBERG: 522.
- pars 2002a *Alectoris donnezani* (DEPÉRET, 1892) – MLÍKOVSKÝ: 159–161.
- 2002b *Coturnix donnezani* (DEPÉRET, 1892) – MLÍKOVSKÝ: 60.
- * 2003 *Palaeocryptonyx donnezani* DEPÉRET, 1892 – BEDETTI: 78–79, Pl. 3, Figs n, q.
- *pars 2003 *Perdix* n. sp. – BEDETTI: 78–79.
- 2009 *Palaeocryptonyx donnezani* DEPÉRET, 1892 – SÁNCHEZ-MARCO: 1150, fig 2a–c.
- * 2012a *Palaeocryptonyx donnezani* DEPÉRET, 1892 – PAVIA *et al.*: 258–262, figs 1, 2B.
- * 2013 *Palaeocryptonyx donnezani* DEPÉRET, 1892 – BEDETTI & PAVIA: 36–37, pl. 1, figs o–p.

Material: Two proximal right humeri (MCSN V12322c, MCSN V12340); left ulna (MCSN V12341), proximal right ulna (MCSN V12319d); two left carpometacarpi (MCSN V12339a, MCSN V12339d), distal left carpometacarpus (MCSN V12339e), right carpometacarpus (MCSN V12319e), two distal right carpometacarpi (MCSN V12339d, MCSN V12339f); three distal tibiotarsi (MCSN V12322d, MCSN V12333, MCSN V12344a), right tibiotarsus (MCSN V12319c); proximal left tarsometatarsus (MCSN V12334), distal left tarsometatarsus (MCSN V12322e), right tarsometatarsus (MCSN V12318d).

Measurements: See Table 1.

Description: In the fossil bones from Cava Sud there are some bone of a small-size Phasia-

nidae, smaller than the extant *Perdix perdix* and larger than *Coturnix coturnix*. All the bones can be referred to *Palaeocryptonyx donnezani* following the characteristics pointed out by PAVIA *et al.* (2012). In particular, the coracoid is not pneumatized, the humerus shows the two pneumatic fossae pneumotricipitalis with lamella and substantia spongiosa in the ventral one, the carpometacarpus shows a well-developed processus intermetacarpalis and the facies articularis digitalis more distally than the convex part of the facies articularis digitalis major, and the distal tibiotarsus is slender. It is also noteworthy to note that the material of Cava Sud allow us to describe and illustrate for the first time the ulna and the tarsometatarsus of *P. donnezani*, as the latter is not present in the type-series while the former is only represented by the distal part (PAVIA *et al.* 2012a). The ulna is relatively short and bent with the proximal end ventrodorsally compressed and the cross section triangular; the margo interosseus is well developed and the olecranon is sharp in caudal view and in continuation of the shaft bending; the impressio musculi brachialis is superficially and clearly bordered. In the distal end, the condylus ventralis ulnae is well developed and pointed distally and the tuberculum carpalis tends cranially. The tarsometatarsus is slender, with the proximal end narrower than the distal one and no evidence of spur; the crista medianoplantaris is absent with the hypotarsus situated slightly laterally; the fossa infracotyloidalis dorsalis is well pronounced and the sulcus extensorius is shallow. The plantar side of the shaft is raised and smooth, with the cristae slightly evident; in the distal part, the trochlea 4 distally surpassed trochlea II and the trochlea II and IV are equally bent plantarly.

Remarks: After the present study we can better precise the specific attribution of the material from Cava Sud, previously indicated as *Palaeocryptonyx* sp. by MOURER-CHAUVIRÉ (1980). The type-series of *P. donnezani* has recently been re-examined by PAVIA *et al.* (2012a) with the selection of lectotype and paralectotypes and also the assessment of the systematic identity of the species. The recently described *Palaeocryptonyx novacki* SÁNCHEZ-MARCO, 2009 from the Late Pliocene of Spain can be excluded because it is overall smaller and shows some morphological



FIGURE 2. Bones of non-Passeriformes from the late Early Pleistocene of Cava Sud (Verona, N-E Italy). *Palaeocryptonyx donnezani*: A, proximal right humerus (MCSNV V12322c), caudal view; B-C, right carpometacarpus (MCSNV V12319e), ventral (B) and dorsal (C) views; D-E, left ulna (MCSNV V12341), ventral (D) and medial (E) views; G-H, right tarsometatarsus (MCSNV V12318d), dorsal (G) and plantar (H) views. *Strix nebulosa*: F, distal right tarsometatarsus (MCSNV V12422), dorsal view; I, right phalanx 1-III (MCSNV V12328h), dorsal view. *Aquila* sp.: J, right phalanx 1-II (MCSNV V12328b), dorsal view. *Rallus aquaticus*: K, distal right tibiotarsus (MCSNV V12344b), cranial view. The scale bars represent 5 mm.

differences in many of the long bones (SÁNCHEZ-MARCO 2009: 1152–1153). The present analysis adds some important information to the knowledge of the species, as we described some bones previously unknown. *Palaeocryptonyx donn-*

ezani is the only small-sized Galliformes found at Cava Sud, as the remains of *Perdix* n. sp. reported by BEDETTI (2003) have been referred here to *P. donnezani*.

This species is reported from the Early Pliocene,

Ruscinian MN 15, of France to the Early/Middle Pleistocene, late Villafranchian/Biharian MNQ 20–21, of various localities (SANCHEZ-MARCO 2009; PAVIA *et al.* 2012a; BEDETTI & PAVIA 2013).

Subfamily Tetraoninae Vigors, 1825

cf. Tetraoninae indet.

Material: distal right tarsometatarsus (MCSN V12348).

Remarks: The bone is very poorly preserved with also the trochlea II and IV broken off. However, the general morphology recalls that of Phasianidae and, in particular, its robustness suggests the taxonomic attribution to the Tetraoninae, even if only tentatively.

Order Accipitriformes VIEILLOT, 1816

Family Accipitridae VIEILLOT, 1816

Genus *Aquila* BRISSON, 1760

Aquila sp.

(Fig. 2J)

Material: right distal tarsometatarsus (MCSN V12318a); left phalanx 1-II (MCSN V12328b); two left phalanges 3-III (MCSN V12328c, MCSN V12328d); left phalanx 4-III (MCSN V12319a).

Remarks: The tarsometatarsus was previously referred to *Circaetus gallicus* by BEDETTI (2003), but the morphology of the lateral side of the distal part of the bone, in particular the shape of the groove proximally to the foramen vasculare distale is more similar to *Aquila* than to *Circaetus*. The five bones can be referred to a small sized *Aquila*, such as *Aquila clanga*, but their scarce number and the quality of preservation do not allow referring these specimens to specific-level taxon.

Order Gruiformes BONAPARTE, 1854

Family Rallidae VIGORS, 1825

Genus *Rallus* LINNAEUS, 1758

Rallus aquaticus LINNAEUS, 1758

(Fig. 2K)

Material: Cranial fragment of a left coracoid (MCSN V12411); distal right tibiotarsus (MCSN

V12344b).

Measurements: See Table 1.

Remarks: The morphology of the two bones clearly reflects that of the Rallidae. In particular the coracoid shows a shallow sulcus on the cranial surface of the diaphysis and the facies articularis humeralis is laterally well expanded; the tibiotarsus shows the condylus medialis clearly smaller and thinner than the condylus lateralis with the incisura intercondylaris asymmetrical in dorsal view. Among the Rallidae the bones are similar in size to *Rallus aquaticus* or *Crex crex*, but match better in dimension with the first, which is overall smaller than those of *C. crex*, and because the sulcus on the cranial surface of the coracoid is as deep as in *R. aquaticus*, whereas it is less deep in *Crex crex*.

Rallus aquaticus is reported from the Early Pleistocene of Ubeidiya in Israel (TCHERNOV 1980), a site little younger in age than Cava Sud. Thus, the Italian record represents the oldest occurrence of the species, given that the record from the Late Pliocene of Csarnóta, Hungary (JÁNOSSY 1979) is only dubious.

Order Charadriiformes HUXLEY, 1867

Charadriiformes indet.

Material: left scapula (MCSN V12407); caudal fragment of a right coracoid (MCSN V12410).

Remarks: The bones can be referred to a middle-sized Charadriiformes, similar in size to *Pluvialis apricaria*, but the remains are too fragmentary to better define their taxonomic affinities.

Order Strigiformes WAGLER, 1830

Family Strigidae VIGORS, 1825

Genus *Bubo* DUMÉRIL, 1806

Bubo bubo (LINNAEUS, 1758)

Material: distal right humerus (MCSN V12423); distal left tarsometatarsus (MCSN V12425).

Remarks: The bones described here can easily be referred to a big-sized Strigidae. The osteological morphology of this species is quite unique in the Palearctic avifauna and it can only be confused with *Bubo scandiacus* (former

Nyctea scandiaca, recently placed in the genus *Bubo* by SANGSTER *et al.* 2004). A detailed analysis of the osteological differences between these two species has been made by BEDETTI & PAVIA (2007), based on which the bones from Cava Sud can be referred to *Bubo bubo*.

This species is known from the Early Pliocene of various European localities (MLÍKOVSKÝ 2002a).

Genus *Strix* LINNAEUS, 1758

Strix nebulosa FORSTER, 1772

(Fig. 2F, I)

Material: distal left tibiotarsus (MCSN V12421); distal right tarsometatarsus (MCSN V12422); left phalanx 2-II (MCSN V12328i); right phalanx 1-III (MCSN V12328h); right phalanx 3-IV (MCSN V12328j); right phalanx 4-IV (MCSN V12328k); right phalanx 5-V (MCSN V12328l).

Measurements: See Table 1.

Remarks: The fossils described here belong to a large-sized Strigidae, smaller than *Bubo bubo*. The morphological characteristics recall those to the genus *Strix*, also according to LANGER (1980). In the Palaearctic, six species of the genus *Strix* have been recorded, both living and fossils (MOURER-CHAUVIRÉ 1975; BALLMANN 1976; DEL HOYO *et al.* 1999). The size of the remains from Cava Sud is comparable only to those of *Strix nebulosa*, the biggest species of the genus (DEL HOYO *et al.* 1999).

Strix nebulosa is known from the Middle Pleistocene, MNQ 21, of Stránská Skála, Czech Republic (MLÍKOVSKÝ 2002b), and in general it is rarely reported as a fossil (TYRBERG 1998, 2012). The record from Cava Sud represents the oldest occurrence of the species.

Strigidae indet.

Material: Right phalanx 1-II (MCSN V12328g); left phalanx 5-IV (MCSN V12319f).

Remarks: The two posterior phalanges clearly belong to a small-sized Strigidae, slightly bigger in size to both *Athene noctua* and *Aegolius funereus*. Unfortunately the bones are not very well preserved and thus we are not able to refer these specimens to a more precise taxon, even at generic level.

Order Passeriformes LINNAEUS, 1758

Family Alaudidae VIGORS, 1825

Genus *Alauda* LINNAEUS, 1758

Alauda arvensis LINNAEUS, 1758

(Fig. 3H)

Material: right humerus (MCSN V12364); three proximal right humeri (MCSN V12361a, MCSN V12361b, MCSN V12362); proximal left humerus (MCSN V12361c).

Remarks: The humeri listed above can clearly be attributed to an Alaudidae, following the morphological characteristics listed by JÁNOSSY (1983) and MORENO (1985). The overall size of the bones is comparable with both *Alauda arvensis* and *Galerida* spp. (JÁNOSSY 1983), but the morphology of the caput humeri, which is — like in *Alauda arvensis* — less prominent and of the crista deltopectoralis, which is gradually joining the diaphysis and not forming a step like in *Galerida* spp., allow us to refer these bones to *Alauda arvensis*. In addition, many of the bones of Passeriformes indet. could be referred to Alaudidae, but their fragmentary status does not allow their better taxonomic attribution.

The species has already been reported from the Italian locality of Pirro Nord (BEDETTI & PAVIA 2013), similar in age with Cava Sud, thus the present record is a confirmation of the occurrence of this taxon from the Early Pleistocene onwards.

Family Corvidae VIGORS, 1825

Genus *Corvus* LINNAEUS, 1758

Corvus pliocaenus (PORTIS, 1889)

(Fig. 3A–D, G)

* 1887 *Numenius* sp. (*Pliocaenus*) – PORTIS: 195 [nomen nudum].

* 1889 *Numenius* sp. (*pliocaenus*) – PORTIS: 13, pl. I, figs 26a–26b.

* 1902 *Corvus* [*pliocaenus* ?] PORTIS, 1889 – REGÁLIA: 220, pl. 27 (1), fig. 1.

1975 *Corvus pliocaenus* PORTIS, 1889 – MOURER-CHAUVIRÉ: 236.

1978 *Corvus pliocaenus* PORTIS, 1889 – BRODKORB: 158.

* 1980 *Corvus pliocaenus* PORTIS, 1889 – MOURER-CHAUVIRÉ: 355.

1997 *Corvus pliocaenus* PORTIS, 1889 – BOCHEŇSKÝ: 325.

1998 *Corvus pliocaenus* PORTIS, 1889 – TYRBERG: 582.

*pars 2002a *Corvus corone* LINNAEUS, 1758 – MLÍKO-



FIGURE 3. Bones of Passeriformes from the late Early Pleistocene of Cava Sud (Verona, N-E Italy). *Corvus pliocaenus*: A-B, distal left ulna (MCSNV V12332b), ventral (A) and dorsal (B) views; C, proximal left ulna (MCSNV V12343), medial view; D, distal left tarsometatarsus (MCSNV V12336), dorsal view; G, right phalanx 1-I (MCSNV V12323a), dorsal view. *Carduelis chloris*: E, maxillary fragment (MCSNV V12338), dorsal view; F, recent skull for comparison (MPOC 153), dorsal view. *Alauda arvensis*: H, right humerus (MCSNV V12364), caudal view. The scale bars represent 5 mm.

vSKÝ: 232.

* 2003 *Corvus pliocaenus* PORTIS, 1889 – BEDETTI: 78, pl. V, figs m–n and p–r.

* 2012 *Corvus pliocaenus* PORTIS, 1889 – ROOK *et al.*: 7, figs 8F–8G.

* 2013 *Corvus pliocaenus* PORTIS, 1889 – BEDETTI & PAVIA: 45, pl. 2, figs r–v.

Material: left quadratum (MCSN V12413a); three right quadrata (MCSN V12389, MCSN

V12405, MCSN V12413); cranial fragment of a right coracoid (MCSN V12311); left scapula (MCSN V12404); distal left humerus (MCSN V12342a); distal right humerus (MCSN V12342b); proximal left ulna (MCSN V12343); distal left ulna (MCSN V12332a); two distal right ulnae (MCSN V12332b, MCSN V12424); three left ossa carpalia (MCSN V12331a,

MCSN V12331b, MCSN V12322b); three distal left carpometacarpi (MCSN V12317, MCSN V12330a, MCSN V12330b); right proximal car-

pometacarpus (MCSN V12319b); right phalanx 1 digiti majoris (MCSN V12401); three distal right femora (MCSN V12346, MCSN V12347a,

TABLE 1. Measurements (in mm) of the bones of selected taxa from the Early Pleistocene of Cava Sud. Measurements of bones that are slightly worn or damaged are given in parentheses.

Abbreviations: GL, greatest length; Wp, proximal width; Dp, proximal depth; Wd, distal width; Dd, distal depth; Ws, smallest width of shaft; Ds, depth of the shaft; Dpm, smallest proximal depth without hypotarsus; Dpt, proximal depth with tuberculum flexorius; Wtf, width of tuberculum flexorius.

	GL	Wp	Dp	Wd	Dd	Ws	Ds	Dpm	Dpt	Wtf
<i>Palaeocryptonyx donnezani</i>										
Humerus MCSNV V12322c	–	10.8	5.0	–	–	–	–	–	–	–
Ulna MCSNV V12319d	–	4.9	6.9	–	–	–	–	–	–	–
Ulna MCSNV V12341	38.4	4.9	6.8	5.4	4.3	2.4	3.2	–	–	–
Carpometacarpus MCSNV V12319e	24.5	6.5	3.7	4.9	2.7	2.1	2.4	–	–	–
Carpometacarpus MCSNV V12339a	25.9	6.5	4.0	5.5	2.7	2.3	2.7	–	–	–
Carpometacarpus MCSNV V12339b	24.7	7.1	3.8	5.4	3.1	2.3	3.9	–	–	–
Carpometacarpus MCSNV V12339c	–	–	–	5.1	2.6	2.3	2.4	–	–	–
Carpometacarpus MCSNV V12339d	–	–	–	5.2	3.1	2.3	2.6	–	–	–
Tibiotarsus MCSNV V12319c	–	–	–	6.0	5.7	(3.0)	–	–	–	–
Tibiotarsus MCSNV V12322d	–	–	–	6.4	3.6	–	–	–	–	–
Tibiotarsus MCSNV V12333	–	–	–	5.5	5.7	–	–	–	–	–
Tarsometatarsus MCSNV V12318d	36.8	6.4	6.1	7.1	5.1	2.9	2.5	3.9	–	–
Tarsometatarsus MCSNV V12322e	–	–	–	7.5	5.1	–	–	–	–	–
Tarsometatarsus MCSNV V12334	–	7.1	6.1	–	–	3.4	2.9	4.1	–	–
<i>Rallus aquaticus</i>										
Tibiotarsus MCSNV V12344b	–	–	–	5.4	5.7	–	–	–	–	–
<i>Strix nebulosa</i>										
Tarsometatarsus MCSNV V12422	–	–	–	15.7	11.9	–	–	–	–	–
Phalanx 2-II MCSNV V12328i	25.1	6.1	6.5	4.6	5.4	5.1	4.2	–	–	–
Phalanx 1-III MCSNV V12328h	10.4	8.8	7.5	7.2	5.8	6.3	4.6	–	–	–
Phalanx 3-IV MCSNV V12328j	7.2	5.4	5.5	4.7	4.9	4.6	4.1	–	–	–
Phalanx 5-V MCSNV V12328l	–	4.8	6.4	–	–	–	–	–	8.9	3.8
<i>Corvus pliocaenus</i>										
Coracoid MCSNV V12311	–	6.6	8.4	–	–	3.9	3.5	–	–	–
Humerus MCSNV V12342a	–	–	–	16.9	8.1	–	–	–	–	–
Humerus MCSNV V12342b	–	–	–	15.2	7.8	–	–	–	–	–
Ulna MCSNV V12332a	–	–	–	8.2	7.1	4.8	4.8	–	–	–
Ulna MCSNV V12343	–	11.5	10.7	–	–	–	–	–	–	–
Ulna MCSNV V12424	–	–	–	9.8	6.9	–	–	–	–	–
Carpometacarpus MCSNV V12319b	–	11.5	10.7	–	–	–	–	–	–	–
Carpometacarpus MCSNV V12330b	–	–	–	11.4	4.9	4.0	4.9	–	–	–
Carpometacarpus MCSNV V12330c	–	–	–	10.3	4.6	4.1	4.2	–	–	–
Carpometacarpus MCSNV V12343	–	11.7	6.7	–	–	–	–	–	–	–
Femur MCSNV V12347a	–	10.5	5.9	–	–	–	–	–	–	–
Femur MCSNV V12347b	–	10.9	5.6	–	–	4.8	4.7	–	–	–
Tarsometatarsus MCSNV V12336	–	–	–	6.5	4.4	3.8	4.4	–	–	–
Phal, 1 digit I MCSNV V12323a	21.7	6.1	4.6	4.2	3.2	3.7	2.6	–	–	–

MCSN V12347b); distal left tarsometatarsus (MCSN V12336); two left phalanges 1-I (MCSN V12379a, MCSN V12379b); right phalanges 1-I (MCSN V12323a).

Measurements: See Table 1.

Description: The measurements of the bones of *Corvus pliocaenus* fall within the same size-class of *Corvus corone* but, on average, are slightly bigger in all elements (TOMEK & BOCHEŃSKI 2000), whereas the general morphology is more similar to that of *Corvus corax* (also according to BEDETTI & PAVIA 2013). More in detail, the coracoid of *C. pliocaenus* is stouter than the one of *C. corone* with the processus acrocoracoideus not pointed as in *C. corone*. The tuberculum coracoideum in the scapula is wider and less developed than in *C. corone*. In the proximal ulna the ventral side of the cotyla ventralis is more pronounced in *C. pliocaenus* and the notch on the olecranon is absent (TOMEK & BOCHEŃSKI 2000); the incisura tendinosa in the distal ulna is deeper than in *C. corone* and the tuberculum carpale is pointed cranially as in *C. corax* and not proximally as in *C. corone*. In the carpometacarpus of *C. pliocaenus* the processus extensorius is bigger than in *C. corone* and the processus intermetacarpalis more proximal than *C. corax* and *C. corone* with the spatium intermetacarpalis thinner. The long depressio along the shaft of the phalanx 1 digitorum majoris in *C. pliocaenus* is deep and begins very close to the proximal part of the bones, more than in *C. corone* and *C. corax*, the proximal surface is more similar to the other two species than previously indicated by BEDETTI & PAVIA (2013). The tarsometatarsus is more similar to that of *C. corax* in having a broader groove in the plantar side of the trochlea metatarsi III and a small tuberculum in the distal part of the small crest on the medial side of the bone in plantar view. The phalanx 1-I is stouter than in *C. corone* with the proximal end proportionately wider.

Remarks: This species has been reported from various European localities since the Late Pliocene (PORTIS 1889; MLÍKOVSKÝ 2002a) and survives up to the Middle Pleistocene (TYRBERG 1998). From the Middle Pleistocene of France, MOURER-CHAUVIRÉ (1975) described the subspecies *Corvus pliocaenus janossyi*, slightly bigger than the nominate one, only reported from three localities. MLÍKOVSKÝ (2002a) considered *C.*

pliocaenus as a junior synonym of *C. corone*, whereas *C. p. janossyi* was synonymized with *C. corax*, both on the basis of the measurements, without considering the morphology. MLÍKOVSKÝ (2002a) also followed BRODKORB (1978) in considering both *C. praecorax* and *C. betfianus* as synonyms of *C. pliocaenus*. The relationships among the various extinct big-sized species of the genus *Corvus* is beside the aim of this paper, and also we are not able to discuss here the validity of the Middle Pleistocene subspecies *Corvus pliocaenus janossyi* and its systematic rank, but the morphological characteristics shown by the Cava Sud remains, together with the material recently described from the coeval locality of Pirro Nord (BEDETTI & PAVIA 2013) allow to confirm *Corvus pliocaenus* as a valid species.

Family Fringillidae VIGORS, 1825

Genus *Carduelis* BRISSON, 1760

Carduelis chloris (LINNAEUS, 1758)

(Fig. 3E)

Material: fragmented maxilla (MCSN V12338).

Remarks: The conical morphology of the bill fragment clearly indicates its relationships with the Fringillidae. In particular, it is wider than any other species of the family except *Coccothraustes coccothraustes*, which is clearly bigger and more robust; thus this fragment can be attributed to *Carduelis chloris*, also following the indication of MORENO (1985).

This species is reported from coeval localities in France and Spain (MLÍKOVSKÝ 2002a) but Cava Sud represents the oldest Italian record for this taxon.

Family Emberizidae VIGORS, 1831

Genus *Emberiza* LINNAEUS, 1758

Emberiza sp.

Material: Four proximal right humeri (MCSN V12314a, MCSN V12375a, MCSN V12375b, MCSN V12375c).

Remarks: The four humeri clearly show the morphological characteristics of the family Emberizidae, as described by JÁNOSSY (1983) and ZELENKOV & KUROCHKIN (2012), in particular the

shape of the fossae pneumotricipitalis and the squared crista deltopectoralis. The various species of the genus *Emberiza* are morphologically very similar even in the humerus and the fragmentary status of the bones from Cava Sud do not allow to better the taxonomic attribution.

Discussion

The high degree of fragmentation of the bird material coming from Cava Sud is probably due to the taphonomic history of the deposits, as the fossils were found in fissure fillings with the bigger bones probably already fragmented by diagenesis, and to the excavation techniques possibly too aggressive for the preservation of fragile bird bones, as a greater attention was dedicated to the recovery of micro-mammal teeth. Because of their high fragmentation, which only allows us to determine a low percentage of the whole bird remains below the family level, the faunal composition of the Early Pleistocene of Cava Sud is not very rich, but we can make some palaeoenvironmental reconstruction, even if only qualitative as it is not possible to evaluate the relative importance of the various taxa. The palaeoenvironment reconstruction based on living bird taxa, which are the majority from Cava Sud, is normally extremely significant, as the ecological needs and characteristics of modern birds are very well studied and understood (PAVIA & BEDETTI 2004).

The relative abundance of Alaudidae recognized at Cava Sud allow to hypothesize the presence of an open grassy habitat, possibly inhabited also by the extinct *Palaeocryptonyx donnezani*. Other areas were probably covered by dense forest, as suggested by the Tetraoninae and *Strix nebulosa*, as the latter one only inhabits the taiga forest in the Boreal region (DEL HOYO *et al.* 1999). Other taxa, such as *Bubo bubo* and probably the extinct *Corvus pliocaenus*, are generalist and so do not give any precise paleoenvironmental indication.

During the European Early Pleistocene we observe the extinction of most of the Pliocene bird taxa of Neogene origin, substituted by the modern taxa (MOURER-CHAUVIRÉ 1993). In fact, the Pliocene fossil bird associations are normally characterized by a great number of extinct

taxa, some of them on the lineage of the recent ones (EMSLIE 1998; OLSON & RASSMUSSEN 2001; BOEV 2002; ZELENKOV & KUROCHKIN 2012). On the other hand, starting from around 1.5 Ma on, one can observe that the European fossil bird association are composed mostly by extant taxa (TYRBERG 1998), with only few taxa already present in older sites, such as *Palaeocryptonyx donnezani* and *Corvus pliocaenus* (TYRBERG 1998; BEDETTI 2003; PAVIA *et al.* 2012a, b). This is particularly evident in the Italian site of Pirro Nord, where more than 40 bird taxa have been detected (PAVIA *et al.* 2012b; BEDETTI & PAVIA 2013), but only three extinct species: *Perdix n. sp.*, *Palaeocryptonyx donnezani* and *Corvus pliocaenus*. The site of Cava Sud is biochronologically coeval with Pirro Nord, only a little older, following the evolutionary degree of the micromammals (MARCOLINI *et al.* 2013) and confirms what was observed already at Pirro Nord: the scarce importance of birds as biochronological tool from the late Early Pleistocene onwards. As a matter of fact we report here the first occurrence of *Strix nebulosa* and *Rallus aquaticus* and the oldest Italian occurrence of *Carduelis chloris* (TYRBERG 1998, 2012; BEDETTI 2003), adding new data on the early history of the extant bird species.

Conclusions

This paper updates the knowledge of the fossil bird association coming from the late Early Pleistocene fissure fillings of Cava Sud. In addition new information about the chronological and geographical distribution of some recent and fossil bird species is given from an area, the Northern Italy, with few fossiliferous localities of that time-span (BEDETTI, 2003). The fossil bird association of Cava Sud shows the composition of a modern-type avifauna, also shown by other bird association of the Early Pleistocene around 1.5 Ma. Despite the low number of taxa determined at generic or specific level, some of them are congruent with the coeval site of Pirro Nord, Southern Italy (BEDETTI & PAVIA 2013) and Monte Argentario (BEDETTI 2003; PAVIA unpubl. data), with the exception of the Tetraoninae and *Strix nebulosa*. This difference is probably related to the paleoenvironment of Cava Sud around 1.5 Ma,

characterized by open grassy habitat with dense Alpine woodlands, while the other sites were characterized by open, more arid, environment. The reconstruction of the environment of the late Early Pleistocene of Italy is also of particular importance, as this area is of interest concerning the early human colonisation of Europe, dating around 1.5 Ma (ARZARELLO *et al.* 2007).

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