

A new Middle Pleistocene bird assemblage from Cava di Breccia di Casal Selce (Ponte Galeria, Rome, Italy)

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Abstract – We present the fossil bird assemblage from the Middle Pleistocene deposits of Cava di Breccia di Casal Selce, which is one of the many fossil localities in the Ponte Galeria area (Roma, Italy). The fossil avian assemblage here described also represent one of the oldest Italian Pleistocene ones well described and highly differentiated. We detected the presence of 26 bird taxa which indicate that the environment of the Tiber paleodelta, during the Middle Pleistocene, was characterized mainly by extensive wetlands, open areas with scattered vegetation and woodlands. We documented the first occurrence of *Egretta garzetta*, *Haematopus ostralegus* and *Turdus pilaris*, and the first Italian occurrence of *Aythya fuligula*, *Platalea leucorodia*, *Plegadis falcinellus*, *Accipiter nisus*, and *Haliaeetus albicilla*.

Key-words: Fossil birds, Casal Selce, Middle Pleistocene, Paleoenvironment, Ponte Galeria area.

INTRODUCTION

The fossil bird assemblages from the Pleistocene deposits reflect the past environmental scenarios, continuously changing in response to the climatic oscillations. As most extant bird species are strictly linked to particular habitat characteristics and are reported in the Palearctic fossil record since the Early Pleistocene (Tyrberg 1998, 2008), the bird fossil remains represent a very good proxy for paleoenvironmental and paleoclimatic reconstructions of the whole Pleistocene. Late Pleistocene bird assemblages are better preserved and relatively well known (Bedetti & Pavia 2007, Carrera *et al.* 2018, in press, Cassoli 1980 among others, see also Tyrberg 1998, 2008). Older well-preserved assemblages are rarer and represent a pivotal source of information about past environments, past climates and on the first appearance of extant species, their paleobiogeography and paleoecology, their early evolution and the presence of currently extinct taxa.

In this paper we describe the Middle Pleistocene fossil bird assemblage deriving from the deposits of the Cava di Breccia di Casal Selce (hereafter Casal Selce), a quarry which provided one of the many sedimentary sequences exposed in the Ponte Galeria area (Roma, Italy, see Marra *et al.* 2014). This area, which hosted the paleodelta of the river Tiber since the beginning of the Middle Pleistocene, shows a series of fluvial–lacustrine, coastal barrier-lagoon-

al and transition-shelf sedimentary successions very rich in fossil mammal remains, interbedded with volcanoclastic deposits of the Albani and Sabatini volcanic complexes. This exceptional archive has been investigated by geologists and paleontologists since the beginning of the 1960s, providing important information on vertebrate assemblages from late Early to Late Pleistocene (from MIS 22-21 to 2-1) and on the Quaternary biochronology (Marra *et al.* 2014, Milli *et al.* 2004, Milli & Palombo 2005, Sardella *et al.* 2015).

In the Casal Selce quarry, located 15 kilometers westwards from the city of Roma (Central Italy) (FIG. 1), are exposed Middle Pleistocene fluvial, lacustrine, sandy and volcanic deposits, contained in a 40 m thick sedimentary sequence (Conato *et al.* 1980, Marra *et al.* 2014, Pavia & Bedetti 2013a, Sardella & Petrucci 2012, Sardella *et al.* 2015). The fossil remains here described were found in the layer G of the Casal Selce succession, following the stratigraphic schemes proposed by Conato *et al.* (1980) and Sardella & Petrucci (2012). This level, together with the layer F, have been considered as “Salmon sand” by Marra *et al.* (2014). The “Salmon sand” deposit of this site provided a rich vertebrate fossil association referred to the Isernia Faunal Unit (Middle Galerian) and has been attributed, on the basis of the correlation with other dated similar deposits in the Ponte Galeria area, to a time span between 615 ± 3 ka and 565 ± 2 ka (MIS 15, a warm isotopic stage)

(Karner & Marra 1998, Marra *et al.* 2014). Within the same fossil assemblage, Pavia & Bedetti (2013a) reported the presence of *Histrionicus histrionicus*, the first European record of the species, which has been interpreted as the record of a vagrant individual with no inferences for the palaeoenvironment.

MATERIALS AND METHODS

In this paper we describe the bird fossil assemblage coming from the “Salmon sand” deposit (Layer G) exposed at the Casal Selce quarry (Ponte Galeria area, Fig. 1). The fossil material is provisionally stored in the Dipartimento di Scienze della Terra, University of Sapienza, Roma, and provisionally catalogued with the acronym CS, as all the vertebrate remains coming from Casal Selce quarry. The identification of fossil bird bones was conducted through comparison with recent bird skeletons stored in the Museo Civico di Storia Naturale di Carmagnola, Torino, Italy (MCCI), the Museum National d’Histoire Naturelle (MNHN), the Institute de Paleontologie Humaine (IPH), Paris, France, and in the Dipartimento di Scienze della Terra of the Torino University, Italy (Marco Pavia Ornithological Collection, MPOC). The osteological terminology follows Baumel & Witmer (1993) and the bird taxonomy follows Del Hoyo *et al.* (2014, 2016).

RESULTS

The systematic analysis of the fossil bird remains allowed us to identify 26 taxa: *Coturnix coturnix*, *Perdix* sp., *Histrionicus histrionicus*, cf. *Somateria* sp., *Mergus* sp., *Tadorna tadorna*, *Aythya nyroca*, *Aythya fuligula*, *Spatula clypeata/Mareca penelope*, *Anas platythynchos*, *Columba palumbus*, *Rallus aquaticus*, *Platalea leucorodia*, *Plegadis falcinellus*, *Egretta garzetta*, *Haematopus ostralegus*, *Scolopax rusticola*, *Accipiter nisus*, *Haliaeetus albicilla*, *Buteo buteo*, *Pica pica*, *Corvus frugilegus/corone*, Alaudidae indet., cf. Sylviidae indet., *Turdus pilaris*, *Turdus philomelos/liliacus*, *Turdus* sp. (Bedetti 2003, Pavia & Bedetti 2013a). This study also confirms that the record of *Perdix palaeoperdix*, *Gyps melitensis* and *Palaeocryptonyx* sp. in the “Salmon sand” deposits reported by Marra *et al.* (2014) is wrong, as already indicated by Sardella *et al.* (2015). Here following we present the main features of the most important bird species, both from a chronological and ecological point of view.

Order Galliformes

Family Phasianidae

Genus *Perdix*

Perdix sp.

Material: 1 scapula, 3 coracoids, 2 humeri, 2 carpometacarpi, 1 femur, 1 tibiotarsus, 1 tarsometatarsus.



Figure 1. Map of Italy with the position of the Cava di Breccia di Casal Selce (Ponte Galeria Area, Roma, Italy) indicated by the star.

All the fossil Galliformes remains found at Casal Selce show the typical characteristics of the genus *Perdix*. However, the fossils are too fragmentary to correctly evaluate the dimensions and morphology. In the Galerian of Europe the extinct species *Perdix palaeoperdix* was described (Mourer-Chauviré 1975), while in the Italian Villafranchian a new species of *Perdix*, still undescribed, is reported (Bedetti 2003). The presence of these two taxa and the incompleteness of the Casal Selce remains make it necessary to compare them with a larger quantity of material to obtain a specific determination.

Order Anseriformes

Family Anatidae

Genus *Tadorna*

Tadorna tadorna (Linnaeus, 1758)

(Fig. 2 B)

Material: 1 ulna.

The proximal epiphysis of the ulna shows a rounded cotyla ventralis which expands laterally. The cotyla dorsalis is located more distally and the internal edge forms a square angle with the cotyla ventralis. Under the cotylae an elongated fossa is present, starting from the internal edge of the cotyla dorsalis and transversally crossing all the proximal end. The muscular impression located laterally to the cotyla ventralis is very elongated. The morphological characteristics here exposed allow to the identification of *Tadorna tadorna* among the Casal Selce fossil assemblage and excludes the congeneric *T. ferruginea*.

Remarks: Mlíkovský (2002) indicated the first occurrence of *Tadorna tadorna* in the lower Pliocene, while Tyrberg (1998, 2008) indicated this first occurrence in the Early Pleistocene. The difference is mainly due to the fact that the first author synonymized with *Tadorna tadorna* some other taxa normally considered as valid (*Tadorna wagneri*, *Anas anatoides*, *Nettapus anatoides*, *Anas submajor*, *Balcanas pliocenica*). This species was reported in Italy from the Late Pleistocene as well as from a few Middle Pleistocene localities (Tyrberg 1998, 2008, Pavia 2000).

Genus *Aythya*

Aythya fuligula (Linnaeus, 1758)

Material: 1 tibiotarsus.

The bone is shorter and more slender compared to the tibiotarsus of the genus *Anas* and shows the general shape of the genus *Aythya*, with a flattened distal part of the bone. All along the diaphysis a crest typical of this genus is present, which is gradually connected to the proximal end, without steps. On the distal part, the fossa under the pons supratendineus is wide and deep. The shape of the bone is

curved, as the distal end protrudes internally in respect of the diaphysis. The two condyla are well separated in posterior view and not so close as in *Aythya nyroca*. The dimensions are in the range variability of *A. fuligula* (Woelfle 1967), and the morphology perfectly fits with this species.

Remarks: The first record of *Aythya fuligula* is dated to the Early Pleistocene; this species becomes more abundant in the Late Pleistocene. The first Italian record dates back to the Late Pleistocene (Tyrberg 1998, 2008), and so the record from Casal Selce represents the oldest Italian one.

Order Pelecaniformes

Family Threskiornithidae

Genus *Platalea*

Platalea leucorodia Linnaeus, 1758

(Fig. 2 E)

Material: 1 carpometacarpus.

The fossil remain shows the morphology of Threskiornithidae. In particular the processus pisiforme is well developed and above this processus there is an embossed area, as observed in the modern *Platalea leucorodia*. The edge of the diaphysis above the processus pisiforme is regular and thick in *P. leucorodia*, while is thin and irregular in other species of the Family. In *P. leucorodia* the outline of the carpometacarpus seems to be rough-edged, thanks to the processus extensorius feeble and pointed and a trochlea less rounded.

Remarks: *Platalea leucorodia* is rarely reported in the Palearctic fossil record; its first occurrence is in the Early Pleistocene (Tyrberg 1998, 2008, Mlíkovský 2002). In Italy this species was never reported in the fossil form and so, the Casal Selce represents its first and only Italian occurrence.

Genus *Plegadis*

Plegadis falcinellus (Linnaeus, 1766)

(Fig. 2 G)

Material: 1 ulna, 1 tibiotarsus.

The fossils found at Casal Selce show the typical features of the Family Threskiornithidae. In particular the ulna is relatively short with the presence of very evident papillae remigiales on the diaphysis of the bone. The proximal end is relatively wide with the cotyla dorsalis tending distalward and showing an enlargement on the upper edge. This feature gives to the cotyla dorsalis a prominent shape from the outline of the epiphysis. The tuberculum ligamenti collateralis ventralis and the tuberculum close to the edge of the impressio brachialis are both very prominent. The morphology of the distal end of the tibiotarsus



Figure 2. Bird remains from the Middle Pleistocene deposits of Cava di Breccia di Casal Selce. A. *Coturnix coturnix*, right carpometacarpus, ventral view (CS 62); B. *Tadorna tadorna*, proximal right ulna, cranial view (CS 78); C. *Aythya nyroca*, distal right ulna, ventral view (CS 75); D. *Spatula clypeata/Mareca penelope*, right coracoid, dorsal view (CS 40); E. *Platalea leucorodia*, proximal right carpometacarpus, ventral view (CS 74); F. *Haliaeetus albicilla*, right carpal, dorsal view (CS 8); G. *Plegadis falcinellus*, distal left tibiotarsus, cranial view (CS 82); H. *Egretta garzetta*, proximal left ulna, cranial view (CS 46); I. *Egretta garzetta*, cranial portion of a left scapula, lateral view (CS 132); J. *Accipiter nisus*, distal left tarsometatarsus, dorsal view (CS 131); K. *Haliaeetus albicilla*, proximal left tarsometatarsus, dorsal view (CS 1); L. *Haliaeetus albicilla*, proximal right carpometacarpus, ventral view (CS 58); M. *Haliaeetus albicilla*, posterior phalanx, side view (CS 14); N. *Corvus frugilegus/corone*, distal left ulna, cranial view (CS 129); O. *Turdus pilaris*, right humerus, caudal view (CS 27); P. *Turdus philomelos/liacus*, right humerus, caudal view (CS 92). Scale bars 1 cm. Bones are coated with ammonium chloride to enhance details.

is not so diversified within the Ciconiiformes. All the species of the Order show a wide pons supratendineus with a very deep sulcus extensorius. The two condyla are distant and tend to diverge laterally, generating a wide groove. In the fossil remain a tuberculum is present close to the condylus medialis. The morphological characteristics of the fossil remains allow us to refer them as *Plegadis falcinellus*.

Remarks: *Plegadis falcinellus* is reported in the Palearctic with one record from the Upper Pliocene deposits of Las Higuieruelas (Spain) (Sánchez Marco 2005) and is successively reported in the late Middle Pleistocene (Tyrberg 1998, 2008). In Italy, it was only reported from the late Middle Pleistocene of Contrada Fusco (Pavia 2001) and thus the record from Casal Selce represents the oldest Italian occurrence of the taxon.

Family Ardeidae

Genus Egretta

Egretta garzetta (Linnaeus, 1766)
(Figs 2 H, I)

Material: 1 sternum, 2 scapulae, 1 coracoid, 2 ulnae, 1 tarsometatarsus.

The fossil remains of the family Ardeidae found in Casal Selce belong to a species with a size comparable to both *Egretta garzetta* and *Bubulcus ibis* (Kellner 1986). The morphological characteristics of the various bones allow to assign the fossil material to *Egretta garzetta*. In particular the scapula seems very flat, both the proximal epiphysis and in the body of the bone. The tuberculum coracoideum is protruding and is not on the same line with the facies articularis clavicularis, as the latter tends to be curved laterally. Moreover, the facies articularis humeralis is wide and rounded. The coracoid is thin and elongated with a shorter processus procoracoideus and a rounded facies articularis humeralis, characteristic of *Egretta garzetta*; the processus lateralis is elongated and tends upwards, the facies articularis sternalis looks wide and developed to the impressio musculi sternocoracoidei. In the ulna the acromion is stout and not prominent; the cotyla dorsalis shows a wide and prominent edge, while the tuberculum ligamenti collateralis and the tuberculum close to the impressio brachialis are less evident. In the diaphysis the papillae remigiales ventralis are evident. On the distal end, the tuberculum carpalis is rounded and the tuberculum ventralis is not very pointed. The distal part of the tarsometatarsus shows the trochleae on the same plan, as shown by the other species of the Ardeidae; in addition, the distal epiphysis is wide, as in the recent *Egretta garzetta*.

Remarks: The oldest European *Egretta garzetta* are dated to the Middle/Late Pleistocene boundary (from Contrada Fusco, Italy, and Binagady, in Azerbaijan) with only one dubious record from the early Middle Pleistocene of Prezletice (Bohemia) (Tyrberg 1998, 2008, Mlíkovský 2002). In Italy this taxon is known only for the Holocene of Buca dei Bersaglieri and the late Middle Pleistocene of Contrada Fusco (Pavia 2001), so the presence at Casal Selce represents the oldest certain record of this taxon.

Order Charadriiformes

Family Haematopodidae

Genus Haematopus

Haematopus ostralegus Linnaeus, 1758

Material: 1 tarsometatarsus.

The general morphology of the fossil remain leads back to the order Charadriiformes, in particular to the family Haematopodidae, present in Europe only with the species *Haematopus ostralegus*. In the fossil remain the extremitas cranialis synsacri is pointed and the sulcus ventralis synsacri is wide and deep, as in modern *Haematopus ostralegus*.

Remarks: *Haematopus ostralegus*, rarely reported in the Palearctic fossil record, is known from the Late Pleistocene and it was never recorded in Italy (Tyrberg 1998, 2008). Thus, the Casal Selce remain testifies the oldest occurrence of this taxon so far and its first occurrence in the Italian fossil record.

Order Accipitriformes

Family Accipitridae

Genus Accipiter

Accipiter nisus (Linnaeus, 1758)
(Fig. 2 J)

Material: 1 radius, 1 tarsometatarsus.

The fossil remains belong to a small-sized Accipitridae. In the radius the facies articularis ulnaris is small and thin; the shape of the tuberculum bicipitalis radialis is pointed and rough-edged. The morphology of the fossil remain is like the one of the genus *Accipiter*; moreover the size is directly comparable to that of *A. nisus*, clearly smaller than *A. gentilis*. The tarsometatarsus, even if not complete, shows a thin and elongated diaphysis; the three trochleae are on the same line, in distal view, and the trochlea metatarsi I is flattened. These characteristics allowed assigning these bones to *Accipiter nisus*.

Remarks: The first occurrence of *Accipiter nisus* is dated to the Middle Pleistocene; this abundant taxon was recorded in most of Europe in the same period. The oldest Italian

occurrences so far are from Spinagallo and Grotta Marasà (Sicily) (Pavia 1999, 2000, Tyrberg 1998, 2008), which are slightly younger than Casal Selce, thus this represents the oldest Italian occurrence of this taxon.

Genus *Haliaeetus*

Haliaeetus albicilla (Linnaeus, 1758)

(Figs 2 F, K, L, M)

Material: 2 coracoids, 2 radii, 2 carpal bones, 3 carpometacarpi, 1 tarsometatarsus, 6 posterior phalanges.

The fossil bones here examined belong to a large-sized Accipitridae such as the larger species of the genus *Aquila* and *Haliaeetus albicilla*. The coracoid of the latter species appears stouter than the one of the different species of *Aquila*. Close to the impressio ligamenti coracoidei, a small relief is present in *Aquila* while it is lacking in *Haliaeetus* and in the fossil record. On the contrary, in the latter species a more extended space is present between the facies articularis humeralis and the impressio ligamenti acroracoidei; the processus acroracoideus is thin. On the distal end, the impressio m. sternocoracoidei shows a callosity, absent in *Aquila*. The facies articularis sternalis close to the angulus medialis is protruding with a bigger edge in *Haliaeetus*. The angulus medialis in *Haliaeetus* points downwards. The proximal end of the fossil carpometacarpus shows an irregular and angular processus extensorius as in *Haliaeetus*, while in *Aquila* it is more rounded. The processus alularis is small and the fovea carpalis caudalis shows a deep rounded fossa, absent in *Aquila*. The processus pisiformis is less protruding and slightly curved toward the corpus of the bone. The proximal part of the os minus in *Aquila* shows a flattened part on the ventral side, while in *Haliaeetus* this part is not as flat as in *Aquila*. In the tarsometatarsus of the genus *Aquila*, behind the cotyla lateralis is present a fossa, absent in the fossil remain. The presence of a wide fossa below the cotylar zone (very reduced in *Aquila*) and the thin crista medialis hypotarsi allowed us to determine the fossil remain as *Haliaeetus albicilla*. Moreover, the crista lateralis hypotarsi is very different in the two genera concerning its starting point on the proximal end: in *Haliaeetus* it lies in the centre of the bone, while in *Aquila* it is located more laterally. The edge of the two cotylae are curved with a very protruding eminentia intercotylaris. More in general, the fossil bones show morphological characteristics typical of *Haliaeetus albicilla* and different from *Aquila*.

Remarks: *Haliaeetus albicilla* is known since the Early Pleistocene in the Palearctic fossil record (Mlíkovský 2002, Tyrberg 1998, 2008). In Italy it was reported only during the Late Pleistocene (Tyrberg 1998, 2008), and so

the Casal Selce fossil remains represent the Italian oldest record of the species.

Order Passeriformes

Family Turdidae

Genus *Turdus*

Turdus pilaris Linnaeus, 1758

(Fig. 2 O)

Material: 1 humerus.

The humerus shows the typical characteristics of the Turdidae, in particular of the genus *Turdus* (Janossy 1983). Within the genus, *Turdus pilaris* shows a very wide crista which divides the two fossae in the proximal end, the widest compared with the other species of the genus of similar size (Janossy 1983). This morphological characteristic, together with the size of the bone, allowed us to determine the bone as *Turdus pilaris*.

Remarks: *Turdus pilaris* is reported in the Palearctic fossil record since the Middle Pleistocene (Tyrberg 1998, 2008), while the earlier Italian occurrence is from Torre in Pietra (Tyrberg 1998, 2008, Bedetti 2003) and dates back to the MIS 7, thus the record from Casal Selce represents the oldest Italian occurrence of this species and probably also the oldest record. In fact, the oldest European certain record so far is from Caune de l'Arago (France) Middle Pleistocene layers (that have been attributed to a slightly younger age than Casal Selce), while three other dubious records (cf.) are similar in age to Casal Selce or even older. These records are the one from the Middle Pleistocene of Stránská Skála (Moravia), of Gran Dolina (Atapuerca, Spain) and the one from the Early Pleistocene of Dursunlu (Southern Anatolia) (Tyrberg 1998, 2008).

DISCUSSION AND CONCLUSIONS

The fossil bird association presented here represent one of the oldest Italian Pleistocene bird assemblage studied to date, together with some preliminary data from Pietrafitta (Bedetti 2003, Zucchetta et al. 2003), Monte Peglia (Bedetti 2003, Piperno et al. 1984), Isernia (Tonon 1989), Spinagallo Cave (with clear endemic characteristics) (Pavia 1999, 2004, Pavia & Mourer-Chauviré 2002), Comiso (Pavia & Insacco 2013), and two recently investigated and well-documented Early Pleistocene bird assemblages, those from Pirro Nord (Bedetti & Pavia 2013) and Soave Cava Sud (Pavia & Bedetti 2013b).

The study of the avifauna is not so useful for a biochronological point of view, because most of the taxa are still living today. However, for some species Casal Selce rep-

resents the oldest Italian record (*Aythya fuligula*, *Platalea leucorodia*, *Plegadis falcinellus*, *Egretta garzetta*, *Haematopus ostralegus*, *Accipiter nisus*, *Haliaeetus albicilla*, *Turdus pilaris*), where not the oldest at all (*Egretta garzetta*, *Haematopus ostralegus*, and *Turdus pilaris*). Furthermore, the fossil remain of *Platalea leucorodia* represents the first and only Italian fossil record of this species.

The bird association found at Cava di Breccia di Casal Selce is abundant and well diversified. Most of the taxa (cf. *Somateria* sp., *Mergus* sp., *Tadorna tadorna*, *Aythya nyroca*, *Aythya fuligula*, *Spatula clypeata*/*Mareca penelope*, *Anas platyrhynchos*, *Platalea leucorodia*, *Plegadis falcinellus* *Haliaeetus albicilla*) indicate the presence, in the area of the Tiber paleodelta, of aquatic environments, as indicated also by the sedimentological composition of the Casal Selce deposits. The presence of *Accipiter nisus*, *Buteo buteo* and *Columba palumbus* suggests the presence of woods, probably close to the water, the same environment used by the Ardeidae to nest (Cramp 1980, 1985). The presence of open areas with scattered vegetation is indicated by taxa like *Coturnix coturnix*, *Perdix* sp., Alaudidae and Corvidae, all of them using this environment for foraging (Cramp 1988, Cramp & Perrins 1994).

The environment of the Casal Selce area during the Middle Pleistocene was probably a mosaic of wooded and extended wet areas and lagoons rich in birds, with scrub areas and also open and arid habitats. The age attribution of this deposit (MIS 15), inferred from the geological and geochronological constraints, attests to the presence of a warm climate during the time interval investigated, which is further confirmed by the paleontological data. In fact, the whole vertebrate assemblage comprises temperate and Mediterranean taxa, with reptiles such as *Testudo hermanni* and *Chalcides chalcides*, and mammals like *Macaca sylvanus*, *Meles meles* and *Cervus elaphus* (Bedetti & Pavia 2013a, Marra *et al.* 2014). Among the bird taxa, no cold-adapted species were found, with the exception for *Histrionicus histrionicus*, described in Bedetti & Pavia (2013a), which should be considered as a record of a vagrant individual.

Acknowledgments – We wish to thank the late A. P. Anzidei, Soprintendenza Speciale per i Beni Archeologici di Roma, C. Petronio and R. Sardella, Sapienza Università di Roma, for their helps in administrative practices and field works. G. Boano (MCCT), C. Lefevre (MNHN), and H. de Lumley (IPH) are thanked for the possibility to access the comparative collections of their institutions. This work has been supported by Torino University Grant ex 60% 2017 and 2018 to MP.

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Associate editor: **Bruno Massa**