

The fossil bird associations from the early Middle Pleistocene of the Ragusa province (SE Sicily, Italy)

Marco PAVIA & Gianni INSACCO

M. Pavia, Museo di Geologia e Paleontologia, Dipartimento di Scienze della Terra, Università degli Studi di Torino, Via Valperga Caluso 35, I-10125 Torino, Italy; marco.pavia@unito.it

G. Insacco, Museo Civico di Storia Naturale, Comune di Comiso, Via degli Studi 9, I-97013 Comiso, Italy; g.insacco@comune.comiso.rg.it

KEY WORDS - Birds, Insularity, Middle Pleistocene, Sicily, Italy, Palaeoenvironment.

ABSTRACT - An analysis of fossil bird remains from early Middle Pleistocene deposits of the Ragusa province is presented herein. The findings occur in the limnic deposits of the Comiso area and in some fissure fillings of the suburbs of Ragusa, in particular Contrada Annunziata and Contrada Tabuna. The fossil bird bones were associated in all the deposits with remains of endemic mammals of the early Middle Pleistocene “*Elephas falconeri* Faunal Complex” of the Sicilian biochronological scheme. This study reveals the presence of at least thirty taxa, three are extinct and endemic to Sicily and Malta: *Cygnus equitum* Bate, 1916, *Grus melitensis* Lydekker, 1890 and a possible new taxon of *Corvidae*. The bird taxa found at Comiso and Ragusa allow a palaeoenvironmental reconstruction of the area to be put forward and provide important information with regard to the palaeobiogeography and early evolution of the avifauna from Sicily.

RIASSUNTO - [Le associazioni a uccelli fossili dall’inizio del Pleistocene Medio della provincia di Ragusa (Sicilia Sud-Orientale, Italia)] - Vengono presentati i risultati dell’analisi dei resti di uccelli fossili provenienti dai depositi limnici dell’area di Comiso e dai riempimenti di fessure carsiche nell’area di Ragusa, in particolare nella zona di Contrada Annunziata e Contrada Tabuna. I resti di uccelli descritti in questo lavoro sono stati trovati associati a quelli di mammiferi endemici tipici del “Complesso Faunistico a *Elephas falconeri*” dello schema biocronologico delle faune pleistoceniche siciliane, datato alla parte iniziale del Pleistocene Medio. Il contesto geologico dei due depositi indica che i sedimenti limnici dell’area di Comiso hanno un’età inferiore rispetto ai riempimenti dell’area ragusana; quindi, pur rientrando nello stesso Complesso Faunistico, non possono essere considerati strettamente coevi nelle ricostruzioni paleoambientali. L’analisi sistematica ha rivelato la presenza di almeno trenta taxa, tre dei quali estinti ed endemici di Malta e della Sicilia: *Cygnus equitum* Bate, 1916, *Grus melitensis* Lydekker, 1890 e un possibile nuovo taxon di *Corvidae*. I taxa riconosciuti nei depositi di Comiso sono prevalentemente specie di ambiente acquatico, mentre altre specie indicano la presenza di ambienti aperti o aree boschive. L’area di Ragusa era invece caratterizzata da ampi spazi aperti con porzioni di aree umide. Da un punto di vista paleobiogeografico, i resti di *C. equitum* e *G. melitensis* rappresentano un’ulteriore prova della connessione esistente tra Malta e la Sicilia Sud-Orientale durante il Pleistocene Medio. I fossili provenienti dai depositi limnici di Comiso costituiscono, infine, la più antica testimonianza della presenza di uccelli in Sicilia e sono quindi di fondamentale importanza per comprendere l’evoluzione dell’avifauna siciliana nel corso del tempo.

INTRODUCTION

The fossil avifauna of Sicily is little known, except for a few studies on bird remains from archaeological sites, where only extant species and continental-like bird associations are listed (Tyrberg, 1998, 2013), and for preliminary analyses of Middle Pleistocene birds from Contrada Fusco and Spinagallo Cave (Siracusa, South-Eastern Sicily), as well as detailed studies on particular species (Cassoli & Tagliacozzo, 1996; Pavia, 1999, 2001, 2004, 2007, 2008; Pavia & Mourer-Chauviré, 2002). In the two last centuries, many localities from Sicily with fossil vertebrate assemblages have been found and excavated (Bonfiglio & Burgio, 1992). Recent palaeontological analyses (Bonfiglio et al., 1997, 2001, 2002; Di Maggio et al., 1999; Petruso et al., 2008) arranged the Pleistocene vertebrates into five Faunal Complexes (FC). Four of these mainly include endemic fossil mammals and reptiles, the “Monte Pellegrino FC” of the Late Pliocene/Early Pleistocene, the “*Elephas falconeri* FC” of the early Middle Pleistocene, the “*Elephas mnaidriensis* FC” of the late Middle Pleistocene/Late Pleistocene and the “Pianetti/S. Teodoro FC” of the Late Pleistocene. The fifth, the “Castello FC”, dating from the latest Pleistocene, contains extant continental species together

with Paleolithic artifacts. Fossil bird remains were found in each FC (Bonfiglio et al., 1997, 2002; Petruso et al., 2008), except for the oldest one, the “Monte Pellegrino FC” which contains only endemic small mammals and reptiles (Burgio & Fiore, 1988). The analyses of some Sicilian fossil birds (Pavia, 2000, 2004, 2008; Pavia & Mourer-Chauviré, 2002) provided detailed information on the avifaunas of the Middle Pleistocene “*Elephas falconeri* FC” and “*Elephas mnaidriensis* FC”, i.e., the 2nd and the 3rd FC of Bonfiglio et al. (2001). These data revealed that endemic bird associations were present in Sicily during the Middle and Late Pleistocene and were included in a revision of the fossil bird associations of the Mediterranean islands isolated in Middle and Late Pleistocene time (Mourer-Chauviré et al., 2001). In fact, Sicily was excluded in the first analysis of the Pleistocene avifaunas of Mediterranean islands (Alcover et al., 1992), because it was supposed that Sicily and the mainland were connected during that time, so no endemic species inhabited the island during the Pleistocene.

In this paper we present the analysis of the fossil bird remains of the early Middle Pleistocene “*Elephas falconeri* FC” found in different localities of the Comiso and Ragusa areas, in the South-Eastern part of Sicily (Figs 1-2), coming from both fissure fillings and lacustrine deposits.

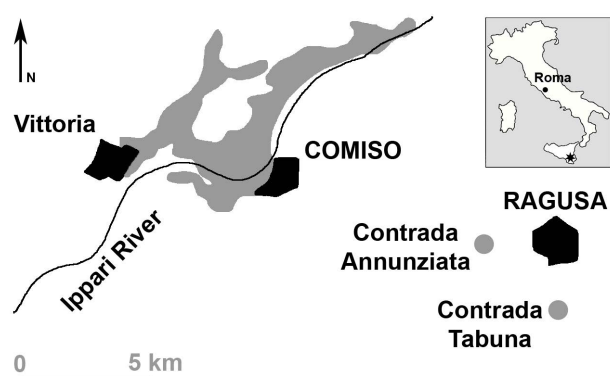


Fig. 1 - Geographic location of Ragusa, South-Eastern Sicily, with the sketch of the study area. The extension of the lacustrine deposits in the Comiso area and the location of Contrada Annunziata and Contrada Tabuna are indicated in grey.

STUDY AREA

The Ragusa province, in the south-eastern part of Sicily (Fig. 1), is characterised by the calcareous Hyblean Plateau, a Cretaceous-Miocene carbonatic platform. The central part of the Plateau, constituting the Ragusa platform, has undergone gradual uplifting, while its margins were affected by the progressive sinking of the Hyblean substratum below the Plio-Pleistocene coverings. In particular, on the western edge of the Hyblean Plateau, in the area of Comiso, a continental limnic succession (Fig. 2a), made up by palaeosols, lacustrine and aeolian deposits is interbedded between Lower Pleistocene marine deposits and early Middle Pleistocene marine sands. In the Comiso area, two Pleistocene lacustrine basins were recognized (Conti et al., 1979) with the basal clays of brackish environment interbedded with Lower Pleistocene marine sands, marking the transition from a marine to a continental environment. The detected limnic sequence of the Comiso area is constituted by five main lithotypes organized in eleven recognized layers of fine sands, silts and clays alternating with soil horizons and aeolian sands (Bonfiglio & Insacco, 1992). Pulmonate and freshwater mollusks and vertebrate remains are extensively preserved in almost all lithologic units, some of them still in anatomic connection. After systematic field research of one of the authors (G.I.), numerous vertebrate remains have been collected in the various levels of the Pleistocene limnic sequence of the Comiso area (Bonfiglio & Insacco, 1992). The palaeontological analyses made on these remains revealed the presence of amphibians, reptiles, birds and endemic mammals of the late Middle Pleistocene “*Elephas falconeri* FC” (Bonfiglio et al., 2002). In particular, some elephant remains are slightly bigger than the known variability of *Elephas falconeri* (Bonfiglio & Insacco, 1992). This fact may suggest, together with the age of the deposits indicated by the geological framework, that the vertebrates from Comiso belong to an early stage of the “*Elephas falconeri* FC” and these bigger elephants represent the ancestors of the typical *Elephas falconeri* (Busk, 1867) commonly found in several Sicilian localities (Bonfiglio & Insacco, 1992; Bonfiglio et al., 2003).

Vertebrate remains have also been collected in the Ragusa area, from fissure-filling deposits in the Hyblean carbonate substrate exposed during excavations of building foundations. In this area several fossiliferous localities have been discovered and dug, yielding rich vertebrate associations of different ages, in particular at Contrada Annunziata (Bonfiglio & Insacco, 1992; Bonfiglio et al., 1993, 2003; G. Insacco, unpublished data), at Contrada Cimillà (Bonfiglio et al., 1993), at Contrada Pianetti (Bonfiglio et al., 1997) and at Contrada Tabuna (Fabiani, 1927; G. Insacco, unpublished data) (Fig. 2b).

The fossil bird remains here presented come from the limnic deposits of the Comiso area and from fissure fillings discovered at Contrada Annunziata and Contrada Tabuna (Ragusa) and associated with vertebrate remains of the “*Elephas falconeri* FC”.

SYSTEMATIC PALAEOLOGY

The systematic analysis was carried out on 145 specimens found in various localities of the Comiso and Ragusa areas and currently stored in the Museo Civico di Storia Naturale of Comiso (MCSNC). The fossil remains have been morphologically compared with recent skeletal material stored at the Dipartimento di Scienze della Terra of the Università di Torino, Italy (Marco Pavia Ornithological Collection - MPOC), at the Museo Civico di Storia Naturale of Carmagnola, Italy and at the University Claude Bernard Lyon 1, Villeurbanne, France.



Fig. 2 - Views of the fossiliferous localities: a) Outcrop of limnic deposits around Comiso; b) Fissure fillings exposed at Contrada Annunziata.

This study revealed the presence of thirty taxa; three of them are extinct and endemic of Sicily and Malta (†). The distribution of the different taxa in the various localities of the study area is reported in Tab. 1. The systematic order of bird species follows the Italian Bird List (Fracasso et al., 2009).

The morphological descriptions and remarks are presented for selected taxa indicated with (*) in Tab. 1, while the synonymic lists are given only for the extinct species. Osteological terminology used in this publication principally follows Baumel & Witmer (1993); measurements were taken after von den Driesch (1976).

Order ANSERIFORMES Wagler, 1831
Family ANATIDAE Vigors, 1825

Genus *Cygnus* Bechstein, 1803

Cygnus equitum Bate, 1916
(Pl. 1, fig. 1)

Taxon	Comiso	CA	CT
<i>Cygnus equitum</i> Bate, 1916 (†) *		X	
<i>Cygnus cygnus</i> (Linnaeus, 1758)*	X		
<i>Anser anser</i> (Linnaeus, 1758)	X		
<i>Anser albifrons</i> (Scopoli, 1769)	X		
<i>Anser</i> sp.		X	
<i>Tadorna</i> sp.	X		
<i>Anas platyrhynchos</i> Linnaeus, 1758	X		
<i>Anas crecca</i> vel <i>A. querquedula</i>	X		
<i>Anas</i> sp.	X		X
<i>Aythya nyroca</i> (Güldenstädt, 1770)	X		
Anatidae indet.	X	X	X
<i>Tachybaptus ruficollis</i> (Pallas, 1764)	X		
<i>Ciconia ciconia</i> (Linnaeus, 1758)	cf.		
<i>Grus grus</i> (Linnaeus, 1758)		X	
<i>Grus melitensis</i> Lydekker, 1890 (†) *	X	X	
<i>Fulica atra</i> Linnaeus, 1758	X		
<i>Otis tarda</i> Linnaeus, 1758	X		
<i>Tetrax tetrax</i> (Linnaeus, 1758)			X
<i>Pluvialis apricaria</i> (Linnaeus, 1758)		X	
<i>Numenius phaeopus</i> vel <i>N. tenuirostris</i>	X		
<i>Scolopax rusticola</i> Linnaeus, 1758		X	
Sternidae indet.		X	
Charadriiformes indet.		X	
<i>Pterocles alchata</i> (Linnaeus, 1766)*			X
<i>Columba livia</i> Gmelin, 1789			X
<i>Columba palumbus</i> Linnaeus, 1758	X		
<i>Streptopelia turtur</i> (Linnaeus, 1758)	X		
<i>Picus canus</i> Gmelin, 1788*	cf.		
<i>Melanocorypha calandra</i> (Linnaeus, 1766)		X	
<i>Turdus</i> sp.		X	
Corvidae indet. (†) *	X		
Passeriformes indet.	X	X	

Tab. 1 - List of bird taxa from studied localities; CA = Contrada Annunziata; CT = Contrada Tabuna. (*): taxa commented in the text. (†): extinct taxa.

- 1916 *Cygnus equitum* BATE, p. 427, text-figs 1A, 2.
 1933 *Cygnus equitum* Bate - LAMBRECHT, p. 386, Fig. 129.
 1964 *Anser equitum* (Bate) - BRODKORB, p. 213.
 1988 *Cygnus equitum* Bate - NORTHCOTE, pp. 725-733, Pl. 69, figs 2, 5, 8; Pl. 70, figs 1, 3, 6, 9, 12; text-fig. 1b, e, i, k.
 1992 *Anser equitum* (Bate) - ALCOVER et al., p. 281.
 1992 *Cygnus equitum* Bate - NORTHCOTE, pp. 286-287, Fig. 2.
 1997 *Cygnus equitum* Bate - BOCHENSKY, p. 304.
 1997 *Cygnus equitum* Bate - LIVEZEY, p. 473.
 2000 *Cygnus equitum* Bate - PAVIA, p. 38, pp. 96-98, Pl. 1, fig. 11.
 2002 *Cygnus equitum* Bate - MLÍKOVSKÝ, p. 114.

Material - Damaged proximal left humeri (MCSNC 368, 369-370) from Contrada Annunziata (Ragusa). The three fragments belong to two bones, as the fragments 369 and 370 were glued after the cataloguing (see Pl. 1, fig. 1). For measurements, see Tab. 2.

Remarks - Two proximal humeri found in a karst fissure at Contrada Annunziata show the characteristics of a big-sized Anatidae. Their size is comparable to *Cygnus* and *Anser* but is closer to the Recent *Anser anser* (Linnaeus, 1758). On the contrary, the morphology is much more similar to the genus *Cygnus*. Actually, our specimens differ from *Anser* in having a less protruding caput humeri, a well pronounced margo caudalis and the crista deltopectoralis much more developed distally. These morphological characteristics can also be observed in the bones figured by Northcote (1988) from the Maltese Pleistocene and in the type humerus (Bate, 1916). The bones are not perfectly preserved, but their morphology allows to refer them to *Cygnus equitum*. The systematic position of this taxon is uncertain, but we follow here the opinion of Northcote (1992) and Livezey (1997), considering it a valid species of the genus *Cygnus*.

Following the analysis made by Northcote (1988), *Cygnus equitum* was capable to fly, even if the wing shape, more elliptical than that of the Recent *Cygnus* species, did not enable to fly for long distances. This species was only known from the Pleistocene of the Maltese Archipelago, where it is not common, and the record from Contrada Annunziata is the only one from Sicily (Petruso et al., 2008). This represents a new confirmation of the connection between the Maltese Archipelago and Sicily, at least the South-Eastern part, during the late Middle Pleistocene “*Elephas falconeri* FC” (Bonfiglio et al., 2002).

Cygnus cygnus Linnaeus, 1758
(Pl. 1, fig. 2)

Material - A proximal left scapula (MCSNC 600); a proximal right humerus (MCSNC 593); a distal left ulna (MCSNC CR Ih 744); a proximal right radius (MCSNC CR Ih 745); a proximal right radius (MCSNC CR Ih 747); a distal right radius (MCSNC CR Ih 667); a left os carpi ulnare (MCSNC 613); a distal left tibiotarsus (MCSNC CR Ih 665); a distal right tarsometatarsus (MCSNC 618). All the bones are from the Comiso area. For measurements, see Tab. 2.

Remarks - Some bones from the limnic deposits of the Comiso area are referable to *Cygnus cygnus*, as they are

indistinguishable in morphology and size from the Recent specimens, also following the indications of Bacher (1967) and Northcote (1981, 1988). Even if the *Cygnus* remains are quite common in the Comiso area, for the numerous preserved specimens, there is no evidence of the presence of other *Cygnus* species in those deposits. The limnic deposits of Comiso are considered older than the typical sites of the “*Elephas falconeri* FC” including the ones of the Ragusa area (Bonfiglio & Insacco, 1992), thus the presence of *C. cygnus* in deposits older than those of Contrada Annunziata seems to confirm the hypothesis that *C. cygnus* is the ancestor of *Cygnus equitum* (Northcote, 1988). *C. cygnus* is now breeding in the Northern part of Europe and Asia, with the wintering ground at median latitudes, e.g. Central Europe, and with scarce records in the Mediterranean Basin. The species was more common during the cold phases of the Pleistocene (Tyrberg, 1998, 2013), thus the presence of populations in Sicily and Malta during a warm phase of the Pleistocene could be explained with a change of ecological characteristics of the species during time.

Order GRUIFORMES Bonaparte, 1854
Family GRUIDAE (Vigors, 1825)

Genus *Grus* Brisson, 1760

Grus melitensis Lydekker, 1890
(Pl. 1, figs 5-6)

- 1890 *Grus melitensis* LYDEKKER, pp. 408-409, Pl. 36, figs 2, 4-5.
1891 *Grus melitensis* Lydekker - LYDEKKER, pp. 162-163, fig. 35.
1933 *Grus melitensis* Lydekker - LAMBRECHT, pp. 524-525.
1967 *Grus melitensis* Lydekker - BRODKORB, p. 151.
1975 *Grus antigone* Linnaeus - MOURER-CHAUVIRÉ et al., p. 47.
1977 *Grus melitensis* Lydekker - HARRISON & COWLES, p. 27.
1979 *Grus melitensis* Lydekker - HARRISON, pp. 14-15.
1982 *Grus melitensis* Lydekker - NORTHCOTE, pp. 76-80, Pl. 6, figs a-f, text-figs 1-3.
1984 pars *Grus grus* Linnaeus - NORTHCOTE, pp. 730-734, text-figs 2-4.
1985 *Grus melitensis* Lydekker - NORTHCOTE & MOURER-CHAUVIRÉ, pp. 201-208, figs 2-4.
1992 ?*Grus melitensis* Lydekker - ALCOVER et al., p. 281.
1992 *Grus melitensis* Lydekker - NORTHCOTE, pp. 288-290.

- 1997 *Grus melitensis* Lydekker - BOCHEŇSKÝ, p. 314.
1999 *Grus* sp. - PAVIA, p. 125.
2000 *Grus melitensis* Lydekker - PAVIA, p. 47, pp. 98-99, Pl. 3, figs 4-5.
2002 *Grus primigenia* Milne-Edwards - MLÍKOVSKÝ, pp. 90-91.

Material - A proximal right ramus mandibulae (MCSNC 333) and a complete right femur (MCSNC 310) from Contrada Annunziata (Ragusa); a proximal left tibiotarsus (MCSNC CR Ih 754) and a left shaft of a tibiotarsus (MCSNC CR Ih 763) from the Comiso area. For measurements, see Tab. 2.

Remarks - The morphology of the femur corresponds to the known material of *Grus melitensis* (Northcote, 1982, 1984, 1992; Northcote & Mourer-Chauviré, 1985). In particular, the ridge below the facies articularis antitrochanterica is absent and this facies is flat as in the Maltese specimens and not rounded as in *Grus antigone* (Linnaeus, 1758). The mandibular condyle, the tibiotarsus and the fibula are referred to this taxon for their size, clearly bigger than the Recent *Grus grus* (Linnaeus, 1758), as none of these bones are preserved in the type-series (Northcote, 1988).

The hindlimb bones of *G. melitensis* are relatively well known and their morphology seems to indicate that this species walked more efficiently than other *Grus* species (Northcote, 1992). On the contrary, the flying capability of *G. melitensis* is currently unknown, as the few forelimb bones of relatively smaller size referred to *G. melitensis* and considered the proof of a reduced flying capability of the species (Harrison, 1979) were reattributed to the Recent *Grus grus* by Northcote (1984). The coexistence of the two species is also documented in this paper, as a distal right ulna attributed to *G. grus* is reported from Contrada Annunziata.

The specimens here documented, together with the one found in the Spinagallo Cave (Pavia, 1999), represent the first record of *G. melitensis* outside the Maltese Archipelago. As for *Cygnus equitum*, this finding confirms the good connection of the southern part of Sicily with the Maltese Archipelago.

The systematic position of *G. melitensis* was debated in several papers, but Northcote (1992) confirmed its validity

EXPLANATION OF PLATE 1

Bird bones from the early Middle Pleistocene of the Comiso and Ragusa areas. The specimens 1, 5-6 and 7 are from the fissure fillings of Ragusa; the others are from the limnic deposits of the Comiso area.

- Fig. 1 - *Cygnus equitum* Bate, 1916; proximal right humerus (MCSNC 369-370), caudal view.
Fig. 2 - *Cygnus cygnus* Linnaeus, 1758; distal left tibiotarsus (MCSNC CR 1e 665), cranial view.
Figs 3-4 - *Anas platyrhynchos* Linnaeus, 1758; 3, right coracoid (MCSNC CR Ih 753), dorsal view; 4, left ulna (MCSNC CR Ih 755), ventral view.
Figs 5-6 - *Grus melitensis* Lydekker, 1890; left femur (MCSNC 310), cranial and caudal views.
Fig. 7 - *Pterocles alchata* (Linnaeus, 1766); right tibiotarsus (MCSNC 388), cranial view.
Fig. 8 - *Picus* cf. *P. canus* Gmelin, 1788; left ulna (MCSNC CR Ih 779), ventral view.
Fig. 9 - Corvidae indet., right humerus (MCSNC 607), caudal view.

Scale bars: 10 mm for figs 1-6 and 5 mm for figs 7-9.



also remarking on the differences from *Grus primigenia* Milne-Edwards, 1869-1871, a different giant extinct *Grus* species widespread in the European Pleistocene, even on islands (Northcote & Mourer-Chauviré, 1985). More recently, Mlíkovský (2002) considered *G. melitensis* as a synonym of *G. primigenia*, but we follow here the opinion of Northcote (1992) and we consider it as a valid species, even if a revision of all the material of *G. melitensis* is required in order to better understand its skeletal morphology and its relationships with the other *Grus* species, in particular with *G. primigenia*.

Order PTEROCLIFORMES Latham, 1790
Family PTEROCLIDAE Bonaparte, 1831

Genus *Pterocles* Temminck, 1815

Pterocles alchata (Linnaeus, 1766)
(Pl. 1, fig. 7)

Material - A distal left tibiotarsus (MCSNC 387) and a distal right tibiotarsus (MCSNC 388) from Contrada Tabuna (Ragusa). For measurements see Tab. 2.

Remarks - Two distal tibiotarsi from Contrada Tabuna show the typical features of the Pteroclididae, in particular the additional foramen on the lateral side of the cranial surface located laterally to the pons supratendineus, that is typical of *Pterocles*. The size of the two bones, that probably belong to the same individual, allows to attribute them to *Pterocles alchata*, the smallest Palearctic species. The remains from Contrada Tabuna represent the oldest record of the species (Tyrberg, 1998, 2013) and the first record for Mediterranean Islands (Mourer-Chauviré et al., 2001). As this species does not show migratory habit in Western Palearctic population (del Hoyo et al., 1997), its presence in Sicily was probably related to a sedentary population that became later extinct, as this species is now only vagrant in Sicily (Brichetti & Fracasso, 2006).

Order PICIFORMES Meyer & Wolf, 1810
Family PICIDAE Vigors, 1825

Genus *Picus* Linnaeus, 1758

Picus cf. *P. canus* Gmelin, 1788
(Pl. 1, fig. 8)

Material - A complete left ulna (MCSNC CR 1h 779) from the Comiso area. For the measurements see Tab. 2.

Remarks - A complete left ulna of a Picidae is here dubitatively referred to *Picus canus*. The morphology of the bone clearly recalls the genus *Picus* for its pronounced tuberculum ligament collateralis ventralis, a deep impression brachialis and the ventral side of the cotyla dorsalis ulnaris not rounded. The overall dimensions of the bone (see Tab. 2) are clearly bigger than any Recent *Dendocopos*, but smaller than the Recent *Picus viridis* Linnaeus, 1758 falling outside its range of variability,

thus recalling the smaller *P. canus*. Unfortunately, we were not able to compare directly the fossil bone with a skeleton of *P. canus*, so we prefer to leave the specimen in open nomenclature.

Order PASSERIFORMES Linnaeus, 1758
Family CORVIDAE Vigors, 1825

Corvidae indet.
(Pl. 1, fig. 9)

1999 Corvidae genus et species indet. - PAVIA, p. 125.

2000 Corvidae n. sp. - PAVIA, pp. 56-57, Pl. 5, fig. 18.

Material - A shaft of right humerus (MCSNC 607) from the Comiso area.

Remarks - A single humerus from the limnic deposits of Comiso is referable to a small-sized Corvidae. This humerus is very similar, in size and morphology, to the more complete bones found in other localities of the “*Elephas falconeri* FC” such as Spinagallo, Marasà and Luparello Caves (Pavia, 1999, 2000). The direct comparison of the fossil bone with specimens of *Pica pica* (Linnaeus, 1758), *Garrulus glandarius* (Linnaeus, 1758), *Nucifraga caryocatactes* (Linnaeus, 1758) and the analysis of the characteristics reported by Tomek & Bocheňský (2000) do not allow us to refer the material to any known genus within the Corvidae. The size of the fossil is intermediate between the smaller *Cyanopica cyanus* (Pallas, 1776) and *Perisoreus infaustus* (Linnaeus, 1758) and the bigger *G. glandarius* and *N. caryocatactes*. The presence of endemic species or subspecies of Corvidae on Mediterranean islands is reported in both living and fossil bird associations (Segui, 2001; Louchart, 2002; Brichetti & Fracasso, 2011), with morphologies not corresponding with this fossil taxon. The analysis of more complete bones from Sicilian localities will better define the taxonomic position of this taxon and its relationships within the Corvidae.

DISCUSSION

The fossil bones discovered in the studied localities near Comiso and Ragusa are well preserved, but rarely complete. Consequently, many of them can be referred only to a supraspecific taxon. Nonetheless, we are able to indicate the presence of at least thirty species (or species-group), mostly being still extant (Tab. 1). As most of the bird taxa have precise ecological needs, a palaeoenvironmental reconstruction of the Comiso lacustrine deposits and of the Ragusa platform is possible on the basis of the fossil bird associations found in the studied localities. The two areas cannot be treated together, as they are not coeval (Bonfiglio & Insacco, 1992), also following the indications of the geological framework (Conti et al., 1979). The palaeoenvironmental information given by birds from the Early Pleistocene onwards, when the avifaunas are constituted mostly by extant taxa, are very precise and sometimes much more effective than those given by the mammalian taxa, especially if the latter ones are inferred from extinct taxa (Bedetti & Pavia, 2007, 2013).

	GL	LM	Wp	Dp	Wd	Dd	Ws	Ds	W	Lfah	Wfah
<i>Cygnus equitum</i>											
Humerus MCSNC 368	-	-	-	-	-	-	12.3	11.7	-	-	-
Humerus MCSNC 369-370	-	-	(32.5)	16.7	-	-	13.1	12.0	-	-	-
<i>Cygnus cygnus</i>											
Scapula MCSNC 600	-	-	-	-	-	-	-	-	24.7	17.2	11.1
Humerus MCSNC 593	-	-	-	(22.5)	-	-	-	-	-	-	-
Ulna MCSNC CR Ih 744	-	-	-	-	17.1	15.7	-	-	-	-	-
Radius MCSNC CR Ih 667	-	-	-	-	(14.5)	6.8	-	-	-	-	-
Radius MCSNC CR Ih 745	-	-	(16.6)	(14.8)	-	-	10.1	9.9	-	-	-
Radius MCSNC CR Ih 747	-	-	10.7	12.0	-	-	7.1	8.0	-	-	-
Os carpi ulnare MCSNC 613	-	-	-	-	-	-	-	-	-	-	-
Tibiotarsus MCSNC CR Ih 665	-	-	-	-	22.3	23.9	10.7	8.6	-	-	-
Tarsometatarsus MCSNC 618	-	-	-	-	27.7	18.3	-	-	-	-	-
<i>Grus melitensis</i>											
Emimandible MCSNC 333	-	-	-	-	-	-	-	-	-	-	-
Femur MCSNC 310	139.9	130.1	32.8	25.8	31.6	30.2	13.5	12.4	-	-	-
Tibiotarsus MCSNC CR Ih 754	-	-	-	-	42.8	-	-	-	-	-	-
Tibiotarsus MCSNC CR Ih 763	-	-	-	-	-	-	11.9	9.5	-	-	-
<i>Pterocles alchata</i>											
Tibiotarsus MCSNC 387	-	-	-	-	5.7	6.5	3.9	3.7	-	-	-
Tibiotarsus MCSNC 388	-	-	-	-	5.8	6.6	3.4	3.1	-	-	-
<i>Picus cf. P. canus</i>											
Ulna MCSNC CR Ih 779	43.8	-	6.2	3.6	3.9	5.0	2.9	3.1	-	-	-
Corvidae indeterminate											
Humerus MCSNC 607	-	-	-	-	-	-	3.1	3.0	-	-	-

Tab. 2 - Measurements (in mm) of the bones of the identified taxa found in the various sites of the Ragusa area. Measurements of bones that are slightly worn or damaged are given in parentheses. Abbreviations: GL: greatest length; LM: medial length; Wp: proximal width; Dp: proximal depth; Wd: distal width; Dd: distal depth; Ws: width of shaft; Ds: depth of the shaft; W: proximal width from caudal margin of facies articularis humeralis to acromion; Lfah: length of facies articularis humeralis; Wfah: width of facies articularis humeralis.

The fossil bird fauna found in different outcrops of the lacustrine succession of the Comiso area contains at least 19 taxa, mostly aquatic species, two of them extinct and endemic of Sicily and Malta: *Grus melitensis* and Corvidae indet. The lacustrine deposits of the Comiso area contain mainly Anatidae of different species, such as *Cygnus cygnus*, *Anser* spp., *Anas platyrhynchos* Linnaeus, 1758 and *Aythya nyroca* (Güldenstädt, 1770), with other strictly aquatic species like *Tachybaptus ruficollis* (Pallas, 1764) and *Fulica atra* Linnaeus, 1758 as well as species related to open environment like *Ciconia ciconia* (Linnaeus, 1758), *G. melitensis* and *Otis tarda* Linnaeus, 1758. The finding of *Picus canus*, *Columba palumbus* Linnaeus, 1758 and *Streptopelia turtur* (Linnaeus, 1758) also suggests the presence of patchy woods in the area.

The fossil bird associations found in the different fissure fillings of the Ragusa platform contain at least 16 taxa, with the extinct species *Cygnus equitum* and *Grus melitensis* endemic of Sicily and Malta. The bird taxa discovered in the Ragusa area indicate the presence of an open dry environment, suggested by *Tetrax tetrax* (Linnaeus, 1758), *Pterocles alchata* and *Melanocorypha calandra* (Linnaeus, 1766), with the presence of scattered

humid areas, as indicated by *C. equitum*, the two *Grus* species, *Pluvialis apricaria* (Linnaeus, 1758) and the Anatidae. None of the taxa determined at specific level are in common between the Comiso lacustrine deposits and the Ragusa plateau, except *G. melitensis*, confirming the great diversity in the palaeoenvironment already suggested by the genesis of the fossiliferous deposits, as the Comiso area was characterised by a lacustrine basin, with different habitats, while the Ragusa platform was a rocky karstic plateau. As a consequence, the fossil bird association found in the Comiso lacustrine deposits is much more diversified than those of the Ragusa platform.

The fossil bird associations here described are also of great importance from a palaeobiogeographical point of view, as they include *C. equitum* and *G. melitensis*, two extinct species previously recorded only on the Maltese Archipelago. The two species can be considered endemic of the Maltese Archipelago and southern Sicily as they are present only there, although the Pleistocene fossil avifauna of Southern Europe and the Mediterranean Basin is well known (Alcover et al., 1992; Mourer-Chauviré et al., 2001). Both species were probably able to fly such as many of the endemic bird species, while the flightless condition

is not common, even in island taxa (Newton, 2003). The present finding represents the first Sicilian record of these two taxa, further supporting the good connection between the Maltese Archipelago and the South-Eastern part of Sicily during the late Middle Pleistocene “*Elephas falconeri* FC”. Interestingly, these records have a precise chronological attribution, that is not the case of the Maltese fossil records which need re-examination.

Most species here reported were already known from older deposits, in Sicily and Italy, with the exception of *P. alchata* for which the Contrada Tabuna finding represents the oldest occurrence (Tyrberg, 1998, 2013; Bedetti, 2003).

The fossil birds from the Comiso lacustrine deposits are the oldest records of birds from Sicily (Bonfiglio et al., 2002). In addition, they contribute to the knowledge of the evolution of the Sicilian avifaunas as, together with the preliminary data published on the Spinagallo Cave (Pavia, 1999, 2004, 2007; Pavia & Mourer-Chauré, 2002), allow to have a first draft on the composition of the avifauna of the Middle Pleistocene “*Elephas falconeri* FC”.

ACKNOWLEDGEMENTS

We would like to thank L. Bonfiglio (Messina) to introduce one to each other and allow this study possible and for her help during all phases of the work. We also thank Z. Boev (Sofia), R. Sardella (Roma) and R. Sanfilippo (Catania) for their comments, which improved the manuscripts. M. Pavia was financially supported by Synthesys Program (FR-TAF 2067 and NL-TAF 2255) and by Italian MIUR PRIN 2009MSSS9L 002 (resp. G. Pavia).

REFERENCES

- Alcover J.A., Florit F., Mourer-Chauvire C. & Weesie P.D.M. (1992). The avifaunas of the isolated Mediterranean islands during the Middle and the Late Pleistocene. *Science Series Natural History Museum Los Angeles County*, 36: 273-283.
- Bacher A. (1967). Vergleichend morphologische Untersuchungen an Einzelknochen des postkranialen Skeletts in Mitteleuropa vorkommender Schwäne und Gänse. 109 pp. Ludwig Maximilians Universität, München.
- Bate D.M.A. (1916). On small collection of vertebrate remains from the Har Dalam cavern, Malta; with note on a new species of the genus *Cygnus*. *Proceedings of the Zoological Society of London*, 1916: 421-430.
- Baumel J.J. & Witmer L.M. (1993). Osteologia. In Baumel J.J. (ed.), *Handbook of avian anatomy: Nomina Anatomica Avium*. Second Edition. Publications of the Nuttall Ornithological Club, 23: 45-132.
- Bechstein J.M. (1803). Ornithologisches Taschenbuch von und für Deutschland oder kurze Beschreibung aller Vogel Deutschlands. 336 pp. Richter, Leipzig.
- Bedetti C. (2003). Le avifaune fossili del Plio-Pleistocene italiano: sistematica, paleoecologia ed elementi di biocronologia. 188 pp. Unpublished Ph.D. Thesis, Università Sapienza di Roma, Roma.
- Bedetti C. & Pavia M. (2007). Reinterpretation of the Late Pleistocene Ingarano cave deposits based on the fossil bird associations (Apulia, South-Eastern Italy). *Rivista Italiana di Paleontologia e Stratigrafia*, 113: 487-507.
- Bedetti C. & Pavia M. (2013). Early Pleistocene birds from Pirro Nord (Puglia, southern Italy). *Palaeontographica Abteilung A-Palaeozoologie-Stratigraphie*, 298: 31-53.
- Bocheński Z. (1997). List of European fossil bird species. *Acta Zoologica Cracoviensia*, 40: 293-333.
- Bonaparte C.L. (1831). Saggio di una distribuzione metodica degli animali vertebrati. 78 pp. Boulzaler, Roma.
- Bonaparte C.L. (1854). Conspectus systematis ornithologiae. *Annales des Sciences Naturelles*. Quatrième Serie (1): 105-154.
- Bonfiglio L. & Burgio E. (1992). Significato paleoambientale e cronologico delle mammalofaune pleistoceniche della Sicilia in relazione all'evoluzione paleogeografica. *Il Quaternario*, 5: 223-234.
- Bonfiglio L., Di Stefano G., Insacco G. & Marra A.C. (1993). New Pleistocene fissure-filling deposits from the Hyblean Plateau (South-Eastern Sicily). *Rivista Italiana di Paleontologia e Stratigrafia*, 98: 523-540.
- Bonfiglio L., Galeani D., Insacco G., Mangano G. & Marra A.C. (2003). *Elephas falconeri* (Busk, 1867) and *Leithia melitensis* (Adams, 1863) from a karst fissure of the Hyblean Plateau (South-eastern Sicily). *Bollettino della Società Paleontologica Italiana*, 42: 23-128.
- Bonfiglio L. & Insacco G. (1992). Paleoenviromental, paleontologic and stratigraphic significance of vertebrate remains in Pleistocene limnic deposits from South Eastern Sicily. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 95: 195-208.
- Bonfiglio L., Insacco G., Marra A.C. & Masini F. (1997). Large mammals, amphibians, reptiles from a new fissure filling deposit of the Hyblean Plateau (South Eastern Sicily). *Bollettino della Società Paleontologica Italiana*, 36: 97-122.
- Bonfiglio L., Mangano G., Marra A.C. & Masini F. (2001). A new late Pleistocene vertebrate faunal complex from Sicily (San Teodoro Cave, North-Eastern Sicily). *Bollettino della Società Paleontologica Italiana*, 40: 149-158.
- Bonfiglio L., Mangano G., Marra A.C., Masini F., Pavia M. & Petruso D. (2002). Pleistocene Calabrian and Sicilian bioprovinces. *Géobios*, 35: 29-39.
- Brichetti P. & Fracasso G. (2006). Ornithologia Italiana 3. Stercorariidae - Caprimulgidae. 437 pp. Alberto Perdida (ed.), Bologna.
- Brichetti P. & Fracasso G. (2011). Ornithologia Italiana 7. Paridae - Corvidae. 493 pp. Alberto Perdida (ed.), Bologna.
- Brisson M.J. (1760). Ornithologie ou méthode contenant la division des oiseaux en ordres, sections, genres, especes & leurs variétés. A laquelle on a joint une description exacte de chaque espece, avec les citations des auteurs qui en ont traité, les noms qu'ils leur ont donnés, ceux que leur ont donnés les différentes nations, & les noms vulgaires. 6 vols. Bauche, Paris.
- Brodkorb P. (1964). Catalogue of the fossil birds: Part 2 (Anseriformes through Galliformes). *Bulletin of the Florida State Museum, Biological Sciences*, 8: 195-335.
- Brodkorb P. (1967). Catalogue of fossil birds: Part 3 (Ralliformes, Icthyornithiformes, Charadriiformes). *Bulletin of the Florida State Museum, Biological Sciences*, 11: 99-220.
- Burgio E. & Fiore M. (1988). La fauna vertebratologica dei depositi continentali di Monte Pellegrino (Palermo). *Il Naturalista Siciliano*, 12: 9-18.
- Busk G. (1867). Description of the remains of three extinct species of elephant, collected by Capt. Spratt, C.B.R.N., in the ossiferous cavern of Zebug, in the island of Malta. *Transaction of the Zoological Society of London*, 6: 227-306.
- Cassoli P.F. & Tagliacozzo A. (1996). L'avifauna. In Basile B. & Chilardi S. (eds), *Le ossa dei Giganti*. Lo scavo paleontologico di Contrada Fusco. Arnaldo Lombardi: 61-67.
- Conti M.A., Di Geronimo I., Esu D. & Grasso M. (1979). Il Pleistocene in facies limnica di Vittoria (Sicilia meridionale). *Geologica Romana*, 18: 93-104.
- Di Maggio C., Incandela A., Masini F., Petruso D., Renda P., Simonelli C. & Boschian G. (1999). Oscillazioni eustatiche, biocronologia dei depositi continentali e neotettonica nella Sicilia nord-occidentale (Penisola di San Vito Lo Capo - Trapani): un approccio interdisciplinare. *Il Quaternario*, 12: 25-49.
- Driesch A. von den (1976). A guide to the measurements of animal bones from archaeological sites. *Peabody Museum Bulletins*, 1: 1-129.
- Fabiani R. (1927). Resti di mammiferi del Terziario e del Quaternario di Ragusa in Sicilia. *Atti Regia Accademia Nazionale dei Lincei Serie 6*, 6: 521-524.

- Fracasso G., Baccetti N. & Serra L. (2009). La lista CISO-COI degli Uccelli italiani - Parte prima: liste A, B e C. *Avocetta*, 33: 5-24.
- Gmelin J.F. (1788). Caroli A Linné systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima tertia, aucta, reformata. 500 pp. Beer, Lipsiae.
- Güldenstädt A.I. (1770). *Anas nyroca*. *Novi Commentarii Academiae Scientiarum Imperialis Petropolitanae*, 14: 403-408.
- Harrison C.J.O. (1979). The extinct maltese Crane. *Il Merill*, 20: 14-15.
- Harrison C.J.O. & Cowles G.S. (1977). The Extinct Large Crane of the north-West Palearctic. *Journal of Archaeological Science*, 4: 25-27.
- Hoyo J. del, Elliott A. & Sargatal J. (1997). Handbook of the Birds of the World. Vol. 4. Sandgrouse to Cuckoos. 679 pp. Lynx Edicions, Barcelona.
- Lambrecht K. (1933). Handbuch der Palaeornithologie. 1024 pp. Verlag von Gebrüder Borntraeger, Berlin.
- Latham J. (1790). Index ornithologicus, sive systema ornithologiae; complectens avium divisionem in classes, ordines, genera, species, ipsarumque varietates: adjectis synonymis, locis, descriptionibus. 920 pp. Leigh & Sotheby, London.
- Linnaeus C. (1758). Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tenth Edition. 824 pp. Laurentii Salvii, Stockholm.
- Linnaeus C. (1766). Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Twelwth Edition. 532 pp. Laurentii Salvii, Stockholm.
- Livezey B.C. (1997). A phylogenetic classifications of waterfowl (Aves Anseriformes), including selected fossil species. *Annals of the Carnegie Museum*, 66: 457-496.
- Louchart A. (2002). Les oiseaux du Pléistocène de Corse et de quelques localités sardes. Écologie, évolution, biogéographie et extinctions. *Documents des Laboratoires de Géologie de Lyon*, 155: 1-287.
- Lydekker R. (1890). On the remains of some large extinct birds from the cavern-deposits of Malta. *Proceedings of the Zoological Society of London*, 28: 403-411.
- Lydekker R. (1891). Catalogue of the fossil birds in the British Museum (Natural History). 368 pp. Taylor and Francis, London.
- Meyer B. & Wolf J. (1810). Taschenbuch der deutschen Vögelkunde oder kurze Beschreibung aller Vögel Deutschlands. Mit illuminirten Kupfern. 614 pp. Wilmans, Frankfurt am Main.
- Milne-Edwards A. (1869-1871). Recherches anatomiques et paléontologiques pour servir à l'histoire des oiseaux fossiles de la France. Vol. 2. 627 pp. Victor Masson et fils, Paris.
- Mlíkovský J. (2002). Cenozoic birds of the World. Part 1: Europe. 406 pp. Ninox Press, Praha.
- Mourer-Chauviré C., Adrover R. & Pons J. (1975). Presence de *Grus antigone* (L.) dans L'«Aven de Na Coma» a Majorque (Espagne). *Nouvelles Archives du Museum d'Histoire Naturelle de Lyon*, 13: 45-50.
- Mourer-Chauviré C., Louchart A., Pavia M. & Segui B. (2001). Les avifaunes du Pléistocène moyen et supérieur des îles méditerranéennes. *Bulletin de la Société des Sciences Historiques et Naturelles de La Corse*, 696-697: 223-244.
- Newton I. (2003). The Speciation and Biogeography of Birds. 668 pp. Elsevier, London.
- Northcote E.M. (1981). Size Differences Between Limb Bones of Recent and Subfossil Mute Swans *Cygnus olor*. *Journal of Archaeological Science*, 8: 89-98.
- Northcote E.M. (1982). The extinct Maltese Crane *Grus melitensis*. *Ibis*, 124: 76-80.
- Northcote E.M. (1984). Crane *Grus* fossils from the Maltese Pleistocene. *Palaeontology*, 27: 729-735.
- Northcote E.M. (1988). An extinct Swan-Goose from the Pleistocene of Malta. *Palaeontology*, 31: 725-740.
- Northcote E.M. (1992). Swans (*Cygnus*) and Cranes (*Grus*) from the Maltese Pleistocene. In Campbell K.E. Jr. (ed.), *Papers in avian paleontology honoring Pierce Brodkorb*, Science Series Natural History Museum Los Angeles County, 285-291.
- Northcote E.M. & Mourer-Chauviré C. (1985). The distinction between the extinct Pleistocene European Crane, *Grus primigenia*, and the extant asian Sarus Crane, *G. antigone*. *Géobios*, 18: 877-881.
- Pallas P.S. (1764). Adumbratiunculae avium variarum praecedenti Elencho insertarum, sed quae in Systemate Naturae Illustr. Linnaei nondum extant. In Vosmaer A. (ed.), Catalogue raisonné, d'une collection supérieurement belle d'Oiseaux. van Os, Maissen: 1-7.
- Pallas P.S. (1776). Spicilegia zoologica quibus novae imprimis et obscurae animalium species iconibus, descriptionibus atque commentariis illustrantur. Fasciculus undecimus. 86 pp. Bertolini, Voss.
- Pavia M. (1999). The Middle Pleistocene avifauna of the Spinagallo Cave (Sicily, Italy): preliminary report. *Smithsonian Contribution to Paleobiology*, 89: 125-127.
- Pavia M. (2000). Le avifaune pleistoceniche dell'Italia meridionale. 155 pp. Ph.D. Thesis, Università di Torino, Torino.
- Pavia M. (2001). The Middle Pleistocene fossil avifauna from the "Elephas mnaidriensis Faunal Complex" of Sicily (Italy): preliminary results. In Cavarretta G., Gioia P., Mussi M. & Palombo M.R. (eds), La Terra degli Elefanti. The World of Elephants. CNR: 497-501.
- Pavia M. (2004). A new large barn owl (Aves, Strigiformes, Tytonidae) from the Middle Pleistocene of Sicily, Italy, and its taphonomical significance. *Géobios*, 37: 631-641.
- Pavia M. (2007). The first occurrence of rock partridge *Alectoris graeca* (Meisner, 1804) in Sicily and its palaeobiogeographical significance. *Avocetta*, 31: 61-66.
- Pavia M. (2008). The evolution dynamics of the Strigiformes in the Mediterranean islands with the description of *Aegolius marteae* n. sp. (Aves, Strigidae). *Quaternary International*, 182: 80-89.
- Pavia M. & Mourer-Chauviré C. (2002). An overview of the genus *Athene* in the Pleistocene of the Mediterranean Islands, with the description of *Athene trinacriae* n. sp. (Aves, Strigidae). In Zhou Z. & Zhang F. (eds), Proceedings of the 5th Symposium of the SAPE. Beijing Science Press: 13-27.
- Petruso D., Cusumano M., Domina D., Pavia M. & Masini F. (2008). Una valutazione tassonomica quantitativa preliminare della documentazione di vertebrati del Quaternario della Sicilia. *Atti del Museo Civico di Storia Naturale di Trieste*, 53 (suppl.): 189-232.
- Segui B. (2001). A new species of *Pica* (Aves: Corvidae) from the Plio-Pleistocene of Mallorca, Balearic Islands (Western Mediterranean). *Géobios*, 34: 339-347.
- Temminck C.J. (1815). Manuel d'ornithologie ou tableau systematique des oiseaux qui se trouvent en Europe; précédé d'une analyse du système general d'ornithologie. 618 pp. Sepp, Amsterdam.
- Tomek T. & Bochenski Z.M. (2000). The comparative osteology of European Corvids (Aves: Corvidae), with a key to the identification of their skeletal remains. 102 pp. Institute of Systematics and Evolution of Animals, Krakow.
- Tyrberg T. (1998). Pleistocene birds of the Palearctic: a catalogue. *Publications of the Nuttall Ornithological Club*, 27: 1-720.
- Tyrberg T. (2013). Pleistocene birds of the Palearctic. <http://web.telia.com/~u11502098/pleistocene.pdf> (Accessed on the 26th of July 2013).
- Vigors N.A. (1825). Observations on the natural affinities that connect the Orders and Families of Birds. *Transaction of the Linnean Society of London*, 14: 395-517.
- Wagler J.G. (1831). Einige Mittheilungen über Thiere Mexicos. *Isis*, 1831: 510-533.

Manuscript received 9 October 2012

Revised manuscript accepted 13 August 2013

Published online 30 October 2013