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NEW DATA AND AN OVERVIEW OF THE PAST AVIFAUNAS FROM THE CANARY ISLANDS

NUEVOS DATOS Y VISIÓN GENERAL DE LAS AVIFAUNAS DEL PASADO DE LAS ISLAS CANARIAS

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SUMMARY.—*New data and an overview of the past avifaunas from the Canary Islands.*

Fossil bones from 16 outcrops have been identified. These outcrops belong to three islands and one islet. Previous data are reconsidered. New taxonomical identifications enlarge the number of known species existing in the past, and the understanding of their geographical distributions. On the same islands, the phenomena of phylogenetic diversification show different strengths and extent in birds than in some other vertebrates. The Canarian fossil record of birds shows differences from those from some other oceanic islands regarding the rate of extinct endemisms, disappearance (extinction plus local extirpation) rates and other frequent phenomena related to insular conditions. There is no unquestionable evidence for bird extinctions after the European contact. First settlers in the Canaries did not exert as much pressure on the avifauna as has been recorded for other oceanic islands.

Key words: biogeography, Canary Islands, endemism, extinctions, fossil birds, insularity, Quaternary.

RESUMEN.—*Nuevos datos y visión general de las avifaunas del pasado de las islas Canarias.*

Se han identificado huesos fósiles de 16 yacimientos. Estas localidades pertenecen a tres islas y a un islote. Se reconsideran datos anteriores. Las nuevas identificaciones taxonómicas amplían el número de especies conocidas en el pasado y el conocimiento de sus distribuciones geográficas. En las mismas islas, los fenómenos de diversificación filogenética muestran en aves diferentes intensidades y extensión que en otros vertebrados. El registro fósil de las aves canarias muestra diferencias con los de otras islas oceánicas respecto a la proporción de endemismos extinguidos, la proporción de desapariciones (extinciones más extirpaciones locales) y otros fenómenos relacionados con condiciones de insularidad. No hay evidencias incuestionables de extinciones de aves posteriores al contacto con los europeos. Los primeros pobladores de las Canarias no ejercieron tanta presión sobre la avifauna como ha quedado patente en otras islas oceánicas.

*Palabras clav*e: aves fósiles, biogeografía, Cuaternario, endemismo, extinciones, insularidad, islas Canarias.

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INTRODUCTION

Interest in the avian fossils from Canary Islands is very recent (Sánchez Marco and Sastre, 2001). It started with the finding of eggshells in sediments from the Miocene/Pliocene boundary at Órzola (northern Lanzarote), which were attributed to two ratites, *Struthio* and an unidentified aepyornithid (Rothe, 1964; Sauer and Rothe, 1972). Later, García-Talavera (1990) collected more eggshells and a fossil bone fragment in the same fossil bed, and tentatively attributed all the remains to Odontopterygiformes.

In these islands, most avian remains are found in volcanic tubes and aeolian deposits –palaeodunes. Prior to the present work 21 localities or areas with fossiliferous outcrops had been studied (table 1). These localities yielded more than 30 taxa, five of them of extinct species: *Carduelis triasi* Alcover and Florit, 1987; *Puffinus olsoni* McMinn *et al*., 1990; *Puffinus holeae* Walker *et al*., 1990; *Coturnix gomerae* Jaume *et al*., 1993, and *Emberiza alcoveri* Rando *et al*., 1999.

The Canary Islands are situated in the North Atlantic Ocean (29º 24' N, 27º 37' W), 100 km off the Northwest coast of Africa. The archipelago is constituted of seven major islands and some small islands and islets. All of these are relatively small –total land area is 7.490 km^2– of volcanic origin and it is generally accepted that they were formed by the Canary hotspot. There is a rough chronological gradient east-west, the eastern islands being the oldest, and the western islands the youngest, approximately (Ancochea *et al*., 1990, 1994 and 1996; Coello *et al*., 1992; Carracedo *et al*., 2002) (figure 1).

MATERIAL AND METHODS

The number of new fossil bones studied in this paper amounts to over 1.600. They came from 16 sites situated in the islands of Fuerte-

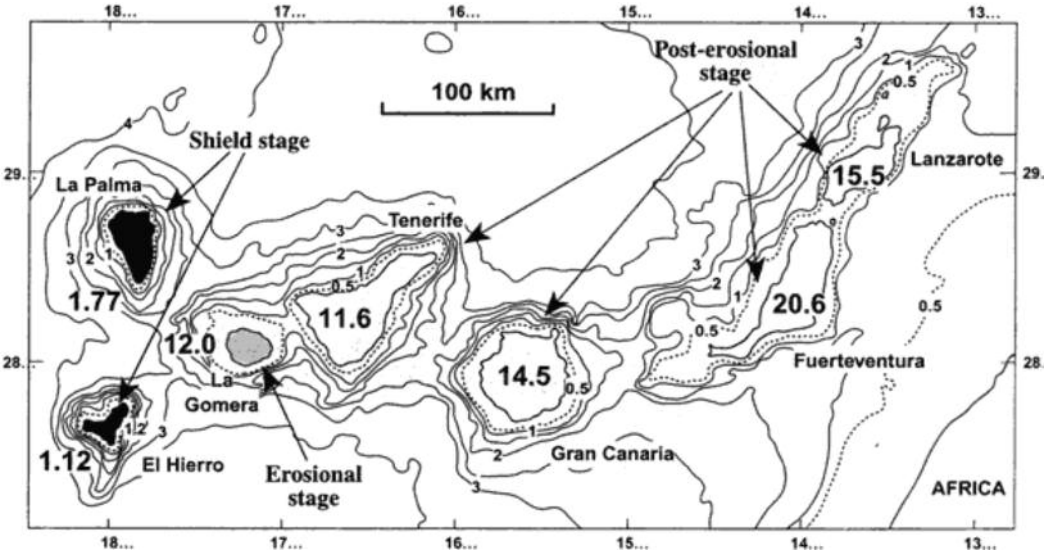

FIG. 1.—Oldest ages of subaerial volcanism in the Canary Islands (after Carracedo *et al*., 2002).
[Edades más antiguas de vulcanismo subaéreo en las islas Canarias (según Carracedo et al*., 2002).]*

TABLE 1

Fossil birds found in the Canary Islands. (*) type-specimen of the corresponding species. (**) new taxa in the Canary fossil or subfossil record.
[Aves fósiles encontradas en las islas Canarias. (*) espécimen-tipo de la especie correspondiente. (**) nuevos taxones en el registro fósil o subfósil canario.]

Órzola (Lanzarote) Rothe (1964), Sauer and Rothe (1972)	*Struthio* sp. (eggshells) Aepyornithidae (eggshells)	
Órzola (Lanzarote) García-Talavera (1990)	Odontopterygiformes indet. (eggshells and one bone)	
Cueva Inferior of Murciélagos caves (La Palma) Alcover and Florit (1987)	*Carduelis triasi* (*)	
La Aldea (Gran Canaria) Alcover and Florit (1989)	*Coturnix* sp. cf. *Puffinus assimilis* *Buteo buteo* *Accipiter nisus* *Charadrius* sp. *Falco tinnunculus*	*Tyto* sp. *Columba* sp. *Turdus merula* *Turdus* sp. *Corvus corax*
Barranco de la Barca (Fuerteventura) Walker *et al*. (1990), Michaux *et al*. (1991)	*Puffinus holeae* (*)	
Cañada del Río (Fuerteventura) Michaux *et al*. (1991)	*Puffinus holeae*	
Cofete 1 (Fuerteventura) Michaux *et al*. (1991)	*Puffinus holeae*	
Cofete 1 (Fuerteventura) New data	*Puffinus holeae*	
Cofete (Fuerteventura) New data	*Puffinus holeae*	
Degollada de Cofete (Fuerteventura) New data	*Puffinus holeae*	
Cueva de las Palomas – **Palomas cave** (Fuerteventura) McMinn *et al*. (1990), Rando and Alcover (2008)	*Puffinus olsoni* (*)	

TABLE 1 (cont.)

Cueva de las Palomas – Palomas cave (Fuerteventura) New data	*Coturnix gomerae* *Calonectris diomedea* *Puffinus olsoni*	*Columba livia* / *oenas* *Columba* sp.
Cueva de las Moscas – Moscas cave (Fuerteventura) Rando and Alcover (2008)	*Puffinus olsoni*	
Cueva de la Laguna – Laguna cave (Fuerteventura) Rando and Alcover (2008)	*Puffinus olsoni*	
Los Jameos (Lanzarote) McMinn *et al*. (1990)	*Calonectris diomedea* *Puffinus holeae* *Puffinus olsoni*	*Haliaeetus albicilla* *Buteo buteo* *Columba livia*
Cueva Chica del Mojón (Lanzarote) McMinn *et al*. (1990)	*Calonectris diomedea* *Puffinus olsoni*	
Bujero del Silo (La Gomera) Jaume *et al*. (1993)	*Coturnix gomerae* (*) *Buteo buteo insularum* *Neophron percnopterus* *Falco tinnunculus* *Falco* sp. *Tyto gracilirostris*	*Columba junoniae* *Turdus* sp. *Carduelis chloris* *Pyrrhocorax pyrrhocorax* *Corvus corax*
Cueva I de Tuineje (Fuerteventura) Rando and Perera (1994)	*Calonectris diomedea* *Puffinus olsoni* *Columba* sp.	*Coturnix gomerae* *Turdus* sp. *Sylvia* cf. *atricapilla*
Cueva II de Tuineje (Fuerteventura) Rando and Perera (1994)	*Calonectris diomedea* *Puffinus olsoni* *Anthus bertelotii*	
Cueva del Viento – Viento cave (Tenerife) Rando (1995a), Rando and López (1996), Rando *et al*. (1999)	*Coturnix gomerae* *Chlamydotis undulata* *Buteo buteo* *Accipiter nisus*	*Columba* sp. *Emberiza alcoveri* (*) *Turdus* sp. *Pyrrhocorax pyrrhocorax*
Hueso del Caballo (Fuerteventura) Rando (1995b)	*Haliaeetus* sp.	
Hueso del Caballo (Fuerteventura) New data	*Puffinus holeae*	

TABLE 1 (cont.)

Cueva del Llano – Llano cave (Fuerteventura) Rando (1995b)	*Haliaeetus* sp.	
Cueva del Llano – Llano cave (Fuerteventura) Castillo *et al*. (2001)	*Haliaeetus* sp.	
Cueva del Tendal – Tendal cave (La Palma) Rando *et al*. (1996)	*Coturnix gomerae* cf. *Coturnix gomerae* *Gallus gallus* *Calonectris diomedea* *Buteo buteo* *Falco tinnunculus*	*Tyto* cf. *alba* cf. *Tyto* sp. *Columba junoniae* *Columba* sp. *Pyrrhocorax pyrrhocorax*
Guinea (El Hierro) Rando *et al*. (1997)	*Gallus gallus* *Coturnix gomerae* *Coturnix* sp. *Calonectris diomedea* *Bulweria bulwerii*	*Larus* sp. *Buteo buteo* *Columba* sp. cf. *Pyrrhocorax pyrrhocorax* *Corvus corax*
Cueva del Curascán – Curascán cave (El Hierro) Rando (2002)	*Oceanodroma castro* *Pterodroma* sp. *Calonectris diomedea*	*Accipiter gentilis*
Cueva del Curascán – Curascán cave (El Hierro) New data	*Coturnix gomerae* *Oceanodroma* cf. *castro* *Calonectris diomedea*	*Puffinus puffinus* *Hieraaetus pennatus***
Barranco del Pecenescal – Pecenescal gully (Fuerteventura) Sánchez (2003)	*Calonectris diomedea* *Puffinus holeae* *Puffinus puffinus*	
Barranco del Pecenescal – Pecenescal gully (Fuerteventura) New data	*Calonectris diomedea* *Puffinus holeae*	
Cueva de los Piquetes – Piquetes cave (Tenerife) New data	*Coturnix gomerae* *Burhinus oedicnemus*** *Asio otus***	
Sima de la Hoyeta – Hoyeta sinkhole (El Hierro) New data	*Sturnus* sp.** *Corvus corax*	
Cueva de Don Justo – Don Justo's cave (El Hierro) New data	*Puffinus assimilis*	

TABLE 1 (cont.)

Sima de Narciso – Narciso's sinkhole (El Hierro) New data	*Calonectris diomedea* *Corvus corax*	
Cueva del Linke – Linke cave (El Hierro) New data	*Coturnix gomerae* *Calonectris diomedea*	*Corvus corax*
Cueva de las Pardelas – Pardelas cave or Hoyo de los Perros (El Hierro) New data	*Puffinus assimilis*	
Cueva Mauricio – Mauricio's cave (El Hierro) New data	*Columba* sp.	
Sima del Cráter – Cráter sinkhole (El Hierro) New data	*Pelagodroma marina*** *Calonectris diomedea* *Puffinus puffinus*	*Puffinus assimilis* *Arenaria interpres***
Islote de Lobos – Lobos islet Rando and Alcover (2008)	*Puffinus olsoni*	
Islote de Lobos – Lobos islet New data	*Bulweria bulwerii* *Calonectris diomedea*	*Puffinus assimilis* *Puffinus olsoni*

ventura, El Hierro and Tenerife, and from the Lobos islet, close to Lanzarote Island (table 1).

Identifications of fossils have been made with the help of the osteological comparative collections of the Laboratorio de Arqueozoología of the Universidad Autónoma de Madrid and National Museum of Natural History (Smithsonian Institution). Osteological nomenclature follows Baumel and Witmer (1993), and the systematic classification of Livezey and Zusi (2007). Status and geographical distribution of each species are mainly based on the work by Martín and Lorenzo (2001).

The following anatomical abbreviations are used: coracoid – cor, furcula – fur, scapula – scp, humerus – hum, ulna – uln, radius – rad, sternum – str, synsacrum – ssc, femur – fem, tibiotarsus – tbt, tarsometatarsus – tmt, digit – dig, phalanx – pha, right (bone) – dex, left (bone) – sin, proximal (zone) – pro, distal (zone) – dis, cranial (zone) – cra, caudal (zone) – cau, juvenil – juv.

RESULTS

Fifteen taxa were identified, two of them at the genus level. Six taxa are new for the fossil record of the Canary Islands (table 1). Moreover, the geographical distribution of eight species previously known in the Canaries has been extended to islands other than those which have been found so far (appendix 1).

The largest number of remains studied were attributed to the group of procellariids. Differences in bone sizes among species within this family are not the only distinguishing characteristic available. The humeri of *Puffinus olsoni* and *Puffinus assimilis* show smaller differences in size than was previously known (table 2). Nonetheless, the section of the humeral diaphysis remains different in both species. The diaphysis is compressed laterally in *Puffinus olsoni*, as is observed in *Puffinus holeae*. In *Puffinus assimilis* the section of the diaphysis is more circular, similar to *Calonectris diomedea* and *Puffinus puffinus*. The femoral diaphysis is almost straight in *Calonectris diomedea* and *Puffinus puffinus*; in *Puffinus olsoni* the diaphysis is clearly curved in antero-posterior direction, but this curvature is more pronounced in *Puffinus assimilis* and *Puffinus holeae*.

GALLIFORMES (Temminck, 1820)
Phasianidae (Vigors, 1825)
Coturnix Bonaterre, 1791
Coturnix gomerae
Jaume, McMinn and Alcover, 1993

Cueva de los Piquetes (Tenerife) – Locus 1: some remains from a single individual.

Locus 3: some remains from a single individual. Locus 5: cranium fragment, hum dex pro, fem sin pro, tbt sin pro, tbt sin dis, tmt sin dis. Locus 21: hum dex, hum sin.

Cueva de las Palomas (Fuerteventura) – Locus 12: cor dex juv. Locus 13: much of a skeleton of one individual, and some remains of others: scp dex, cor sin, hum sin, hum dex, uln sin, fem sin pro, fem dex pro, fem sin dis, tbt sin dis, tbt dex pro, tbt dex dia, tbt sin dia, tmt sin dis, tmt dex.

Cueva del Linke (El Hierro) – Higher zone: neurocranium, hum dex.

Cueva del Curascán (El Hierro) – Locus 1: cor sin, cor sin cra, cor dex, hum dex, cmc dex, tbt dex pro. Locus 2: scp sin, scp sin cra, cor dex, 2 cor dex cra, hum sin, hum dex dis, uln dex, uln dex dis, uln sin dia, 2 cmc dex, cmc sin, fem sin pro, fem dex pro, fem dex dis, fem sin dis, tbt dex, 2 tbt sin pro, tbt dex dis, 2 tmt sin, tmt dex. Locus 3: 2 cor sin, hum dex, cmc sin, fem sin, fem sin dis, fem dex pro, tbt dex dis, tmt sin dia. Locus 4: cor sin, str, scp sin, hum sin pro, hum sin dis, uln sin, cmc sin, fragment of ssc, fem sin dis, tbt dex, tmt dex, tmt dex dis.

Only the hind-limb bones can be referred to as *C. gomerae* with confidence. The rest of the skeletal elements can only be attributed tentatively.

PROCELLARIIFORMES Fürbringer, 1888
Oceanitidae Forbes, 1882
Pelagodroma Reichenbach, 1853
Pelagodroma marina (Latham, 1790)

Sima del Cráter (El Hierro) – Deepest secondary sinkhole: cmc sin.

The carpometacarpus of the white-faced storm-petrel (*Pelagodroma marina*) is smaller than in Leach's storm-petrel (*Oceanodroma leucorhoa*), and greater than in Wilson's storm-petrel (*Oceanites oceanicus*) and in British storm-petrel (*Hydrobates pelagicus*). *Pelagodroma* is distinguishable by its morphology. The most distinctive feature is that in *Pelagodroma* the metacarpale minus branches off proximally from the epiphysis. In *Oceanodroma* the metacarpale minus departs directly from the metacarpale majus. Furthermore, in *P. marina* there is an apparent larger distance between metacarpals than in other species compared.

Oceanodroma Reichenbach, 1853
Oceanodroma cf. *castro* (Harcourt, 1851)

Cueva del Curascán (El Hierro) – Locus 8: remains probably belonging to the same in-

dividual: fragments of cranium and str, fur, cor sin, hum sin, uln sin, uln dex, rad sin, rad dex, cmc sin, cmc dex, fem sin, tbt sin pro, tmt sin, tmt dex. Additionally: 2 cor sin, hum sin, hum dex, hum sin dis.

These bones do not show morphological differences from *O. leucorhoa* (Vieillot, 1818), but they have not been compared with skeletons of *O. castro*. These bones probably belonged to *O. castro*, a species identified in the fossil record of Curascán by Rando (2002), and the sole species within this genus currently breeding in the Canary Islands.

Procellariidae Leach, 1820
Calonectris Mathews and Iredale, 1915
Calonectris diomedea (Scopoli, 1769)

Cueva de las Palomas (Fuerteventura) – Locus 12: cor sin, scp dex, hum dex pro, hum dex dis, rad dex dis, cmc dex, 2 cmc sin dis, cmc dex dis, fem sin, 2 fem dex, fibula, 2 tmt sin, 2 pedal pha.

Barranco del Pecenescal (Fuerteventura) – Red clays with gasteropods: fragments of cranium, cmc sin, tmt dex, 3 hum pro juv, rad sin pro, rad dex pro. FAR 1: cor sin, hum sin, uln dex dia, uln sin pro juv.

Sima de Narciso (El Hierro) – tmt sin dis.

Cueva del Linke (El Hierro) – Lower section: fur, scp sin, cor sin, cmc dex, vertebrae, costae and pedal phalanges. Locus 1: remains of one individual: cranium, fur, str, cor sin, hum dex, uln sin, pelvis, tbt sin pro, tbt sin dis, costae, pedal phalanges.

Sima del Cráter (El Hierro) – Deepest sinkhole: cranium, scp dex cra, cor dex, hum dex dis, uln dex dis, cmc dex pro, fem dex pro-dis. Further hall: quadrate, articular area of mandible, cor sin, cor dex, 2 hum dex pro, 2 hum sin pro, 2 hum sin dis, hum dex dis, 2 uln dex pro, uln sin pro, uln sin dis, rad sin pro, rad dex pro, rad sin dis, 3 rad dex dis, 2 cmc dex pro, cmc sin pro, cmc sin dis, alar pha 1 dig majoris dex, alar pha 1 dig majoris sin, 4 ssc, fem dex dia, 2 tbt sin, tbt dex pro, tbt sin pro, 2 tbt sin dis, tmt sin, tmt sin dis.

Cueva del Curascán (El Hierro) – Locus 1: fragments of cranium (burnt), 3 mandible fragments, quadrate, 2 cor sin, cor dex, 2 cor dex dia, cor sin cra, hum sin pro, scp sin, 3 hum dex dis, 2 hum sin dis, uln sin dis, uln sin dia, cmc sin pro, cmc dex dis, 3 fem dex, fem dex pro, 3 fem juv, tbt dex pro, 2 tbt dex dis, tbt sin dis, tmt sin, tmt dex pro, tmt dex dis, some vertebrae and costae. Locus 2: fragments of cranium, cor sin cra, cor sin dia, hum dex pro, hum dex dis, uln sin dis, fem dex pro, tbt sin pro, some vertebrae and pedal phalanges. Locus 3: between 50 to 60 remains of all kinds. Locus 4: 3 fragments of calvaria, rostrum, mandible, some str, cor sin, con sin juv, cor dex, cor dex juv, scp dex, 2 hum sin pro, 2 hum dex pro, hum sin dis, hum dex dia, hum dex dis, 2 uln dex pro, uln sin pro, 2 uln dex pro, uln dex dia, 4 uln dex dis, 4 uln sin dis, rad sin pro, 2 rad sin dis, rad dex dis, cmc dex, 3 cmc dex pro, cmc sin dis, cmc dex dis, ssc fragment, 3 fem sin, 2 fem sin pro, fem dex pro, tbt dex pro, tbt dex dis, tmt sin, tmt sin dis, 2 tmt dex dis and abundant vertebra and costae, including immatures. Locus 5: cranium fragment, mandible fragment, 2 fur, scp dex, cor dex, cor sin cra, hum sin pro, 2 hum sin dia, 2 hum dex dia, 2 hum dex pro, 2 hum dex dis, 3 uln sin pro, uln dex pro, 2 uln dex dis, uln sin dis, 3 rad dex dis, rad sin pro, 2 cmc dex pro, cmc sin dis, 2 ssc, fem dex dis, fem sin, fem sin pro, 2 fem dex dia, 2 tbt sin dis, tmt dex, 2 tmt sin pro and some vertebrae. Locus 6: hum dex dis, cmc dex pro, 2 uln sin dis, fem sin pro (all the bones are burnt). Locus 7: approximately one hundred bones.

Islote de Lobos – rad dex dis, uln sin dia, uln dex pro.

Puffinus Brisson, 1760
Puffinus puffinus (Brünnich, 1764)

Sima del Cráter (El Hierro) – Deepest sinkhole: mandible, quadrate, fur, scp sin, scp dex, str, cor sin, cor dex, 2 hum dex pro, hum sin pro, hum sin dis, 2 hum dex dis, uln dex dis, uln dia, rad sin dis, cmc dex, cmc sin pro, cmc dex dis, alar pha 1 dig majoris, ssc, fem sin, fem dex, tbt sin pro, tbt dex pro, tbt sin dis, tmt sin, tmt dex dis and some vertebrae. Farther hall: fur, str, 2 cor sin, 2 cor dex, cor dex cau, cor sin cau, hum dex, 2 hum sin pro, hum dex pro, 2 hum sin dis, hum dex dis, uln dex pro, uln sin dia, 2 uln dex, uln sin dis, rad sin dis, cmc sin, cmc sin dis, alar pha 1 dig majoris dex, 2 ssc, fem dex, fem dex dis, fem sin pro, fem sin dis, 2 tbt dex pro, tbt dex dis, tbt sin dis, tmt dex, tmt sin, 2 tmt sin pro.

Cueva del Curascán (El Hierro) – Locus 2: quadrate, str fragment, cor sin, hum sin, hum dex pro, uln dex, uln sin pro, 2 rad dex pro, rad dex dis, cmc sin, cmc dex, alar pha 1 dig majoris, 2 ssc, tmt sin. Locus 3: 2 hum sin dis, uln dex pro, rad sin pro, rad dex pro, rad dex dis, rad sin dis, cmc dex, cmc sin, 2 alar pha dig majoris dex, alar pha dig majoris sin, ssc. Some bones have fire marks. Locus 4: hum sin pro, hum sin dis, uln sin pro, rad dex dis, cmc sin, ssc, fem dex prodis, tbt sin pro. Locus 5: cranium fragment, hum dex pro, hum dex dia, hum dex dis, 2 uln dex dis, uln sin dis, rad dex pro, rad sin dis, cmc dex dis, cmc sin dia, alar pha 1 dig majoris dex, fem sin dis, tmt dex dis. Locus 7: cranium fragment, scp sin, scp sin cra, fur, cor sin, cor dex, hum dex juv, 3 hum dex pro, 2 hum sin dis, hum sin dis juv, hum dex dis juv, 2 uln dex, 2 uln dex pro, 2 uln sin pro, uln sin dis juv, 3 uln dex dis, uln sin dis, 2 rad dex pro, 2 rad dex dis, cmc sin, 2 cmc dex pro, cmc sin pro, cmc dex dia, 2 alar pha 1 dig majoris dex, alar pha 1 dig majoris sin, 2 ssc, fem dex, fem dex dis, fem sin pro, tbt sin, tbt dex, 2 tbt sin dis, tbt sin pro, tmt sin pro, tmt sin dis. Locus 8: cranium fragment, scp sin cra, cor sin, 2 hum sin pro, 2 hum dex pro, 3 hum sin dis, 2 hum dex dis, uln sin, uln sin pro, uln dex dis, 2 rad sin dis, rad dex dis, cmc sin, cmc sin pro, fem sin, fem sin pro, fem dex pro, 2 tmt dex pro. Locus 9: fragment of cranium, mandible fragment, str fragment, cor dex, 2 cor sin, hum dex, 2 hum dex pro, 4 hum sin pro, 5 hum dex dis, hum sin dis, 2 uln dex, 3 uln sin pro, 2 uln dex pro, 2 uln dex dis, uln sin dia, rad dex, 3 rad sin pro, rad sin dis, 3 cmc sin, 2 cmc dex, cmc sin pro, 2 cmc dex dis, 3 ssc, fem dex, tmt dex dis.

Puffinus assimilis Gould, 1838

Cueva de Don Justo (El Hierro) – Associate bones of a single individual: fragment of rostrum, articular area of mandible, cor dex, hum dex, hum sin dis, uln sin, uln dex dia, rad dex dis, cmc sin, cmc dex dis, cmc dex pro, alar pha 1 dig majoris dex, alar pha 1 dig majoris sin, ssc, fem dex, tbt sin dis, tmt dex (table 2).

Cueva de las Pardelas (El Hierro) – Locus 1: Bones belonging to a single individual: fragments of calvaria and mandible, cor dex, hum sin pro, hum sin dis, hum dex pro, hum dex dis, uln dex pro, uln dex dis, uln sin dis, cmc sin pro, cmc dex pro, ssc, fem sin dis, tbt sin dis, tbt dex dis, tmt dex pro, tmt dex dis. Locus 2: Associate bones of a single individual: fragments of cranium, articular area of mandible, scp dex, cor dex, cor sin, 2 hum dex dia, hum dex dis, uln sin dis, rad dex pro, rad dex dis, cmc sin, cmc dex, tbt sin dis, tbt dex dis, vertebreae, ribs. Locus 3: Remains of two individuals: fragments of 2 sterni, mandible fragments, scp sin cra, 2 cor dex, cor sin, 2 hum dex pro, hum sin pro, hum sin dis, 2 uln sin pro, 2 uln sin dis, uln dex dis, cmc sin, cmc dex pro, alar pha 1 dig majoris dex, fem sin, 2 tbt sin pro, tbt sin dis, tbt dex dis. Locus 4:

Associate bones of a single individual: fragments of cranium and sternum, scp sin, scp dex cra, con sin, cor dex, hum sin dis, uln dex pro, ssc, fem dex, tbt sin, tbt dex pro, tbt dex dis, tmt sin, tmt dex pro, vertebrae. Locus 5: Associate bones of a single individual: fragments of calvaria, articular area of mandible, scp dex, cor sin cau, cor dex dia, hum sin, hum dex dis, uln dex, uln sin pro, rad sin pro, cmc sin, alar pha 1 dig majoris dex, tbt sin pro-dis, tbt dex dis, tmt sin dis. Locus 6: cor dex cau, cor sin cra. Locus 7: 2 crania, mandible fragments, str fragments, cor sin, cor dex, hum sin pro, 3 hum dex dis, uln sin pro, rad sin pro, rad sin dis, 3 cmc sin, ssc, fem sin pro, tbt sin pro, tbt sin dis, tmt dex, tmt dex pro. Locus 8: Associate bones of a single individual: fragments of cranium, cor dex, hum sin, uln sin, uln dex, cmc sin, cmc dex, ssc, part of pelvis, fem sin, tbt dis. Locus 9: Associate bones of a single individual: fragments of calvaria and mandible, cmc sin, part of pelvis, fem sin, vertebrae and ribs (table 2).

Sima del Cráter (El Hierro) – Farthest hall: cor dex, cor sin pro, hum sin pro, cmc sin dis.

Islote de Lobos – str cra, cor sin, 3 hum sin, 4 hum dex, hum sin pro, 3 hum dex pro, hum dex dis, hum sin dis, hum dex dia, hum sin juv, hum sin dis juv, 3 uln dex, 3 uln dex pro, 4 uln dex dis, uln sin dis, rad dex, 2 rad dex dis, 2 rad dex pro, rad sin pro, 3 cmc sin, cmc dex, ssc, fem sin, fem dex, tbt dex (table 2).

Puffinus olsoni
McMinn, Jaume and Alcover, 1990

Cueva de las Palomas (Fuerteventura) – Locus 12: rostrum, 2 cor sin, cor dex, hum sin pro, uln dex pro, 2 fem sin, fem dex, fem dex pro, fem dex dis, tbt dex pro, tbt sin dis (table 2).

Islote de Lobos – cor dex, scp sin cra, hum sin, 2 hum dex, hum sin pro, hum sin pro juv, 3 hum dex pro, hum sin dis, hum dex dis, uln sin, uln sin dis, 2 uln dex, 3 uln dex pro, uln dex dis, uln dex dia, rad sin juv, rad dex pro, rad dex dis, 2 cmc dex, cmc sin pro, ssc fragments, fem sin, fem dex dia, tbt dex, tmt dex juv (table 2).

Puffinus holeae
Walker, Wragg and Harrison, 1990

Degollada de Cofete (Fuerteventura) – huge number of all types of bones.

Cofete 1 (Fuerteventura) – huge number of all kinds of bones.

Cofete (Fuerteventura) – huge number of all kinds of bones.

Hueso del Caballo (Fuerteventura) – a large number of all kinds of bones.

Barranco del Pecenescal (Fuerteventura) – Red clays with gastropods: rostrum, cor dex, 2 hum sin, 2 hum sin pro, fem sin, fem sin pro, vertebrae. FAR-1: complete immature individual together with remains of adults: 3 cor dex, hum dex, cranium, 2 fragments of mandible, quadrate, 2 rostri, fur, str, 3 cor dex, hum sin dis, uln sin, tbt dex, tbt dex pro, tbt dex dis, tmt sin, tmt dex. FAR 2: a large number of bones. Quarry (upper level): a large number of bones.

Bulweria Bonaparte, 1843
Bulweria bulwerii (Jardine and Selby, 1828)

Islote de Lobos – cor dex, scp dex cra, hum sin pro, fem dex pro.

CHARADRIIFORMES (Fürbringer, 1888)
Scolopacidae Vigors, 1825
Arenaria Brisson, 1760
Arenaria interpres Linnaeus, 1758

Sima del Cráter (El Hierro) – Deepest secondary sinkhole: uln sin.

TABLE 2

Bone measurements of *Puffinus assimilis* and *Puffinus olsoni* from the localities of Lobos islet, Don Justo, Pardelas and Palomas caves. (*) Measures after McMinn *et al*. (1990).
[Medidas óseas de Puffinus assimilis *y* Puffinus olsoni *de las localidades del islote de Lobos y de las cuevas de Don Justo, de las Pardelas y de las Palomas*. (*) *Medidas según McMinn* et al. *(1990).]*

	Puffinus assimilis			***P. olsoni***		***P. assimili****	***P. olsoni****
	Pardelas	Lobos	Don Justo	Palomas	Lobos		
Beak bones							
Maximum length	–	–	–	37.5	–	30.4 – 30.5 (n = 2)	38.1 – 41.9 (n = 3)
Length from nostrils to distal end	–	–	–	25.2	–	17.6 – 17.7 (n = 2)	23.2 – 26.3 (n = 2)
Coracoid							
Maximum length	17.8 – 21.1 (n = 5)	–	–	28.5, 28.4	–	24.0	28.2 – 31.0 (n = 11)
Length from processus acrocoracoideus toangulus medialis	15.7 – 17.1 (n = 6)	–	–	24.4, 24.8, 24.1	–	–	–
Humerus							
Maximum length	61.3	59.8 – 64.3 (n = 6)	61.2	–	69.7, 71.5, 72.3	60.3	66.7 – 73.6 (n = 21)
Width of distal epiphysis	–	5.9 – 6.9 (n = 4)	–	–	8.4, 8.9, 9.2	–	–
Width of diaphysis at midpoint	2.7 – 3.6 (n = 7)	2.7 – 3.0 (n = 6)	3.2	3.3	2.8 – 3.0 (n = 6)	2.5	–
Ulna							
Maximum length	–	63.0, 63.2, 64.3	61.0	–	61.2, 61.5	55.9	60.3 – 65.1 (n = 18)
Width of proximal epiphysis	5.4 – 5.6 (n = 6)	–	–	5.7	–	–	–
Width of diaphysis at midpoint	2.2 – 2.8 (n = 6)	2.6 – 2.8 (n = 7)	2.5	–	2.8 – 3.0 (n = 4)	–	–
Radius							
Maximum length	–	62.2	–	–	–	53.7	58.4 – 62.0 (n = 8)
Width of diaphysis at midpoint	–	1.5 – 1.7 (n = 4)	–	–	2.2, 2.3	–	–

TABLE 2 (cont.)

	Puffinus assimilis			*P. olsoni*		*P. assimili**	*P. olsoni**
	Pardelas	Lobos	Don Justo	Palomas	Lobos		
Carpometacarpus							
Maximum length	29.1 – 30.8 (n = 5)	29.0 – 31.0 (n = 4)	29.6	–	36.1, 36.3	33.0	35.2 – 39.1 (n = 13)
Width of proximal epiphysis	6.9 – 7.6 (n = 7)	7.0 – 7.1 (n = 3)	–	–	8.3, 8.5	–	–
Width of diaphysis at midpoint	1.9 – 2.3 (n = 7)	2.2 – 2.3 (n = 4)	2.4	–	2.6, 2.8	–	–
Femur							
Maximum length	19.2, 19.9	22.8, 22.8	19.7	27.0, 28.0, 28.4	28.3	23.3	26.7 – 29.3 (n = 19)
Width of proximal epiphysis	3.9	5.6, 5.7	–	6.2, 6.2, 6.9	6.5	–	–
Width of distal epiphysis	3.6, 3.8	5.2, 5.4	–	5.8 – 6.5 (n = 4)	5.8	–	–
Width of diaphysis at midpoint	1.7, 1.8, 1.8	2.6, 2.6	1.7	2.8, 2.9, 2.9	3.1	–	–
Tibiotarsus							
Maximum length	–	41.8	–	–	–	52.9	53.8 – 59.9 (n = 12)
Width of distal epiphysis	3.2 – 3.8 (n = 9)	3.4	–	5.1	4.6	–	–
Width of diaphysis at midpoint	1.6 – 1.7 (n = 5)	1.8	–	3.1	–	–	–
Tarsometatarsus							
Maximum length	28.0	–	27.9	–	–	37.2	39.3 – 42.1 (n = 12)
Width of diaphysis at midpoint	1.8 – 1.9 (n = 4)	–	1.9	–	–	–	–

Burhinidae Mathews, 1912
Burhinus Illiger, 1811
Burhinus oedicnemus (Linnaeus, 1758)

Cueva de los Piquetes (Tenerife) – Associate bones of the same individual, mostly burnt: fragments of cranium, str, cor sin, cor dex, hum dex pro-dis, hum sin pro-dis, uln sin pro-dis, uln dex pro, cmc sin, alar pha 1 dig majoris sin, ssc, fem sin, fem dex pro-dis, tbt dex, tbt sin dia-dis, tmt dex pro, tmt sin dis.

FALCONIFORMES Sharpe, 1874
Accipitridae Savigny, 1809
Hieraaetus Kaup, 1844
Hieraaetus pennatus (Gmelin, 1788)

Cueva del Curascán (El Hierro) – Locus 7: tbt dex dis.

STRIGIFORMES (Wagler, 1830)
Strigidae Leach, 1818
Asio Brisson, 1760
Asio otus (Linnaeus, 1758)

Cueva de los Piquetes (Tenerife) – Locus 7: scp dex cra, uln dex pro, uln sin dis, tbt sin pro, tbt dex pro.

COLUMBIFORMES (Garrod, 1874)
Columbidae (Illiger, 1811)
Columba Linnaeus, 1758
Columba livia Gmelin 1789 /
oenas Linnaeus 1758

Cueva de las Palomas (Fuerteventura) – Locus 13: scp sin juv, cor sin juv, hum dex pro juv, hum sin dis juv, uln dex pro juv, cmc sin dis juv, cmc sin pro juv, fem dex juv, fem sin dis juv, tbt dex pro juv (all bones apparently belonging to a single immature individual). Locus 14: str, cor sin, hum sin, uln sin, uln dex, rad dex, rad sin pro, cmc sin, pelvis fragments, ssc, fem dex, fem sin dia, tbt dex, tbt sin pro (again, all bones appear to belong to a single individual).

Columba sp.

Cueva de las Palomas (Fuerteventura) – Locus 12: str fragments, scp sin, uln dex dis, rad dex, alar pha 1 dig majoris dex, fem dex pro.

Cueva de Mauricio (El Hierro) – scp sin cra, cor sin cra, cor dex cra.

In a preliminary examination, some morphological differences between the aforementioned bones from Cueva de las Palomas and those of *C. livia* and *C. oenas* have been observed. The remains collected in Cueva de Mauricio are quite damaged, yet they seem to have morphological features similar to Cueva de las Palomas. The remains of these two caves will be studied in more detail shortly in a separate work.

PASSERIFORMES (Linnaeus, 1758)
Sturnidae Vigors, 1825
Sturnus Linnaeus, 1758
Sturnus sp.

Sima de la Hoyeta (El Hierro) – Fragments of cranium, mandible and str, scp sin, hum sin pro, uln sin, uln dex, fem sin dis, tbt dex pro, tbt sin dis. Some of these ascriptions are tentative.

Corvidae Leach, 1820
Corvus Linnaeus, 1758
Corvus corax Linnaeus, 1758

Sima de la Hoyeta (El Hierro) – Remains of a single individual: quadrate, mandible fragment, scp dex pro, cor, hum dex dispro, uln sin pro, uln dex pro, rad sin dis, cmc sin pro, cmc dex dis, frag. ssc, fem dex, fem sin pro, tbt dex pro, tbt sin dia, tmt sin pro, tmt dex pro, vertebrae.

Sima de Narciso (El Hierro) – A complete cranium, fem dex.

Cueva del Linke (El Hierro) – Locus 6: rostrum, cor dex, alar pha 1 dig majoris, tmt dex dis, vertebrae, pedal phalanges. Locus 8: cranium. Higher zone: quadrate, cor sin, str fragments, uln sin, fem dex, tbt dex.

Discussion

The relatively low number of small passeriforms found so far, compared with the significantly larger record of the Mediterranean islands (e.g., Alcover *et al*., 1992), is probably due to the different nature of the deposits. Fossilization processes are in general better guaranteed in karstic infillings than in volcanic tubes. It is clear that the list of the Canary avifauna from the past is still far from complete, despite the fact that there are many sites that have been studied in recent years.

In spite of a considerable lack of absolute dating, the fossilization state of the material and the stratigraphic contexts prompt us to consider that few of the reported localities consisting of volcanic tubes were deposited during the Pleistocene. Apparently, most of them are Holocene in age, which suggests that the Pleistocene climatic disturbances that could have affected the Canary Islands did not play a key role in any possible removal of birds. The late Pleistocene (Walker *et al*., 1990) record of *Puffinus holeae* is an exception. The huge number of remains of this shearwater found in a wide diversity of deposits in Fuerteventura is underlining important fisheries in this sector of the Canary Islands (Alcover and McMinn, 1995). The same fossil findings might indicate that global or regional climatic changes during the Pleistocene could have triggered the extinction of this species.

All current species in the Canaries are included in appendix 1, with the exception of rare, accidental or those clearly and recently introduced by humans. The current systematics and distribution of the subspecies within the Canarian blue tits takes into consideration the studies by Salzburger *et al*. (2002) and Dietzen *et al*. (2008). Likewise, a newly found subspecies of Goldcrest (Päckert *et al*., 2006) is included. In fact, appendix 1 contains a number of geographical subspecies recognized by comparative molecular analysis, with the aim to be the most conclusive, although this decision introduces an endemicity-bias in biogeographical features of the avian community.

Total entries in appendix 1 are 176, being three of them the dubious Miocene taxa from Órzola. Therefore, 173 taxa can be considered as a good approach to the Canarian Quaternary avifauna so far. Living Canary avian species plus endemic subspecies rise to 165, of which 92 breed in the archipelago. The number of current endemisms exclusive to the Canaries (including species and subspecies) is 35, which constitutes 38 % of nesting birds in the archipelago, and 21.2 % of all current taxa. Appendix 1 also incorporates all taxa discovered as fossils, a total of 39 to date. Eight of them are extinct or extirpated: (a) *Haliaeetus* sp., *Accipiter gentilis*; two taxa that can not be considered as belonging to the current Canary fauna because the few citations of their presence that exist are very doubtful (Martín and Lorenzo, 2001), (b) *Pterodroma* sp., which today is accidental and probably corresponds to individuals of *P. feae* or *P. madeira*, (c) five extinct endemic species: *Coturnix gomerae*, *Puffinus holeae*, *P. olsoni*, *Carduelis triasi* and *Emberiza alcoveri*, and (d) the somewhat dubious identifications of *Struthio* sp., Aepyornithidae and Odontopterygiformes (= Pelagornithidae). Thus, the Canarian Quaternary fossil record embraces 36 taxa. Note that all fossils have been identified up to the species level, with the exceptions of *Buteo buteo insularum* and *Tyto alba gracilirostris* from La Gomera (Jaume *et al*., 1993). The studies on skeletal morphology and morphometry of the implied taxa in this paper do not allow either referring fossils to subspecific categories or to previous subspecies recently risen to species categories. Thus, in spite of the fact that some entries in Appendix 1 are current subspecies, the related fossils are ascribed to the corresponding species category only, with the ex-

ceptions of the mentioned *B. b. insularum* and *T. a. gracilirostris*. Olson's shearwater may have become extinct after the arrival of the Europeans (Rando and Alcover, 2008), although the datings obtained in that work seem inconclusive. The rest of the endemic species included in item "c" undoubtedly became extinct before the first human arrivals. *Haliaeetus* and *Accipiter gentilis* constitute the only clear evidences of extirpated species from the archipelago. Consequently, the disappearance (extinctions plus Canarian extirpations) rate of species that can be attributed to palaeoclimatic or palaeobiotic factors, or to the action of the first human colonists, is approximately 22 % (the taxa from Órzola are not counted).

It would be inadequate to compare the rate of current endemic species with the rate of endemisms in the past owing to the usual incompleteness of the fossil record of land vertebrates, as well as to the fact that morphological characteristics on the skeleton can not always distinguish taxa established on genetic analysis, plumage patterns and morphological features on soft tissues. However, we can compare the disappearance rate of species in the Canaries with those from other islands or archipelagos. For example, in New Zealand (far larger than the Canaries), the extinction rate of endemic species from the arrival of humans reaches 41 %, and the disappearance rate of breeding species is 31 % (Worhty and Holdaway, 2002). In Hawaii, 50 % of birds became extinct in prehistoric times; in New Caledonia, 40 % of no-passeriforms; in the Marquesas, at least 39 % (Olson, 1990). Thus, for the moment it can be conjectured that the first settlers in the Canaries apparently did not exert a pressure on the avifauna they found as intense as exerted by human groups in other archipelagos.

A constant in the Mediterranean islands is the small number of extinct endemic species of birds (Tyrberg, 1988), as it is in the Canaries, which is contrary to what is known from most oceanic islands. Thus, some important differences stand out when comparing Canary avifauna with other oceanic islands, such as Chatham (Millener, 1999), Hawaii (Olson and James, 1982), islands of Oceania (Steadman, 1989; Steadman and Rolett, 1996; Steadman, 2006) or Mascarenes (Mourer-Chauviré *et al*., 1999): (i) the high number of current species in the Canary Islands, (ii) the small proportion of extinct endemic species, (iii) endemic forms do not increase their size nor do they become flightless –with the sole possible exception of the Alcover's Bunting *Emberiza alcoveri* (Rando *et al*., 1999), and (iv) a relatively low rate of disappearance, both prehistoric (before the arrival of Europeans) and historic. The Mediterranean region provides a similar pattern to some degree, apparently owing to the fact that all insular populations of Mediterranean birds are relatively close to those on the continents or receive contingents during migrations, which prevents these populations from becoming isolated and probably explains the few existing endemic species of birds. The Canary avifauna has been influenced, at least since the Late Pleistocene, by the major migratory route flowing along the western side of Africa. This factor has limited the isolation of their populations and, consequently, has precluded the speciation phenomena observed in birds on other oceanic islands (Steadman, 1986; Balouet and Olson, 1989; Sorenson *et al*., 1999; Olson and Wingate, 2001). Therefore, the low disappearance rate of avian taxa observed in the Canary Islands could be explained in part by the small number of insular forms, and also because the continuous arrival of European and African individuals prevented Canary bird populations to lose fear of humans, and so birds were never easy to hunt.

Most of the Canary waders are wintering species or are observed during winter or spring passes. Perhaps this is one of the reasons for the meagre fossil record of this group. The only two waders identified up to the species

level are the turnstone from El Hierro, and the specimen of stone curlew from Tenerife, which consists of some burnt bones of a single individual.

Órzola outcrop

Situated on the Famara cliffs, in the north of Lanzarote, fossil material was collected in a palaeodune, a layer of aeolian origin of variable thickness with a maximum of 7 meters, which is intercalated between two basaltic beds dated using the K/Ar method. The ages obtained were 6 Ma for the bottom layer and 5.3 Ma for the top one (Coello *et al*., 1992). Thus, the site documents just the beginning of the Miocene –chronological boundary between both epochs: 5.33 Ma (Gradstein *et al*., 2004).

Rothe (1964) and Sauer and Rothe (1972) found eggshells in Valle Grande and Valle Chico, two localities where this outcrop is exposed, attributed to *Struthio* and to an aepyornithid. Báez (1982 and 1992) expressed doubts about the latter identification and suggested that these eggs are a consequence of birds coming from individuals of a flying species that once arrived in insular conditions lost its flight abilities and increased in size. Subsequently, García-Talavera (1990) found new shells and a bone fragment in the fertile stratum of Órzola, and tentatively attributed all the remains to an odontopterygiform (= Pelagornithidae). According to Alcover and McMinn (1995), the five complete eggs found so far do not appear to belong to the ratites.

Eggshells found in several localities of northern Africa have been attributed to the ichnotaxon *Psammornis* (Rich, 1974, Sauer and Sauer, 1978). Morphological patterns similar to those observed in Aepyornithidae have been mentioned regarding these shells. Michailov and Kurochkin (1988) reviewed some of this material, and assigned it to two morphological groups, both present in the eggshells of *Struthio* (see discussion in Mlíkovský, 2003). This fact may explain the most likely incorrect attribution by Rothe (1964) and Sauer and Rothe (1972) of Lanzarote eggshells to an aepyornithid. On the other hand, the assignation of some shells and one bone fragment to Odontopterygiformes by García-Talavera (1990) must be reevaluated once the fossil material being described and compared. The only picture of the bone fragment (García-Talavera, 1990, fig. 4) shows that it has no diagnostic features. Therefore, the presence of Odontopterygiformes in the Canaries needs to be confirmed by new conclusive evidence.

The arrival of *Struthio* to Lanzarote may not be ruled out at the moment. Clearly, the putative presence of ostriches in the Canary Islands results in a very interesting biogeographical problem, as it should involve a land connection between these volcanic islands and the African continent before the beginning of the Pliocene, which apparently is not supported by regional geologic studies. It would be strongly advisable to re-study eggshells from Órzola - Famara and to look for fossil bones to solve this question.

Canary quail

New findings of *Coturnix gomerae* in Fuerteventura (table 1, appendix 1) support the idea that this extinct endemic species spread throughout all islands of the archipelago. It is common at the sites of the first human settlements. No doubt it was a part of the diet of these early human populations (Rando and Perera, 1994), and hunting of it was probably one of the main factors that lead to its demise. The data collected so far suggests that the Canary quail became extinct during the occupation of the islands by the first humans. The common quail *Coturnix coturnix*, currently nesting in the archi-

pelago does not appear in the fossil record, thus their arrival in the Canary Islands has to be very recent, apparently after that of the Europeans, although not necessarily like a man-introduced species.

White-faced storm-petrel

Pelagodroma marina currently nests at Montaña Clara, a small island north of Lanzarote, probably also in two other nearby islands, La Graciosa and Alegranza, and at the islet of Lobos, north of Fuerteventura (Martín and Lorenzo, 2001). Its discovery at the sinkhole locality (El Hierro) places it at the other end of the archipelago at some point in the past, although it cannot be excluded that such an occurrence was caused by the capture of a passing individual by a raptor or during site prospection prior to breeding.

Manx shearwater

The finding of a large number of *Puffinus puffinus* bone deposits in two El Hierro localities confirms its presence in the past in the Canary Islands. Previously, only one bone had been found in a late Pleistocene wind deposit in southern Fuerteventura (Sánchez Marco, 2003). This fact bears palaeobiogeographic and palaeoclimatic interest because, at present, the Canary Islands are the southern boundary of the breeding area of this species (Martín and Lorenzo, 2001).

Little shearwater

Puffinus assimilis has been found in three El Hierro localities and in the Lobos islet. Immature individuals have been found only in Lobos. Previously, this species had been identified with doubts –cf. *Puffinus assimilis* in La Aldea site (Gran Canaria) (Alcover and Florit, 1989). Its presence in western and eastern ends of the archipelago suggests that the species spread during late Pleistocene/Holocene over the whole of the Canaries, in a similar way as it is today.

Lava or Olson's shearwater

This shearwater, *Puffinus olsoni*, was originally described on bones from Lanzarote and Fuerteventura (McMinn *et al*., 1990). Its remains are abundant at sites in lava fields on both mentioned islands and on Lobos islet (Rando and Alcover, 2008). New findings of this species on the latter, along with its absence from rich deposits in the other islands, suggest that this species might require some particular environmental condition unique to the eastern islands for its existence.

Hole's shearwater

Puffinus holeae has been found so far in Lanzarote and Fuerteventura (table 1, appendix 1). It was likewise identified in the Portuguese locality of Figueira Brava (Mourer-Chauviré and Antunes, 1991 and 2000) on the basis of a few bones, mostly incomplete, in layers dating from around 30,500 years BP. This identification relies on the idea that this shearwater is intermediate in size between the sooty shearwater *P. griseus* on one hand and yelkouan shearwater *P. yelkouan* or Balearic shearwater *P. mauretanicus* on the other –*yelkouan* and *mauretanicus* are osteologically indistinguishable each other. This conception was based on rather limited osteometrical data in the original description of this species (Walker *et al*., 1990). In fact, *Puffinus holeae* is not intermediate-sized among mentioned shearwaters, in either all the bones or all the parameters normally used (Sánchez Marco, 2003). Hole's Shearwater populations were

probably very large on Fuerteventura as there are a huge number of skeletal remains in aeolian sediments throughout the south of the island (Alcover and McMinn, 1995; Rando, 2003).

Bulwer's petrel

Bulweria bulwerii is a widely distributed species in the Canaries today. It was found in the Guinea locality of El Hierro (Rando *et al*., 1997). The new finding in Lobos, on the other side of the archipelago seems to prove a wide distribution in the past.

Turnstone

Until now this species had not been found in Canary deposits, but its occurrence in El Hierro is not surprising because, at present, *Arenaria interpres* is the most abundant wintering wader and reaches all the islands (Martín and Lorenzo, 2001).

Stone curlew

Two endemic subspecies of *Burhinus oedicnemus* are recognized in the Canary Islands today, one in the eastern islands and another in the rest of the archipelago.

Booted eagle

At present, some individuals of *Hieraaetus pennatus* are seen through the eastern islands and Tenerife during migration. In the western islands, they are less frequent. The bone fragment that appears in Curascán cave (El Hierro) is the first finding of this eagle in the Canary record. It can not be excluded this finding was related with wind-drifted birds from the African coast.

Long-eared owl

The fossil remains from Tenerife are the only occurrence of *Asio otus* so far. Its appearance here is consistent with the abundance and wide distribution of this species now on this island. Its current presence in La Gomera, El Hierro and La Palma had gone unnoticed until very recently, and it is absent from Lanzarote and Fuerteventura (Martín and Lorenzo, 2001).

Pigeons

Most of the remains studied in this work are indistinguishable from *Columba livia* and *Columba oenas*. Some of them might belong to any of the endemic Canarian pigeons, but further study is required to confirm this point. The phylogenetic relationships of *Columba junoniae* and *Columba bollii* as well as their differentiation over time are among the most interesting topics to be solved. However, in addition to taxonomic and systematic studies, a plan is required for direct radiometric dating of fossils to address one of the weakest aspects of the avian fossil record of the Canary Islands.

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APPENDIX 1 *[APÉNDICE 1]*

List of birds of Canary Islands (anthropogenic introductions, vagrant and very rare species are excluded). Islands: L- Lanzarote, F- Fuerteventura, Lo- Lobos islet, GC- Gran Canaria, T- Tenerife, G- La Gomera, H- El Hierro, P- La Palma, (*)- islet close to the corresponding isle, (**)- islands with new fossil record for the corresponding taxon. Status: N- resident, I- winter visitor, P- passage visitor. Endemisms: ce- (current) Canarian endemism, me- (current) Macaronesian endemism, ece- extinct Canarian endemism.

[Lista de aves de las islas Canarias (se excluyen las introducciones antropogénicas, errantes y especies muy raras). Islas: L- Lanzarote, F- Fuerteventura, Lo- islote de Lobos, GC- Gran Canaria, T- Tenerife, G- La Gomera, H- El Hierro, P- La Palma, (*)- islote próximo a la isla correspondiente, (**)- isla con nuevo registro fósil para su correspondiente taxón. Estatus: N- residente, I- visitante invernal, P- visitante de paso. Endemismos: ce- (actual) endemismo canario, me- (actual) endemismo macaronésico, ece- endemismo canario extinguido.]

Birds recorded in Canary islands	**Current status and current and historical distribution**	**Islands with fossil and subfossil record**
Struthio sp.	–	L
Aepyornithidae indet.	–	L (doubtful identification)
Odontopterygiformes indet. (= Pelagornithidae)	–	L (doubtful identification)
Bulweria bulwerii	N (L, Lo, T, G, H, P)	Lo**, H
Pterodroma sp.	–	H
Calonectris diomedea borealis (me)	N (L, F, Lo, GC, T, G, H, P)	L, F, Lo**, H, P
Puffinus puffinus	N (T, P)	F, H**
Puffinus assimilis baroli (me)	N (L, T, G, P)	Lo**, GC (cf. *P.a.*), H**
Puffinus gravis	P (L, GC, T, G, P)	–
Puffinus holeae (ece)	–	L, F
Puffinus olsoni (ece)	–	L, F, Lo
Pelagodroma marina hypoleuca (me)	N (L*)	H** (*P. m.*)
Hydrobates pelagicus	N (Lo, T*, G, H)	–
Oceanodroma castro	N (L, Lo, T*, H*)	H
Phaethon aethereus	N (G)	–
Morus bassanus	P-I (L, F)	–
Ixobrychus minutus	N (T)	–
Nycticorax nycticorax	P-I (L, F, GC, T)	–
Bubulcus ibis	N (L)	–

APPENDIX 1 *[APÉNDICE 1]* (cont.)

Birds recorded in Canary islands	**Current status and current and historical distribution**	**Islands with fossil and subfossil record**
Egretta garzetta	N (L)	–
Ardea cinerea	N (L, F, GC, T)	–
Ardea purpurea	P-I (L, F)	–
Plegadis falcinellus	P-I (L)	–
Platalea leucorodia	P-I (L, F, GC, T)	–
Anas penelope	I (L, T)	–
Anas crecca	I (L, F, GC, T)	–
Marmaronetta angustirostris	N (F, GC)	–
Aythya ferina	I (GC, T)	–
Aythya collaris	I (T)	–
Aythya fuligula	I (T)	–
Milvus migrans	P (L, F)	–
Milvus milvus	N (GC, T, G, H)	–
Haliaeetus albicilla	–	L, F (*Haliaeetus* sp.)
Neophron percnopterus	N (L, F, GC, T, G)	G
Circus aeruginosus	P-I (L, F, GC, T)	–
Accipiter gentilis	–	H
Accipiter nisus granti (ce)	N (GC, T, G, H, P)	T, GC
Buteo buteo insularum (ce)	N (L, F, GC, T, G, H, P)	L, T, GC, G, H, P
Hieraaetus pennatus	P-I (L, F, T)	H**
Pandion haliaetus	N (L, F, Lo, GC, T, G, H, P)	–
Falco tinnunculus dacotiae (ce)	N (L, F, Lo)	–
Falco tinnunculus canariensis (me)	N (GC, T, G, H, P)	GC, G, P
Falco eleonorae	N (L, F)	–
Falco pelegrinoides	N (L, F, GC, T, G, H, P)	–
Coturnix coturnix confisa (me)	N (L, F, GC, T, G, H, P)	–
Coturnix gomerae (ece)	–	F**, GC (*Coturnix* sp.), T, G, H, P

APPENDIX 1 *[APÉNDICE 1]* (cont.)

Birds recorded in Canary islands	**Current status and current and historical distribution**	**Islands with fossil and subfossil record**
Porzana porzana	P-I (F, T)	–
Porzana parva	P (L, F, T)	–
Gallinula chloropus	N (F, GC, T, G, P)	–
Fulica atra	N (F, GC, T, G)	–
Chlamydotis undulata fuertaventurae (ce)	N (L, F, Lo)	T (*C. u.*)
Haematopus ostralegus	P (L, F)	–
Haematopus meadewaldoi (ce)	N (L, L*, F)	–
Himantopus himantopus	N (L, F, GC)	–
Recurvirostra avosetta	P (L, F, GC, T)	–
Burhinus oedicnemus insularum (ce)	N (L, F, Lo)	–
Burhinus oedicnemus distinctus (ce)	N (GC, T, G, H, P)	T**
Cursorius cursor	N (L, F, GC)	–
Glareola pratincola	P (L, F, GC, T)	–
Charadrius dubius	N (F, GC, T)	–
Charadius hiaticula	I-P (L, F, Lo, GC, T, G, H, P)	GC (*Charadrius* sp.)
Charadrius alexandrinus	N (L, F, Lo, GC, T)	–
Pluvialis apricaria	I-P (L, F, GC, T)	–
Pluvialis squatarola	I-P (L, F, Lo, GC, T, G, H, P)	–
Vanellus vanellus	I-P (L, F, GC, T, G, H, P)	–
Calidris canutus	I-P (L, F, GC, T)	–
Calidris alba	I-P (L, F, Lo, GC, T, G, H, P)	–
Calidris minuta	I-P (L, F, GC, T)	–
Calidris ferruginea	P (L, F, GC, T)	–
Calidris alpina	I-P (L, F, GC, T)	–
Philomachus pugnax	I-P (L, F, GC, T)	–
Gallinago gallinago	I-P (L, F, GC, T)	–
Scolopax rusticola	N (GC, T, G, H, P)	–

APPENDIX 1 *[APÉNDICE 1]* (cont.)

Birds recorded in Canary islands	**Current status and current and historical distribution**	**Islands with fossil and subfossil record**
Limosa limosa	I-P (L, F, GC, T)	–
Limosa lapponica	I-P (L, F, GC, T)	–
Numenius phaeopus	I-P (L, F, GC, T, G, H, P)	–
Numenius arquata	I-P (L, F, GC, T)	–
Tringa erythropus	I-P (L, F, GC, T)	–
Tringa totanus	I-P (L, F, GC, T, P)	–
Tringa nebularia	I-P (L, F, GC, T)	–
Tringa ochropus	I-P (L, F, GC, T)	–
Tringa glareola	I-P (L, F, GC, T)	–
Actitis hypoleucos	I-P (L, F, GC, T, G, H, P)	–
Arenaria interpres	I-P (L, F, GC, T, G, H, P)	H**
Catharacta skua	P (L, F, GC, T, G, H, P)	–
Larus ridibundus	I-P (L, F, GC, T, G)	–
Larus fuscus	I-P (L, F, GC, T, G)	–
Larus cachinnans atlantis (me)	N (L, F, GC, T, G, H, P)	H (*Larus* sp.)
Sterna sandvicensis	I-P (L, F, GC, T, G)	–
Sterna dougallii	N (H)	–
Sterna hirundo	N (L, F, GC, T, G, H, P)	–
Pterocles orientalis	N (L, F, GC)	–
Columba livia	N (L, F, Lo, GC, T, G, H, P)	L, F** (*Columba livia/oenas*), GC (*Columba* sp.), T (*Columba* sp.), H (*Columba* sp.), P (*Columba* sp.)
Columba bollii (ce)	N (GC?, T, G, H, P)	
Columba junoniae (ce)	N (T, G, P)	G, P
Streptopelia decaocto	N (L, F, GC, T, G, H, P (very recently)	–
Streptopelia turtur	N (L, F, GC, T, G, H, P)	–

APPENDIX 1 *[APÉNDICE 1]* (cont.)

Birds recorded in Canary islands	**Current status and current and historical distribution**	**Islands with fossil and subfossil record**
Cuculus canorus	P (L, F, GC, T, G, H, P)	–
Tyto alba alba	N (GC, T, G, H, P)	GC (*Tyto* sp.), P (*T.*cf.*a.*)
Tyto alba gracilirostris (ce)	N (L, F, Lo)	G
Asio otus canariensis (ce)	N (GC, T, G, H, P)	T**
Apus melba	P (L, F, GC, T, G, H, P)	–
Apus unicolor (me)	N (L, F, GC, T, G, H, P)	–
Apus apus	N (L, GC, T)	–
Apus pallidus	N (L, F, GC, T, G, H, P)	–
Merops apiaster	P (L, F, GC, T, G)	–
Coracias garrulus	P (L, F, GC, T)	–
Upupa epops	N (L, F, GC, T, G, H, P)	–
Dendrocopos major canariensis (ce)	N (T)	–
Dendrocopos major thanneri (ce)	N (GC)	–
Calandrella rufescens rufescens (ce)	N (T)	–
Calandrella rufescens polatzeki (ce)	N (L, F, Lo, GC)	–
Alauda arvensis	I (L, F, GC, T, G, H, P)	–
Riparia riparia	P (L, F, GC, T)	–
Hirundo rustica	N (GC)	–
Hirundo daurica	P (L, F, GC, T, G)	–
Delichon urbica	P-I (L, F, GC, T, G, H, P)	–
Anthus campestris	P-I (L, F, GC, T)	–
Anthus berthelotii (me)	N (L, F, Lo, GC, T, G, H, P)	F
Anthus trivialis	P-I (L, F, GC, T)	–
Anthus pratensis	P-I (L, F, GC, T)	–
Motacilla flava	P (L, F, GC, T, G, H, P)	–
Motacilla cinerea canariensis (ce)	N (GC, T, G, P)	–
Motacilla alba	I (L, F, GC, T, G, H, P)	–
Erithacus rubecula superbus (ce)	N (GC, T)	–

APPENDIX 1 *[APÉNDICE 1]* (cont.)

Birds recorded in Canary islands	**Current status and current and historical distribution**	**Islands with fossil and subfossil record**
Erithacus rubecula rubecula	N (G, H, P)	–
Phoenicurus ochruros	P (L, F, GC, T)	–
Phoenicurus phoenicurus	P (L, F, GC, T)	–
Saxicola rubetra	P (L, F, GC, T)	–
Saxicola dacotiae dacotiae (ce)	N (F)	–
Oenanthe oenanthe	P (L, F, GC, T, G, H, P)	–
Turdus merula cabrerae (me)	N (GC, T, G, H, P)	F (*Turdus* sp.), GC, T (*Turdus* sp.), G (*Turdus* sp.)
Turdus philomelos	I (L, F, GC, T, G)	–
Hippolais pallida	P (L, F, GC, T)	–
Hippolais polyglotta	P (L, F)	–
Sylvia conspicillata orbitalis (me)	N (L, F, Lo, GC, T, G, H, P)	–
Sylvia cantillans	P (L, F, GC, T)	–
Sylvia melanocephala leucogastra (ce)	N (GC, T, G, H, P)	–
Sylvia melanocephala melanocephala	N (L, F)	–
Sylvia communis	P-I (L, F, GC, T)	–
Sylvia borin	P-I (L, F, GC, T)	–
Sylvia atricapilla	N (L, F, GC, T, G, H, P)	F (*S.*cf.*a.*)
Phylloscopus sibilatrix	P (L, F)	–
Phylloscopus collybita canariensis (ce)	N (GC, T, G, H, P)	–
Phylloscopus collybita exsul	N (L, F)	–
Phylloscopus trochilus	P (L, F, GC, T)	–
Regulus regulus teneriffae (ce)	N (T, G)	–
Regulus regulus ellenthalerae (ce)	N (H, P)	–
Muscicapa striata	P (L, F, GC, T)	–
Ficedula hypoleuca	P (L, F, GC, T)	–

APPENDIX 1 *[APÉNDICE 1]* (cont.)

Birds recorded in Canary islands	**Current status and current and historical distribution**	**Islands with fossil and subfossil record**
Parus teneriffae ultramarinus (ce)	N (L, F)	–
Parus teneriffae teneriffae (ce)	N (T, G)	–
Parus teneriffae hedwigii (ce)	N (GC)	–
Parus teneriffae palmensis (ce)	N (P)	–
Parus teneriffae ombriosus (ce)	N (H)	–
Lanius excubitor koenigi (ce)	N (L, F, GC, T)	–
Lanius senator	P (L, F, GC, T)	–
Pyrrhocorax pyrrhocorax	N (P)	T, G, H (cf. *P.p.*), P
Corvus corax	N (L, F, Lo, GC, T, G, H, P)	GC, G, H
Sturnus vulgaris	N (GC, T), I (L, F, GC, T, G, H, P)	H** (*Sturnus* sp.)
Passer hispaniolensis	N (L, F, Lo, GC, T, G, H, P)	–
Petronia petronia	N (GC, T, G, H, P)	–
Fringilla coelebs canariensis (ce)	N (GC, T, G)	–
Fringilla coelebs ombriosa (ce)	N (H)	–
Fringilla coelebs palmae (ce)	N (P)	–
Fringilla teydea teydea (ce)	N (T)	–
Fringilla teydea polatzeki (ce)	N (GC)	–
Serinus canarius (me)	N (L, F, GC, T, G, H, P)	–
Carduelis triasi (ece)	–	P
Carduelis chloris	N (F, GC, T, G, H)	G
Carduelis carduelis	N (L, F, GC, T, G, H, P)	–
Carduelis cannabina meadewaldoi (ce)	N (GC, T, G, H, P)	–
Carduelis cannabina haterti (ce)	N (L, F, Lo)	–
Bucanetes githagineus	N (L, F, Lo, GC, T, G)	–
Emberiza alcoveri (ece)	–	T
Miliaria calandra	N (L, F, GC, T, G, H, P)	–